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DEPARTMENT OF BIOLOGICAL AND ENVIRONMENTAL SCIENCES

MAKING BIODIVERSITY VISIBLE: SPECIES REPRESENTATION ON SIGNS IN VÄSTRA GÖTALAND'S NATURE RESERVES

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Degree project for Master of Science (120 hec) with a major in Biology
BIO796 Degree project Conservation biology (45 hec)
Second cycle
Semester/year: Autumn 2025- Spring 2026
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ABSTRACT

Interpretive signs in nature reserves are an important on-site communication tool for conveying ecological knowledge to visitors and fostering connections between people and nature. However, little empirical research exists on what ecological information these signs convey and how well this communication aligns with visitor interests. This study examines biodiversity communication on interpretive signs in nature reserves in Västra Götaland, Sweden. A mixed-methods approach combined a visitor survey with a systematic content analysis of 300 signs. The survey, conducted via QR codes placed on signs across 16 reserves, assessed visitor interests and motivations for nature conservation using predominantly Likert-scale questions. Respondents (n = 122) were mainly frequent visitors to nature reserves and were predominantly over 45 years old. Overall, interest in ecological information was high, as well as the importance of nature conservation was rated very highly. The signage analysis recorded ecological content and interpretation tools to capture not only what information is communicated but also how it is presented. In total, 4,444 species occurrences representing 1,265 distinct species were identified, with plants being the most frequently presented group and also appearing most often in illustrations. However, relative to text occurrences, invertebrates were proportionally more illustrated. A good practice example is oaks (*Quercus* spp.), which appeared on nearly one-third of the signs and effectively linked species presentation with broader biodiversity explanations. Temporal analyses revealed shifts in communication strategies: texts have become longer while readability indices decreased, the number of illustrations and species mentioned per sign declined, and the use of interpretation tools increased. Overall, the patterns identified in the signage analysis largely corresponded with visitor interests expressed in the survey. The study highlights strengths and limitations of current interpretive practices and suggests that emphasizing ecological connections and effective interpretation tools could improve nature conservation communication.

Sammanfattning (Svenska)

Informationsskyltar i naturreservat är ett viktigt kommunikationsverktyg på plats för att förmedla ekologisk kunskap till besökare och stärka relationen mellan människor och natur. Trots detta finns begränsad empirisk forskning om vilken information som förmedlas och hur väl den överensstämmer med besökarnas intressen. Denna studie undersöker hur biologisk mångfald kommuniceras på informationsskyltar i naturreservat i Västra Götaland, Sverige. En mixed-methods-ansats kombinerade en besökarundersökning med en systematisk innehållsanalys av 300 skyltar. Enkäten, genomförd via QR-koder i 16 reservat, undersökte besökarnas intressen och motivationer för naturvård med främst Likertskalefrågor. Respondenterna (n = 122) var huvudsakligen frekventa besökare och över 45 år. Intresset för ekologisk information var högt och naturvård värderades mycket högt. Skyltanalysen registrerade ekologiskt innehåll och tolkningsverktyg för att fånga både vad som kommuniceras och hur. Totalt identifierades 4 444 artförekomster (1 265 unika arter), där växter dominerade både i text och illustrationer. Ryggradslösa djur var dock proportionellt oftare illustrerade i förhållande till textförekomster. Ekar (*Quercus* spp.) utgör ett exempel på god praxis genom att effektivt koppla artpresentation till bredare förklaringar av biologisk mångfald. Tidsanalyser visade förändringar i kommunikationsstrategier: texterna har blivit längre samtidigt som läsbarheten ökat, medan antalet illustrationer och arter per skylt minskat och användningen av tolkningsverktyg ökat. Mönstren i skyltanalysen överensstämde i stor utsträckning med besökarnas intressen. Studien belyser styrkor och begränsningar i nuvarande tolkningspraxis och visar att ett ökat fokus på ekologiska samband och effektiva tolkningsverktyg kan förbättra kommunikationen om biologisk mångfald och naturvård.

INTRODUCTION

Nature connectedness

Human societies are increasingly characterized by a growing distance from the natural world. In many countries, urbanization, digitalization, and lifestyle changes have reduced opportunities for direct experiences with natural environments (Bratman et al 2019, Ives et al 2018). As a result, levels of nature connectedness, a psychological construct capturing an individual's emotional, cognitive, and experiential relationship with nature, are declining (McEwan et al., 2019; Richardson et al., 2022; Soga & Gaston, 2016). Lower nature connectedness is associated with reduced pro-environmental behaviors, weaker support for conservation initiatives, diminished willingness to engage in biodiversity protection, and poorer mental health outcomes, such as higher stress levels and reduced well-being (Barragan-Jason et al., 2022; Martin et al., 2020; Mayer & Frantz, 2004; Rosa et al., 2018).

Loss of biodiversity

At the same time, biodiversity itself is under increasing pressure. Across the globe, species populations are declining at an alarming rate, primarily due to anthropogenic drivers such as habitat loss, pollution, climate change, and overexploitation (IPBES 2019). These trends highlight the central role that humans play, not only as causes of biodiversity loss, but also as potential agents of change and reverse the trend. Compounding this challenge is a documented decline in people's ability to identify species (Lindemann-Matthies, 2002; Páll-Gergely et al., 2024; Straka et al., 2025). Species knowledge is not only a foundation of ecological literacy but also a gateway to meaningful connections with local biodiversity; when this knowledge erodes, opportunities to build and sustain nature connectedness are diminished (Bashan et al., 2021). If conservation goals are to be achieved, it is essential to foster awareness and understanding of biodiversity among the general public (IPBES et al., 2019). This requires communication strategies that not only transfer knowledge but also strengthen people's personal connection to nature.

Nature reserves

One way to strengthen the connection to nature is to experience nature, for example by visiting protected natural areas. In Sweden, nature reserves are established under the Environmental Code with the aim of preserving biodiversity and providing opportunities for recreation (The Swedish Environmental Code (Ds 2000:61), 1998). These areas therefore serve a dual function: they safeguard ecological values while simultaneously offering people the chance to engage with nature in everyday life. By allowing visitors to encounter species, ecosystems, and landscapes firsthand, nature reserves create opportunities for experiences that can increase knowledge, evoke emotional responses, and strengthen nature connectedness (Barragan-Jason et al., 2022; Pocock et al., 2023; Zylstra et al., 2014).

Visitor experience

One approach to enhance the experience of visiting natural areas is through interpretation (S. H. Ham & Weiler, 2007; Hwang et al., 2005; Munro et al., 2008). Ham (2014) defines interpretation as "a mission-based approach to communication aimed at provoking in audiences the discovery of personal meaning and the forging of personal connections with things, places, people, and concepts." Rooted in the principles of thematic interpretation, this approach goes beyond the mere transmission of factual information. It emphasizes the importance of creating meaningful connections between new content and the visitors' pre-existing values, beliefs, and experiences, ultimately fostering deeper engagement with the natural environment. Well-designed interpretive materials (e.g. leaflets, signs, guides) can spark curiosity, encourage learning, and foster a sense of relevance by linking ecological knowledge to personal and societal contexts (Hughes & Morrison-Saunders, 2002; Hwang et al., 2005). They thereby enrich recreational experiences while simultaneously strengthening environmental awareness and conservation support (S. H. Ham, 1992; Hughes & Morrison-Saunders, 2005; Ismail, 2006; Munro et al., 2008).

Interpretation

Among the different forms of interpretation, signage plays a particularly important role. Interpretive signs are present in nature reserves year-round, accessible to all visitors, and relatively cost-effective compared to other communication formats. Positioned directly in natural settings, they allow visitors to connect what they read with what they observe, thus embedding learning within lived experience. Well-designed panels can enrich the visitor experience and recreational value of an area (Colquhoun, 2005; S. H. Ham & Weiler, 2007; Ismail, 2008; Koo et al., 2013), create a more meaningful connection between visitors and the site they explore (Hughes & Morrison-Saunders, 2005; Hwang et al., 2005; Munro et al., 2008), and help foster positive environmental attitudes, support for conservation, and the development of species identification skills (S. H. Ham, 1992; Hughes & Morrison-Saunders, 2005; Ismail, 2008; Jensen, 2006; Munro et al., 2008).

For effective and successful interpretation, research recommends the integration of different means: relevant content that links information directly to the site and its ecological or cultural significance (Ballantyne & Hughes, 2003; S. Ham, 2014; Hwang et al., 2005; Marschall et al., 2017; Tilden, 1957); accessible language that is easy to read and free from unnecessary jargon (Janeczko et al., 2021; Wandersee & Clary, 2007) and visual media (including clear design, imagery, and other graphical elements) to attract attention, aid understanding, and enhance retention of information (Janeczko et al., 2021; Jensen, 2006; Lundin, 2003; Zhu et al., 2021).

Study area

While these means are broadly applicable, their impact is shaped by local cultural and environmental factors. In regions where outdoor recreation is a central part of daily life, interpretive signage can be especially effective. Sweden offers a compelling case, with a strong tradition of *friluftsliv* (outdoor life) alongside widely accessible protected natural areas. Nationwide, there are around 15 000 protected nature areas, whereas around 5 700 of them are nature reserves, covering more than 4.3 million hectares (*Skyddad Natur*, 2025). The study area, Västra Götaland County, alone contains 536 reserves, encompassing approximately 83 000 hectares (*Skyddad Natur*, 2025). This highlights both the opportunities and responsibilities of interpretive communication: signs placed in these reserves reach a broad audience and have considerable potential to promote biodiversity awareness and connectedness. Despite the prevalence of interpretive signage across numerous reserves, there is a lack of empirical knowledge regarding the messages conveyed and the information visitors are most interested in. Examining the Swedish case therefore not only generates insights for local practice but also offers lessons that may inspire conservation communication in other contexts.

Aim of study

The present study addresses this need by combining a content analysis of interpretive signage with a visitor survey in protected areas of Västra Götaland. Specifically, it evaluates three dimensions of signage effectiveness: the relevance of content (assessed in relation to visitor interests and conservation values), the representation of ecological information (e.g. species representation), and the interpretation tools used to convey these information.

This leads to the following research questions (RQ):

RQ1: What topics and conservation issues are visitors interested in, and what values underlie their attitudes toward nature conservation?

RQ2: How are species, ecosystems, and biodiversity represented on interpretive signs, and to what extent are ecological links communicated?

RQ3: To what extent do existing interpretive signs align with visitor interests and conservation values?

By integrating these elements, the study adopts a holistic perspective on interpretive communication. Rather than focusing solely on information content or exclusively on visitor perceptions, it brings together multiple dimensions that collectively influence how people engage with interpretive signage. This approach makes it possible to highlight both strengths and weaknesses of current practice and to identify opportunities for improvement. This project contributes to the following Sustainable Development Goals: Quality education, life below water and life on land (United Nations, 2015).

METHODS

The study employed a mixed-methods approach, combining quantitative and qualitative data to provide a comprehensive understanding of visitor interests and the content of interpretive signage. This combination of a visitor survey and a systematic signage analysis allowed for the examination of both audience perspectives and the ecological and interpretive quality of signs, thereby linking human perceptions with the information presented in nature reserves.

Survey

Data collection

The survey was conducted in nature reserves in the county of Västra Götaland, Sweden and was accessible from beginning of July to beginning of October in 2025 exclusively via QR codes placed on interpretive signs in the reserves. The goal of this survey was to capture general visitor interests, preferences, and attitudes toward interpretive signage in nature reserves, particularly in relation to species information, ecological content, and conservation themes. A total of 47 QR codes were placed across 16 nature reserves in Västra Götaland, selected to ensure a representative coverage of different habitat types, reserve sizes, and accessibility from urban areas. Specifically, the selection included 3 coastal, 1 river, 3 lake, 5 forest-and-lake, and 4 forest-only reserves; 12 of the reserves were relatively remote, located outside the central public transport zones and at least 30 km from Gothenburg, while 4 were closer to the city (Figure 1). Reserve sizes ranged from under 500 ha (6 reserves), between 500 and 1500 ha (4 reserves), to over 1500 ha (6 reserves).

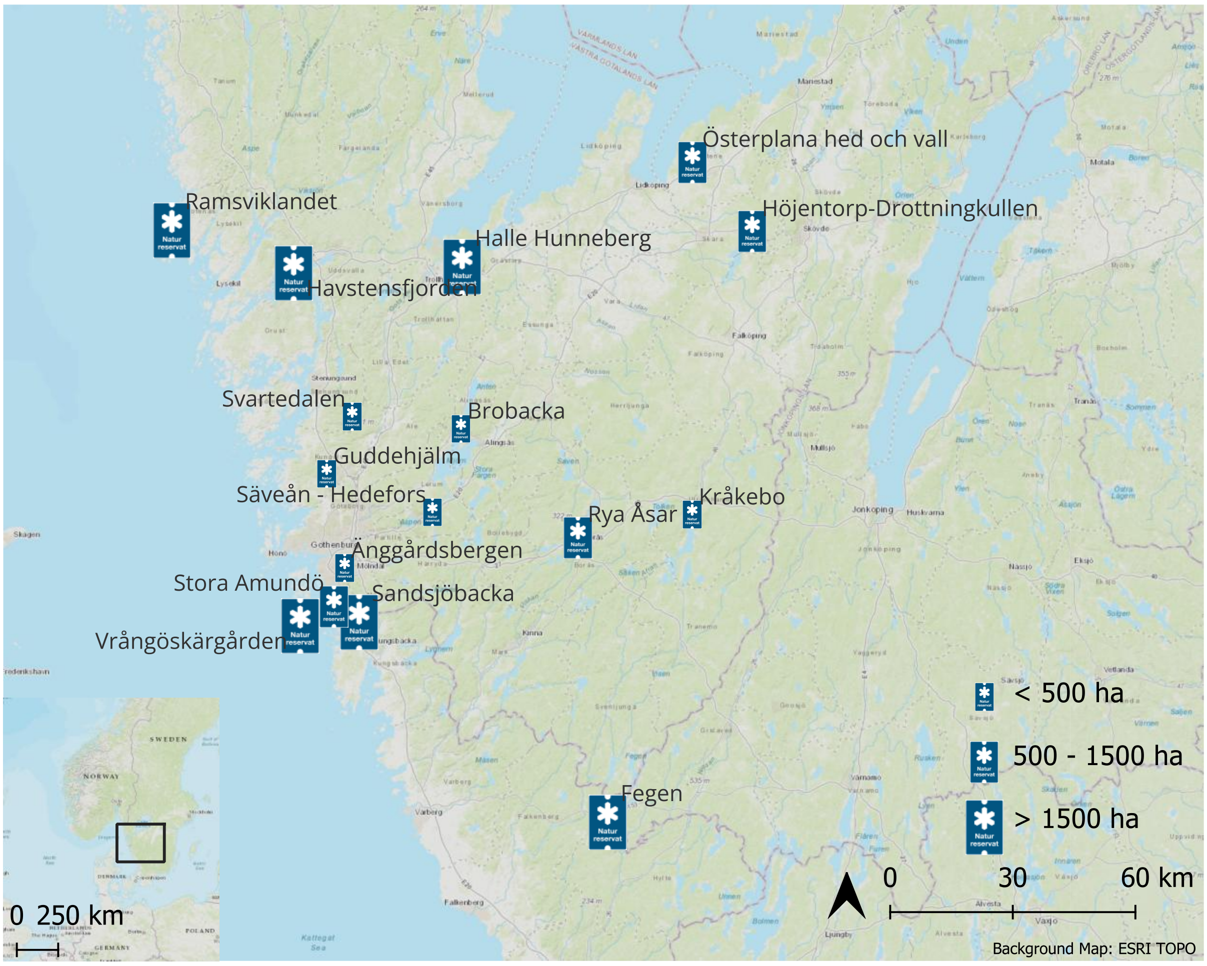

Figure 1. Overview over the different reserves. Created with QGIS. (QGIS Development Team, 2026).

The survey (Table A1) consisted of 12 questions designed to capture visitors preferences and attitudes regarding biodiversity communication. Quantitative assessments were primarily conducted using a 5-point Likert scale, where a value of 1 represented the lowest level (e.g. "not interested at all") and a value of 5 represented the highest (e.g. "very interested"). To obtain a more nuanced understanding of visitors perspectives, these quantitative measures were supplemented by optional open-ended questions, allowing for the collection of qualitative feedback.

The survey was structured into three thematic blocks to generate distinct datasets for analysis. The first section focused on information preferences, aiming to identify interest of reserve visitors. This section assessed the general interest in various content types (e.g. maps, regulations, local history). It also measured interest across different groups of organisms (e.g., mammals, birds, insects), and differences in interest between common / uncommon species. Following this, the second section explored the underlying motivations for nature conservation using conditional logic. By distinguishing between intrinsic values (nature's inherent right to exist) and anthropocentric benefits (ecosystem services like pollination or recreation), this section provided a nuanced basis for understanding how visitors relate to nature conservation. Finally, in the third part of the survey, participants provided direct feedback on the specific sign they encountered through a 5-star rating and an open-ended suggestion field. The survey concluded with demographic questions regarding age, gender, and the frequency of visits to nature reserves.

Responses were treated anonymously and stored in compliance with the EU General Data Protection Regulation (GDPR, Directive 2007/2/EC (INSPIRE), 2007).

Data analysis

All statistical analyses were conducted in R version 4.3.3 (R Core Team, 2025). Descriptive statistics, including means and standard deviations, were computed for scaled and closed endend questions. Qualitative responses were analyzed by categorizing open-ended comments into thematic groups (e.g., comments on maps, rules, or other aspects of signage) to identify recurring patterns and insights. The analysis was performed across all responses collectively to maintain sufficient sample sizes and ensure meaningful interpretation. A paired Wilcoxon signed-ranked test was conducted for respondents' interest in common and uncommon species, as responses represented a clear and meaningful distinction. Other survey items showed only minor differences in response levels, and statistical testing was therefore not pursued, as potential significance would not have translated into meaningful interpretative differences.

Signage analysis

Data collection

Information on 300 signs from Västkuststiftelsen[1] and Länsstyrelsen Västra Götaland[2] was extracted from digital copies of the panels. The signs analyzed in this study were "Welcome-signs" for the reserves, providing a broad amount and range of information for the visitors. One signs per reserve was analyzed. All data was extracted manually by one person by reviewing each digital version of the panels. To ensure consistency in data collection and keep the coding process transparent, a fixed coding matrix was applied to all signs, covering different categories (Table A2). The main categories for the analysis were: ecological information (species specific and information about ecology and biodiversity), interpretation tools and general information.

Species analysis

To analyze how species are represented on signs, species-specific information was recorded for each sign (Table A3). The following attributes were documented: scientific name, illustration, description, uncommon status, and whether the species was linked to another species or to the ecosystem. Recording whether the scientific name was included allowed documentation of the use of formal species nomenclature on signs. The presence of illustrations was noted to capture the use of visual elements in species communication, as visuals can support recognition and recall (Spooner et al., 2024). It was further recorded whether a textual description of the species was provided, indicating whether additional explanatory information accompanied the species mention. Species were also coded for whether they were described as uncommon, documenting whether certain species were highlighted as noteworthy. Finally, the linkage of species to other species or to the ecosystem was recorded. For linkage to the ecosystem an ordinal scale was used, where 0 = no connection, 1 = in which ecosystem / landscape the species lives (e.g., "1 = Knärot, *Goodyera repens*, is a barely decimeter-high orchid that grows in moss-rich coniferous forests.") and 2 = a specific description of how the species is connected to the ecosystem (e.g., 2 = "That the rattle grasshopper thrives in Bölet's meadows is a very good sign. The elusive grasshopper has a strict list of requirements: it must be sunny, dry, and well-maintained – otherwise it won't settle. These conditions clash strongly with the modern agricultural landscape. Consequently, the rattle grasshopper has disappeared from large areas of the country. It is now rare and endangered."). In order to get a broader view on the species, they were combined to the following three categories (Table 1).

[1] Västkuststiftelsen is a non-profit organization dedicated to nature conservation and outdoor recreation in West Sweden (Västkuststiftelsen, 2026)

[2] County Administrative Board for Västra Götaland

*Table 1. Classification of species. *Non-flowering are plants that are not orchids, trees or shrubs and that do not have a conspicuous flower. *Flowering are plants that are not orchids, trees or shrubs and have a conspicuous flower. This classification was done to differentiate between the appearance of the plants.*

class	**Animals**		**Fungi**	**Primary producers**		
group	*Invertebrates*	*Vertebrates*	*Fungi*	*Plants*	*Mosses and Lichen*	*Aquatic plants and algae*
subgroup	Other arthropod Crustacaea Insect Other invertebrate	Amphibian Bird Fish Mammal Reptile	Fungi	*Non-flowering Orchid *Flowering Tree Shrub	Moss Lichen	Aquatic plants Algae

Ecological information

As ecological relationships and biodiversity can be communicated independently of specific species, ecosystem and biodiversity information were included to capture broader ecological framings. To capture the depth of the provided information, an ordinal scale was used for information about ecosystems (0-2) and biodiversity (0-3; see Table 2 for details). As communicating the rationale behind protection measures has been associated with greater appreciation of protected areas and acceptance of conservation regulations (Colquhoun, 2005; Marschall et al., 2017), it was also documented how that was implemented on the signs.

Table 2. Explanation of specific entries of coding matrix. Swedish version of the examples are found in Table A4.

Column	Explanation	Example
Ecosystem	0 = no explanation 1 = ecosystem(s) named and explained shortly 2 = explained more detailed	1 = "There are several old pines and oaks in the nature reserve. Beautiful and impressive trees well worth observing and admiration. The oaks and pines thrive along the dramatic sandstone cliff that runs through the area." 2 = "Attebo Nature Reserve mainly consists of old and undisturbed coniferous forest, but patches of deciduous forest and wet areas occur in between. A stream has carved its way through the southwestern part of the reserve. In the moist areas the moss *missne* thrives, while the rare lichen *sotlaven* prefers drier habitats."
Biodiversity/ Species Richness	0 = not named or described 1 = named or described 2 = how multiple species are linked to each other 3 = why biodiversity/species richness is important	1 = "Many different plants thrive in the deciduous groves. In the shallow waters south of Älgön there are seagrass meadows, which are an important nursery habitat for fish." 2 = "Old deciduous trees are rare today. And they are valuable! An old oak can provide habitat for hundreds of plant and animal species: lichens and mosses on the trunk and branches, insects on the bark and in the wood, and many other organisms living in decaying trunks. Other deciduous trees such as elm and maple also host a wide range of associated species."
Conservation purpose	0 = no explanation 1 = at the edge 2 = explained in the text	1 = "Nature reserves are designated to preserve areas of valuable nature and to ensure access to land for outdoor recreation." (written in the corner of the sign) 2 = "Ålstadnäset became a nature reserve in 2019. The aim is to restore the traditional agricultural landscape and its natural values. Spruce forests are being cleared and grazing areas are being restored. Old and valuable deciduous trees will once again receive light and space. At the same time, a landscape is created that is attractive for people to explore."
Call-to-action question	Number of calls-to-action or questions	" If you look closely at the maiden pink…"

Direct address	Number of direct reader address	”If you want to experience rarities, you need to sit quietly in the moist spruce forest and wait for the hazel grouse.“ (Grimmestorp)
Storytelling	Number of uses of storytelling	”The cherry blossoms wrap the landscape of Bolums Lider in spring. It is as if soft clouds have come to rest among the hills. Bumblebees buzz in the treetops and cowslips and pasque flowers stretch towards the light.”

Interpretation tools

Beyond analyzing the ecological content presented on the signs, the study also examined how this information is communicated. For this purpose, different interpretive tools were recorded to capture strategies used to structure information, engage visitors, and support the communication of ecological and conservation messages. These tools included readability, use of subheadings, direct address of the reader, call-to-action, questions, and storytelling elements. The readability of sign texts was assessed using the LIX[3] (Läsbarhetsindex), a readability index widely applied in Sweden (Heimann Mühlenbock, 2013; Reichenberg, 2011). In this study, LIX was used to describe the overall text complexity of interpretive signage and to provide a standardized, reproducible measure that can indicate whether texts are generally more or less complex. Text from each sign was copied into the LIX online tool (lix.se,*LIX Räknare*, 2026), excluding standalone words such as labels on maps or text in languages other than Swedish. Additionally, it was recorded whether thematic subheadings were present as they can help navigate information and understand text organization (Hartley & Trueman, 1983; Sanchez et al., 2001).

Features of interpretation, including direct address of the reader, calls-to-action, questions, and storytelling, were recorded to document strategies for engaging visitors (Table 2). Direct address of the reader was noted as a way in which signs communicate personally with visitors, potentially increasing attention and involvement (S. Ham, 2014; Symons & Johnson, 1997). Calls-to-action and questions were recorded when the text invited visitors to observe, interact, or reflect, capturing one approach to encourage engagement and as a feature that may stimulate curiosity or reflection (for examples see Table 2; Ballantyne & Hughes, 2003; S. Ham, 2014). Storytelling was noted when narrative elements were present, describing ecological or nature conservation topics in story form (Table 2; S. Ham, 2014; Hwang et al., 2005).

Considering that visual media can attract attention, support comprehension, and enhance information retention (Janeczko et al., 2021; Zhu et al., 2021), the number of illustrations on each sign was recorded. To provide a standardized measure of the relative use of visuals, a ratio of illustrations to word count was calculated, offering an indication of how densely images were used alongside text.

General information

General information consisted of year of installation, presence of English text, explanation of rules, and the existence of maps or trail information. Year of installation was recorded to capture potential changes in content or design over time. The presence of English text was recorded to capture accessibility for non-Swedish-speaking visitors. Rules were noted due to their potential influence on visitor behavior (Marschall et al., 2017). The presence and content of maps were recorded, as maps can attract visitors’ attention by providing spatial orientation for recreational use.

[3] LIX was developed by the Swedish linguist Carl-Hugo Björnsson (1968) and is calculated based on two structural features of a text: the average sentence length and the proportion of long words (defined as words containing more than six letters), with higher values indicating greater linguistic complexity.

Statistical analysis

All statistical analyses were conducted in R version 4.3.3 (R Core Team, 2025). To get an overview of the data, descriptive statistics, including means and standard deviations were computed. Missing values were removed for analyses requiring complete cases. Several types of visualizations were created to explore patterns in the data, including violin plots, heatmaps, bar plots and waffle plots that were created using *tidyverse* (Wickham et al., 2019) as well as treemaps (Tennekes, 2023) and upset plots (Gehlenborg, 2019).

Particular attention was given to illustrations, as they represent one of the main components of interpretive signs alongside text, maps, and regulations. Additionally, illustrations are especially relevant in interpretive communication because visual elements are often highly memorable and have been shown to have high recall in educational signage (Spooner et al., 2024). Because the absolute numbers of mentions and illustrations differed substantially between species groups, a corrected ratio was calculated to compare how different species groups were presented in text and illustrations. The ratio was calculated by dividing the percentage share of total illustrations by the percentage share of total text mentions:

$$\frac{\frac{number\ of\ illustrations\ of\ species\ group}{total\ number\ of\ illustrations} \times 100\%}{\frac{number\ of\ text\ mentions\ of\ species\ group}{total\ number\ of\ text\ mentions} \times 100\%} = \frac{\%\ \text{illustrations}}{\%\ \text{mentions}}$$

To explore relationships between broader ecological variable and the species related variables, a principal component analysis (PCA) was conducted using the *stats* package (R Core Team, 2025). All variables were standardized prior to the analysis. To test the robustness of the results, an additional PCA was conducted after removing the most extreme observations (top 10% of distances in the PCA space).

During signage analysis it was noticed that oak (*Quercus ssp.*) is often presented on the signs and linked to biodiversity and different species. To analyze that also quantitatively a Kruskal-Wallis test was conducted between signs with and without oak present using the *stats* package (R Core Team, 2025).

Temporal changes in sign characteristics were analyzed by examining the relationship between the year of installation and several variables describing sign content and design. Both Call-to-action/question counts and direct address counts were divided by the number of words to correct for the text length. None of the variables meet the assumptions of normality, therefore generalized linear models (GLMs) were applied. Depending on the distribution of the data, models with a Poisson distribution or negative binomial models (*MASS* package, Venables & Ripley, 2002) for overdispersed variables were fitted.

RESULTS

Survey

Reserve characteristics

In total, 122 visitors participated in the survey. Most of the responses (64%) came from reserves located close to Gothenburg city center, even though more reserves in the survey were classified as remote than as urban. The distribution of nature types across reserves was relatively even, except for lake-type reserves, which accounted for only around 7% of responses. More than half of the answers (57%) originated from reserves larger than 1,500 ha (Table 3). A large share of the responses (44%, n = 54) came from the reserves *Ängårdsbergen* and *Sandjöbacka*, which are close to Gothenburg city center. No participants were recorded from three reserves: *Fegen*, *Havstensfjorden*, and *Kråkebo* (Table A5).

Table 3. Distribution of sampled nature reserves and study participants.

	Reserves (n)	Responses (n)	% of reserves	% of responses
Accessibility				
City	4	78	25.0	63.9
Remote	12	44	75.0	36.1
Nature type				
River	1	15	6.3	12.3
Lake	3	8	18.8	6.6
Coastal	3	26	18.8	21.3
Forest	4	38	25.0	31.2
Forest and lake	5	35	31.3	28.7
Area				
< 500 ha	6	30	37.5	24.6
> 500 ha and < 1500 ha	3	23	18.8	18.9
> 1500 ha	7	69	43.8	56.6

The column 'Reserves (n)' represents the absolute number of reserves in each category, with its relative proportion displayed in 'Reserves (%)'. Participation data is presented accordingly: 'Responses (n)' indicates the total number of respondents per category, while 'Participants (%)' shows their respective share of the overall survey sample. The study includes responses of 13 nature reserves and 122 participants.

Demographics

Gender distribution was approximately balanced, with female and male participants representing similar shares of the sample, and a small number identifying as non-binary or preferring not to say. The most common age group among respondents was 46–60 years (n = 45 (37%)). Age groups 31-45 and 46-60 were similar distributed (Table A6).

The participant pool shows a strong inclination towards frequent nature interaction. Approximately 50% of the participants are aged 46 or older and visit nature reserves frequently (either a few times a week or a few times a month) represented by the upper right quadrant of Figure 2. Regardless of age, about 50% of all participants visit a nature reserve at least a few times a week (as shown in the first row of Figure 2). The largest single demographic group within the sample consists of individuals aged 46-60 who visit a nature reserve a few times a week, accounting for approximately 20% of the total sample.

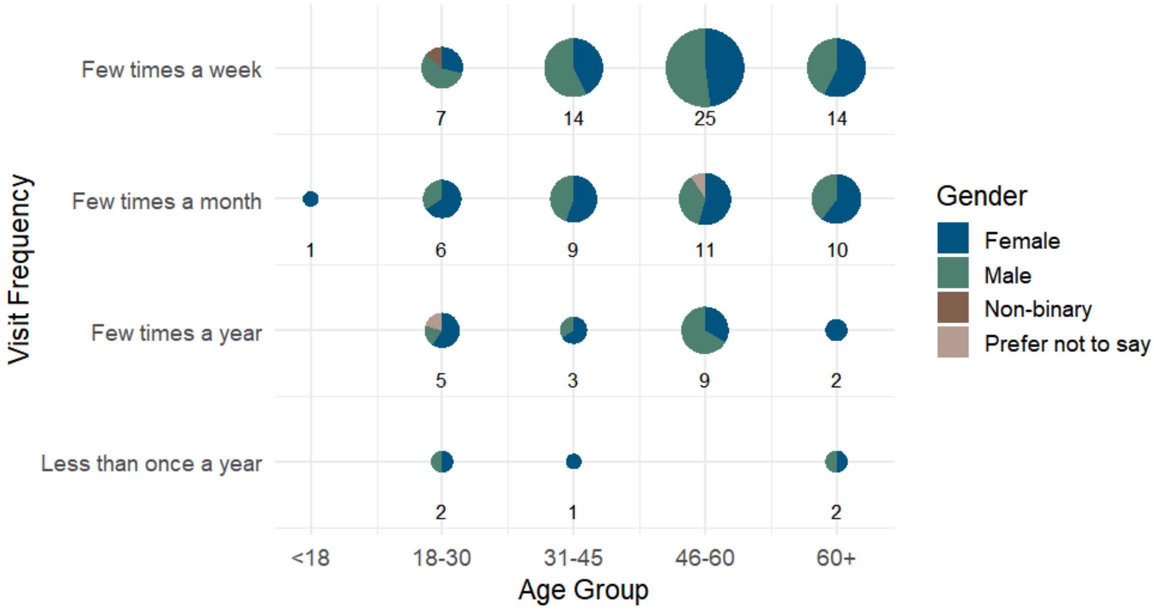

Figure 2. Participants characteristics. Age groups are shown on the x-axis and visit frequency on the y-axis. Pie charts display the gender composition within each age–frequency category.

Interest in signs

Participants reported a generally high interest in information signs, with a mean rating of 4.48 (SD = 0.07). Regarding specific topics presented on information signs (Question 2), interest was particularly high (mean > 0.45) for flora and fauna, protected species, as well as maps and orientation. In contrast, comparatively lower interest was expressed for pictures/illustrations and topics related to environment and sustainability (mean approximately 3.8, SD = 0.1; Figure 3). Interest in different groups of organisms (Question 3) was relatively consistent across the groups with mean rating from 3.7 to 4.16. The highest level of interest was reported for mammals and birds. A clearer distinction emerged when comparing interest in common versus uncommon species (Question 4). Uncommon species received significantly higher ratings (mean = 4.52, SD = 0.07) than common species (mean = 3.75, SD = 0.01), indicating a stronger interest in rare species (Wilcoxon signed-rank test, p < 0.001, r = 0.63).

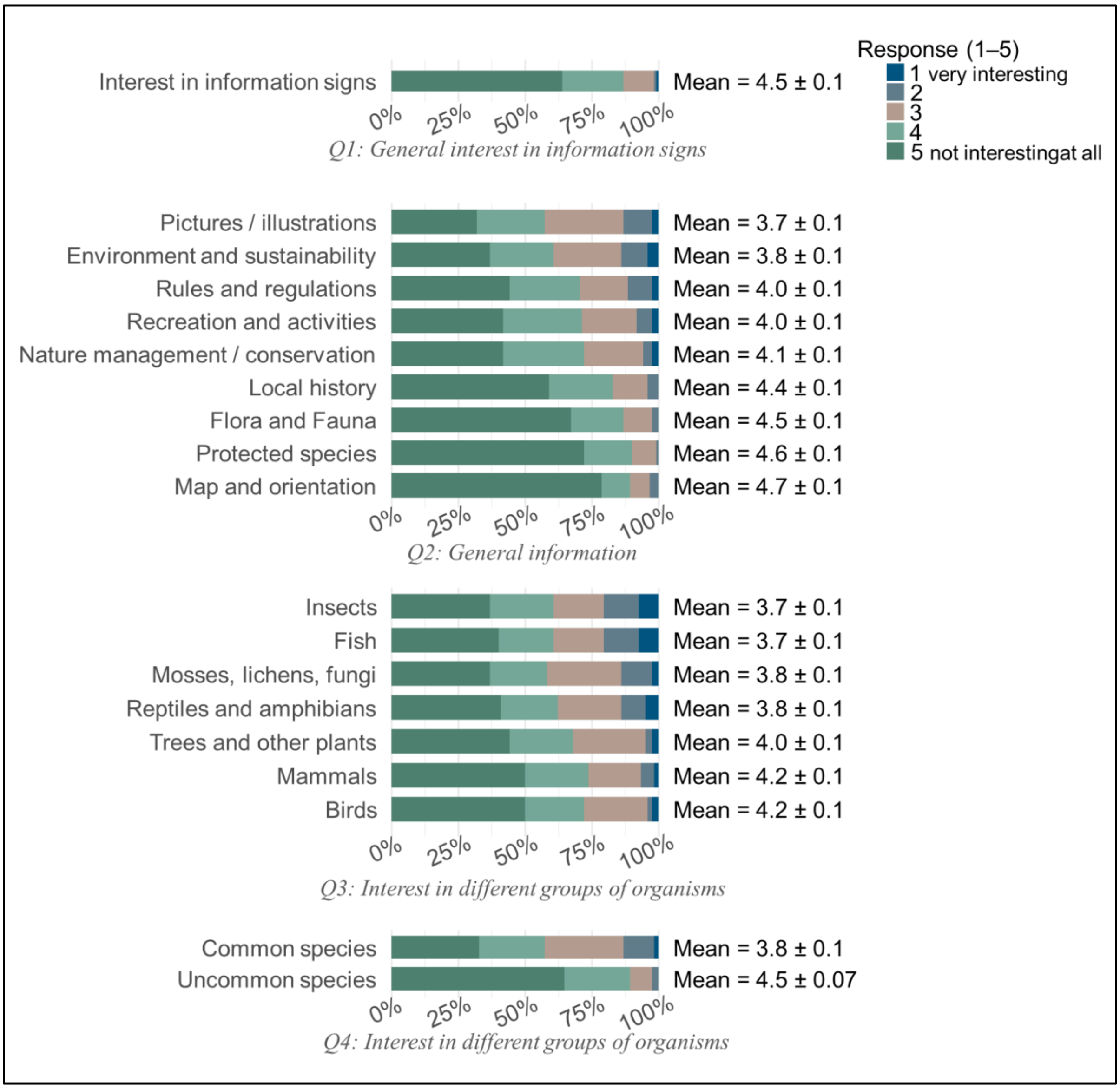

Figure 3. Interest in different types of information. Responses of the first four survey questions rated on a scale from "not interesting at all" to "very interesting". Color scale: green = interested, brown = neutral, blue = not interested.

Interest in nature conservation

The importance of nature conservation was rated very highly with a mean score of 4.96 (SD = 0.02, Figure 4). Both underlying reasons for nature conservation presented to participants (value for humans and nature's intrinsic value) were rated equally high (mean = 4.8, SD ≈ 0.05). Similarly, the different ecosystem service-related reasons were evaluated consistently highly, with mean ranging from 4.6 to 4.9. Among these, ecosystem services received the highest overall ratings.

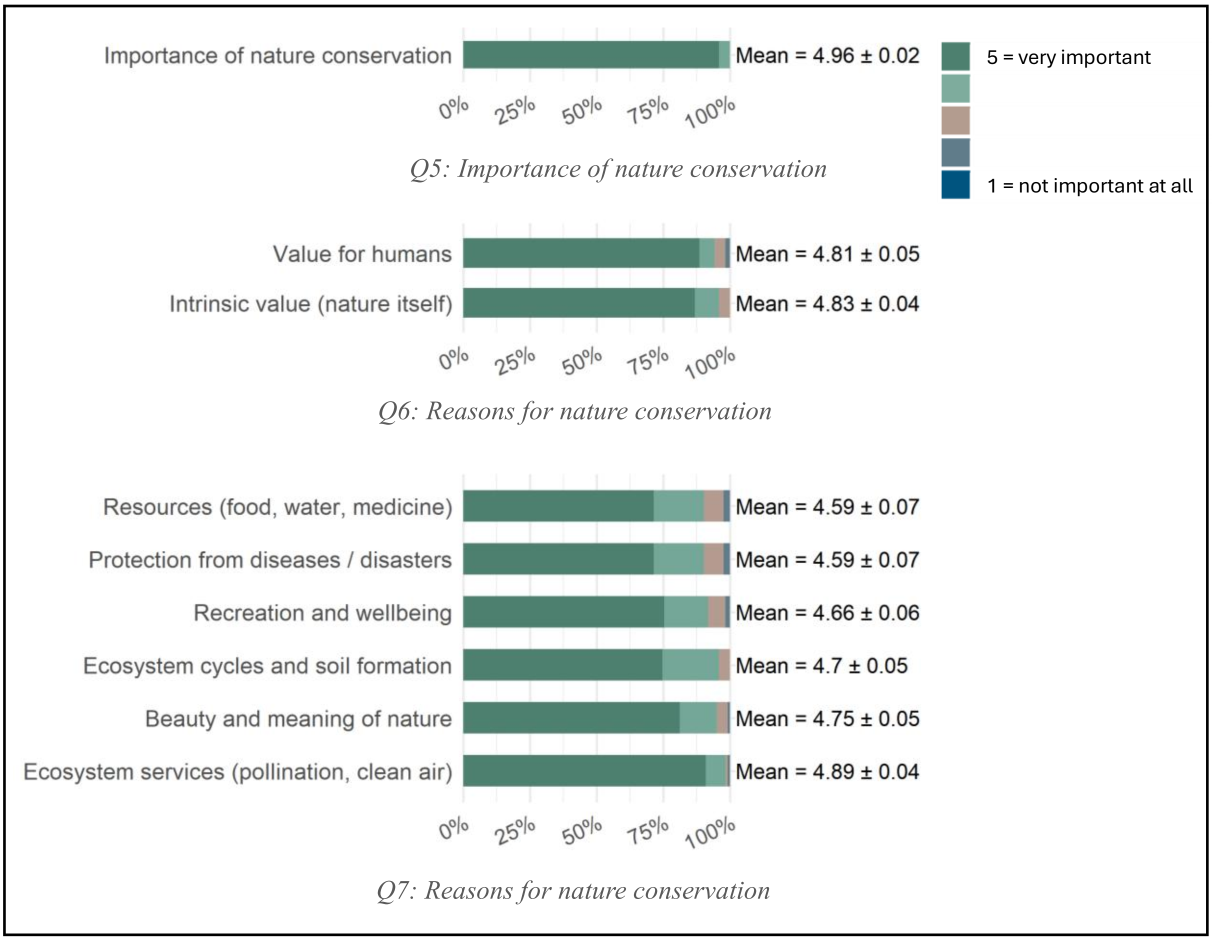

Figure 4. Importance and reasons for nature conservation. Responses of the survey questions about nature conservation rated on a scale from "very important" to "not important at all". Color scale: green = important, brown = neutral, blue = not important.

Signage rating

On average, the signage received a high appreciation score of 3.9 out of 5. When broken down by individual nature reserves, mean ratings remained consistently high, ranging between 3.5 and 4.1. This narrow range indicates a uniform level of visitor satisfaction across all locations, with no significant outliers or notable differences between the reserves (Table 4).

Table 4. Detailed visitor ratings across the 13 nature reserves.

Reserve	n	Mean	SD
Sandsjöbacka	27	4.1	1.0
Änggårdsbergen	26	4.0	0.9
Guddehjälm	8	4.0	0.9
Halle Hunneberg	1	4.0	*NA*
Höjentorp-Drottningkullen	3	4.0	1.0
Vrångöskärgården	12	3.8	0.9
Österplana hed och vall	5	3.8	0.8
Svartedalen	4	3.9	1.0
Säveån	14	3.7	0.8
Brobacka	3	3.7	1.2
Rya Åsar	3	3.7	0.6
Stora Amundön	12	3.7	0.8
Ramsviklandet	2	3.5	0.7
total	120	3.9	0.1

'n' represents the number of participants per reserve, 'Mean' indicates the average rating (on a scale of 1–5), and 'SD' denotes the standard deviation.

Open questions

In total, 68 answers were received from the open-ended questions. Because many of the responses to the open-ended questions addressed topics beyond the specific scope of the questions, the comments were categorized into key themes based on their content (Table 5, see Table A7 for full details). The following themes represent the most frequent suggestions and observations from the participants:

Table 5. Open questions. Responses to the open questions were grouped for better comprehension. 'n' represents number of responses.

Category	n	Description
Management and practical infrastructure		
Navigation and spatial orientation	27	The most common feedback concerned the need for maps, clear trail markings, activity suggestions, and "you are here" indicators to improve orientation within the reserve.
Regulations and guidelines	17	Many participants suggested that rules should be explained clearly to ensure they are understood and followed.
Maintenance and quality	9	Several respondents noted that signs were old or worn out and suggested that they should be updated more frequently and better maintained.
Accessibility and Digital Innovation		
Multilingual access	6	Some participants expressed a desire for information to be available in other languages.
Digital access	8	Some respondents suggested providing digital access (e.g., via QR Code) for more information.
Interactivity	3	A small group of respondents suggested that interactive elements on the signs would enhance the visitor experience.
Nature conservation		
Human-nature connection	14	A notable number of comments focused on the psychological and physical benefits of nature, emphasizing human dependence on ecosystems and the positive impact nature has on human well-being.

Signage analysis

In total, 300 signs were analyzed. The data on general and ecological information provides an overview of the content conveyed to visitors in nature reserves and the strategies used to communicate it (See Table A8 for a summary of variables).

Species representation

A total of 4444 species occurrences were recorded across the 300 analyzed signs, representing 1265 unique species. On average, each sign contained 15 species (*SD* = 9, Figure 5) and 4.7 (SD = 2.0) of the 19 subgroups (Table 1). 3.7 % of the signs (11 signs) did not present any species. The maximum number was 43 species on one sign. 22% of all signs (65 signs) had more than 20 species per sign.

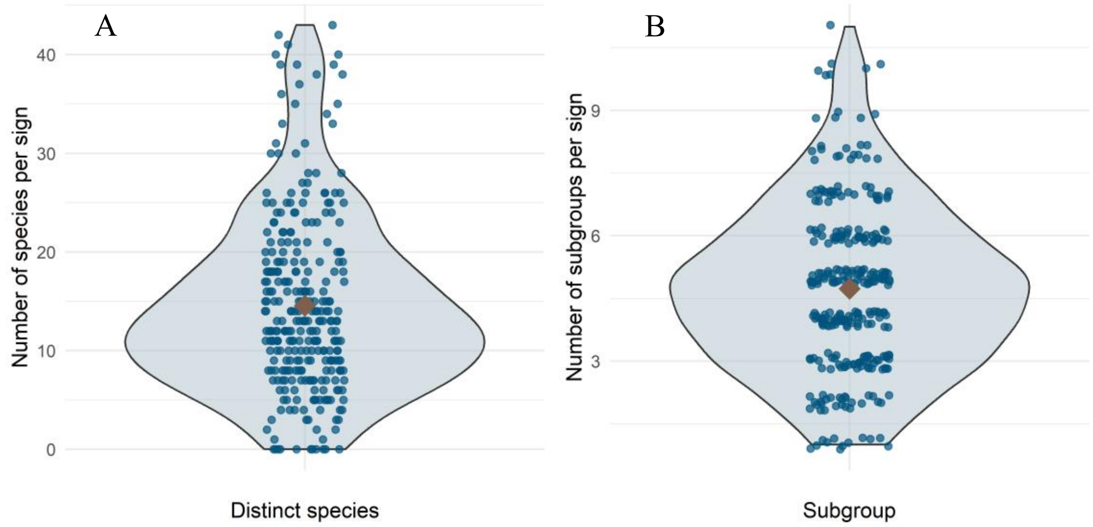

Figure 5. Distribution of number of species (A) and number of subgroups (B) per sign. 5A: Each dot represents the number of species recorded on a single sign ranging from 0 to 43 species. On average, each sign contained 15 species (SD =9). 5B: Each dot represents the number of subgroups recorded on a single sign ranging from 0 to 11. On average, each sign contained 4.7 subgroups (SD = 2.0).

Approximately 52% of the species were presented once, around 17% of the species were presented twice and roughly 32% of the species were presented more than twice (Figure 6A). The most frequently presented species was the oak (*Quercus ssp.*) with 96 occurrences, followed by the pine (*Pinus sylvestris)* with 80 occurrences. Notably, the top seven most frequently presented species all belonged to the plant group, of which six were trees (Figure 6B). Together, these six tree species accounted for 60% of the tree occurrences (406 occurrences of 671 tree occurrences), although they only make 13% of the total number of tree species.

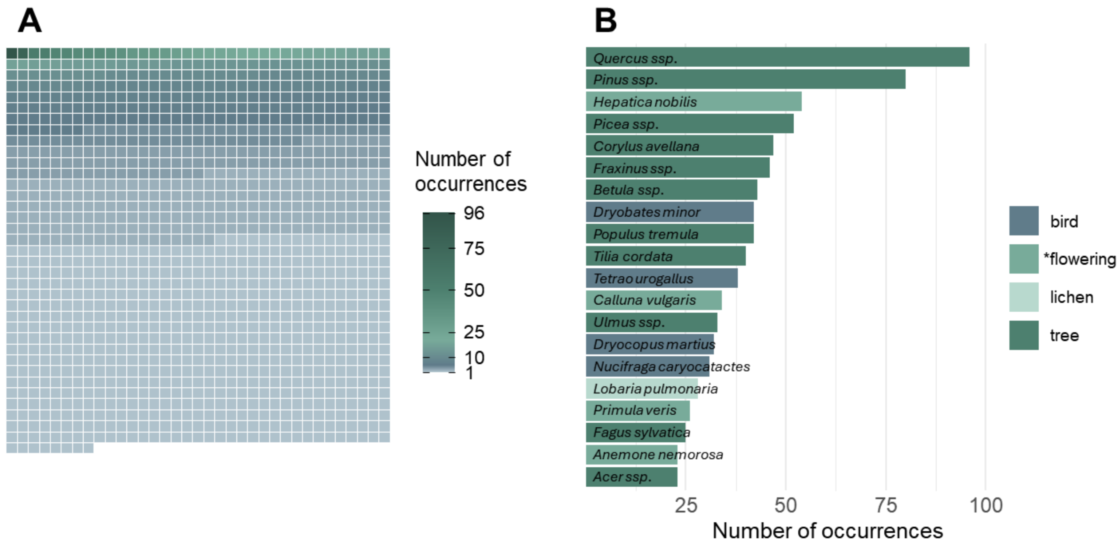

Figure 6. A: Number of occurrences per species. Each cell shows one species and its number of occurrences from 1 (light blue) to 96 (dark green). B: Top 20 species presented on the signs and the corresponding number of occurrences

Distribution across main species groups

The frequency of species occurrences varied across major taxonomic groups, subgroups, and individual species. Plants accounted for the largest share of all records, with 2339 occurrences (54% of all species occurrences, Figure 7A) representing 508 unique species (40% of all unique species, Figure 7). Within this group, *flowering plants were the most frequently represented subgroup in terms of both total mentions and number of distinct species. Trees ranked second in total number of mentions, whereas *non-flowering plants ranked second in number of distinct species. Vertebrates constituted the second most represented group, with 1306 occurrences and 306 unique species (Figure 7, Table 6). Among vertebrates, birds dominated in both in terms of total number of mentions (1080 occurrences, Table 6) and number of distinct species. Notably, the total number of bird occurrences approached that of *flowering (1189 occurrences, Table 6). For plants, the proportion in number of total mentions exceeded their proportion of distinct species. This pattern can be observed also for vertebrates but not for other species groups.

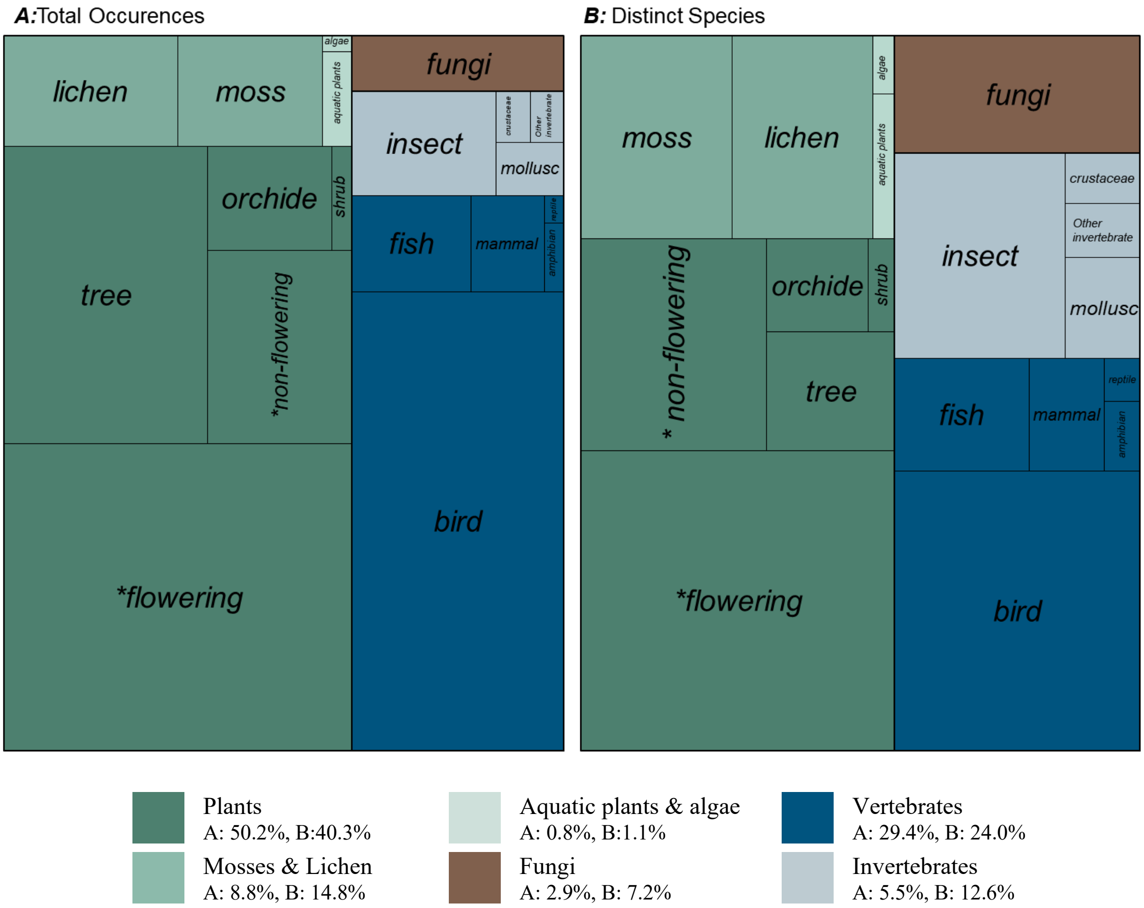

Figure 7. Distribution of number of species occurrences in each group (A) and number of distinct species in each group (B). The area of each rectangle represents the number of species occurrences (A) or number of distinct species (B) in each group.

Table 6. Occurrences, richness, and top 3 species of every group. Swedish common names found in Table A9.

Group	Count	Richness	Subgroup	Count	Richness	Top 3 Species	Count
Plants	2339	508	*Flowering	1188	299	*Hepatica nobilis*	54
						Calluna vulgaris	34
						Primula veris	26
			Tree	671	48	*Quercus ssp.*	96
						Pinus sylvestris	80
						Picea abies	52
			*Non-flow-ering	312	125	*Eriophorum vaginatum*	15
						Briza media	12
						Chrysosplenium al-ternifolium	11
			Orchid	144	30	*Dactylorhiza incarnata*	17
						Goodyera repens	16
						Corallorhiza trifida	9
			Shrub	24	8	*Myrica gale*	8
						Lonicera xylosteum	6
						Rhamnus cathartica	3
Vertebrates	1306	303	Bird	1080	218	*Dryobates minor*	42
						Tetrao urogallus	38
						Dryocopus martius	32
			Fish	127	45	*Salmo trutta*	14
						Esox lucius	11
						Anguilla anguilla	10
			Mammal	78	27	*Capreolus capreolus*	13
						Alces alces	11
						Castor fiber	9
			Amphibian	15	8	*Lissotriton vulgaris*	3
						Triturus cristatus	3
						Epidalea calamita	2
			Reptile	6	5	*Coronella austriaca*	2
						Other species were only named once	
Mosses and lichen	389	187	Lichen	212	90	*Lobaria pulmonaria*	28
						Pectenia plumbea	9
						Felipes leucopellaeus	8
			Moss	177	97	*Antitrichia curtipen-dula*	11
						*Sphagnum*ssp.	11
						Crossocalyx helleria-nus	9
Invertebrates	244	160	Insect	166	111	*Bombus* ssp.	8
						Papilio machaon	8
						Lycaenini ssp.	5
			Mollusk	40	24	*Mytilus edulis*	7
						Margaritifera margar-itifera	5
						Vertiginidae ssp.	3
			Crustacea	19	12	*Balanomorpha* ssp.	3
						Crangon crangon	3
						Brachyura	2
			Other invertebrate	19	13	*Asteroidea*	4
						Polychaeta	2
						Arenicolidae	2
Fungi	130	91	Fungi	130	91	*Artomyces pyxidatus*	8
						Laetiporus sulphureus	4
						Aleurocystidiellum disciforme	3
Aquatic plants and algae	36	14	Aquatic plant	31	10	*Zostera marina*	10
						Nymphaeaceae	5
						Nymphaea	4
			Algae	5	4	*Saccharina latissima*	2
						Fucus vesiculosus	1
						Phaeophyceae	1

How are species represented

Species were presented on signages primarily through mentions in the main body text (3759 species occurrences; 84.6 % of all species occurrences). In 42% of all cases (1842 occurrences) species were mentioned only in the text, without any additional form of presentation (Figure 8). Other modes of presentation were used less frequently. The modes *describe* or *uncommon* were applied in 1019 cases (23 % of all species occurrences, Figure 8). Illustrations were used 1256 times. Of these, 22% (279 illustrations) were stand-alone illustrations, meaning that no other presentation form was used in these cases. During the analysis, it was observed that scientific names were often used as labels for illustrations. This is also seen in the data, where 888 of the occurrences combined illustrations with scientific names (sometimes together with other elements). The high number of occurrences that combine text-mentions and simple links to the ecosystem indicates that connections to the ecosystem were mainly established in the main text (and not e.g. in the description of an illustration). However, these connections often remained at a basic level (the text stated in which ecosystem a species occurs but did not further explain how or why the species is ecologically connected to that system).

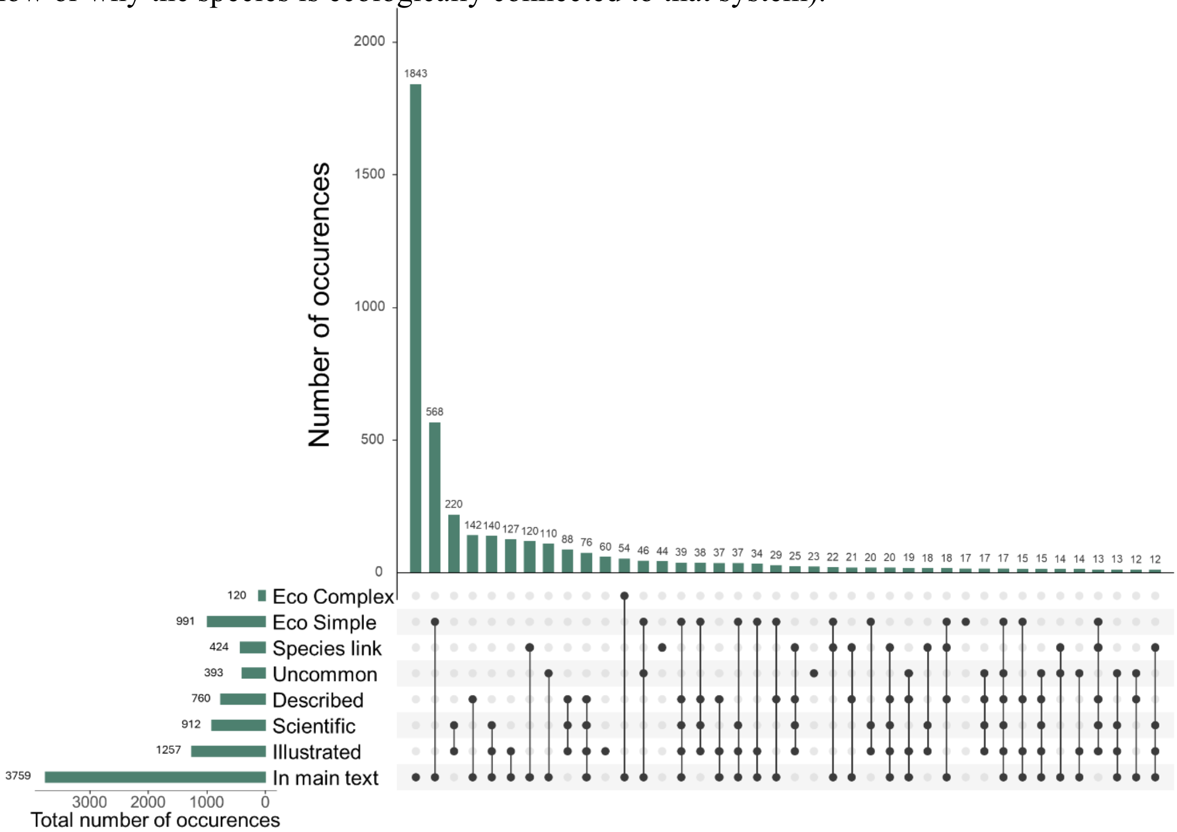

Figure 8. Different forms of species presentation. The use of different forms of species presentation (in the text, illustrated, scientific, uncommon, species-link, ecosystem-link (simple and complex). The horizontal bars show the total number of uses of these tools, the vertical bars show the number of uses of the tools alone or in combination with others.

Species illustrations

When looking at the absolute numbers, plants account for the highest number of illustrations, representing almost 50% of all images on the signage, followed by vertebrates (Figure 9). This generally aligns with the total number of species occurrences (Figure 7), where plants (dark green) and vertebrates (dark blue) are also the most frequently presented groups.

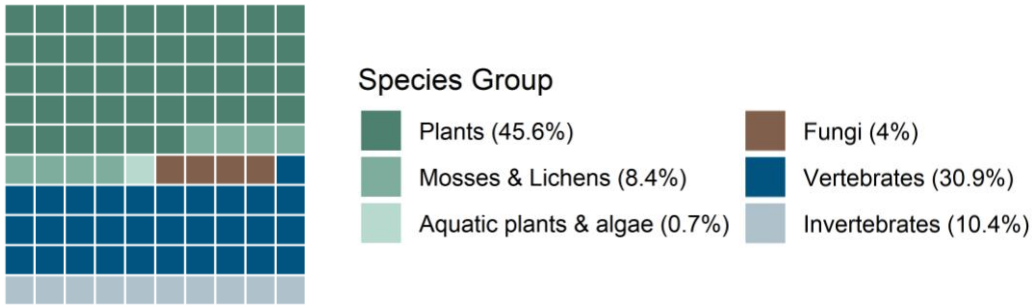

Figure 9. Distribution of recorded illustrations across the different species groups. Each square represents around 1% of the total number of images.

While plants account for the highest absolute number of illustrations, their representation relative to their high number of text mentions is notably low (33%, Figure 10). This is reflected in the corrected ratio ($\frac{\%\ \text{illustrations}}{\%\text{mentions}}$), where plants, along with aquatic plants, algae, mosses, and lichens, show values below 1.0 (Figure 11). This indicates that these groups are primarily described through text rather than visual aids. In contrast, invertebrates show a markedly high ratio of 1.9. This demonstrates that even though they are mentioned less frequently in the text, they are considerably prioritized in the visual design of the signage.

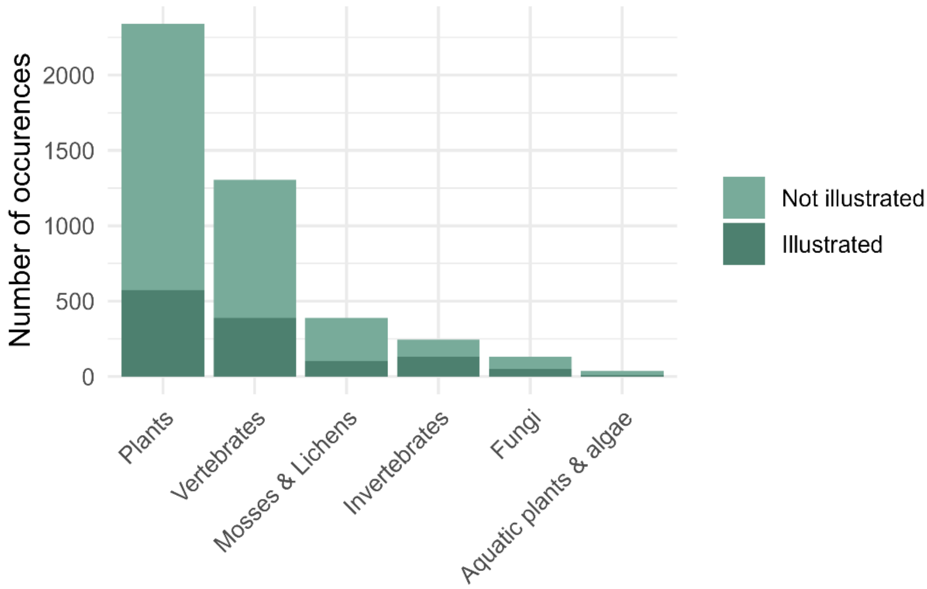

Figure 10. Total number of species occurrences and illustrations. Full bar height shows recorded number of species occurrences in each species group. The dark green section of each bar represents the number of species that are illustrated on the signage.

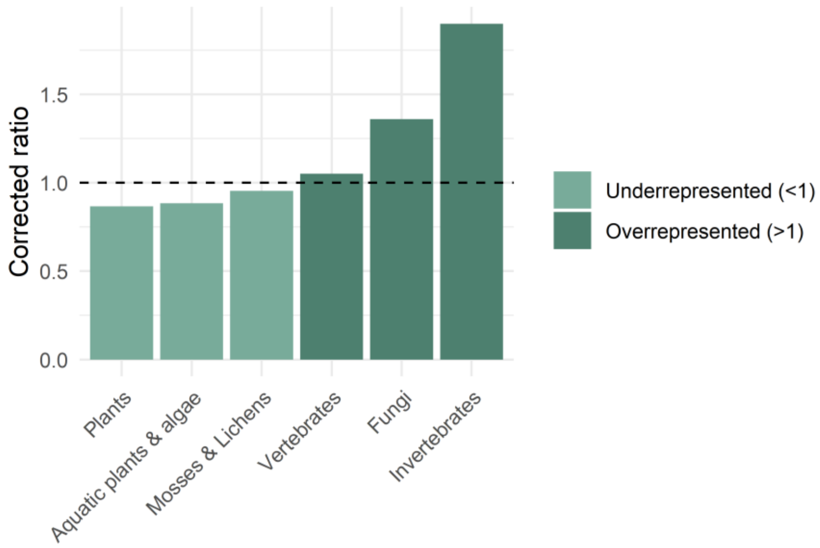

Figure 11. Over- and underrepresentation of species groups in illustrations. The ratio is calculated by dividing the percentage share of total illustrations by the percentage share of total text mentions ($\frac{\%\,illustrations}{\%mentions}$). A value of 1.0 indicates a representation that is proportional to the frequency of mentions in the text. Values above 1.0 indicate that a group is proportionally illustrated more frequently than it is mentioned, while values below 1.0 indicate that a group is proportionally mentioned more frequently than it is illustrated.

Ecological information

Across the surveyed signs, the amount and depth of information provided on conservation, ecosystems, and biodiversity differed (Figure 12). The purpose of conservation was communicated on 93% of the signs, and in most cases (63%) it was addressed in the main text (see Figure 9, score 2, dark green). Ecosystem information showed a more heterogeneous pattern. On roughly one third of the signs, the ecosystem was only briefly mentioned (Figure 9, score 1, light green), while on another third it was described in more detail (Score 2). For 26 % of the signs, no ecosystem information was recorded, as this category was introduced later during the analysis. Biodiversity was mentioned (Figure 9, score 1) on 42 % of the signs and explained in more detail (Score 2) on 18 % of the signs. However, none of the signs explicitly addressed the importance of biodiversity (Score 3).

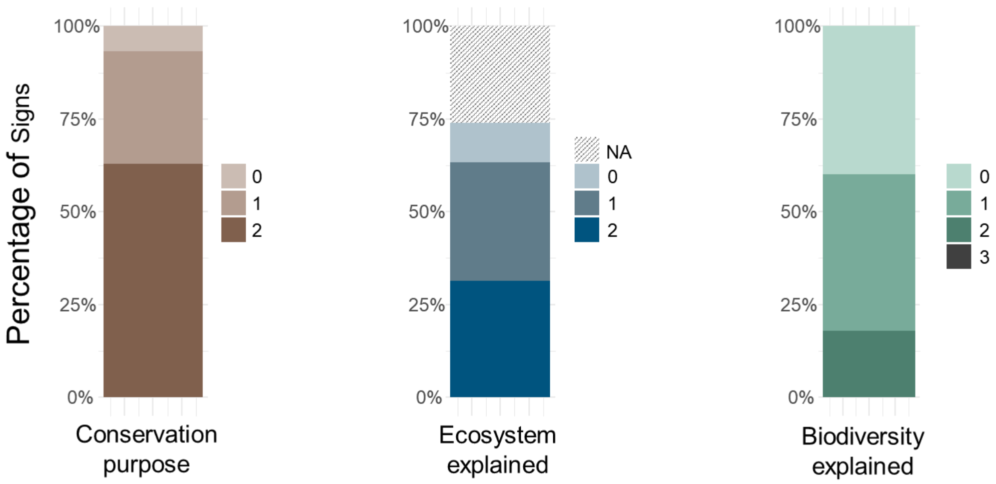

Figure 12. Variation in information on signs regarding conservation purpose, ecosystem, and biodiversity. Bars represent proportion of signs addressing each category. The level of detail is indicated by scores, with 0 = not mentioned for all categories. For Conservation purpose: 1 = mentioned at the edge of the sign, 2 = addressed in the main text. Ecosystem information: 1 = brief mention, 2 = detailed description. Biodiversity: 1 = simple mention, 2 = explained in more detail including connections between species, 3 = explicitly addressed the importance of biodiversity.

Biodiversity and ecosystem explanations are not primarily associated with naming a large number of species, but rather with the use of linking elements (Figure 13). The variables representing the corrected number of links (both inter-species links and ecosystem links) are located closer to the ecosystem/biodiversity explanation axis in the PCA space, suggesting a structural association between linking elements and explanatory depth. In contrast, the number of species is positioned further away from the ecosystem/biodiversity explanation variable, indicating a weaker relationship between simply listing species and providing broader ecosystem or biodiversity explanations. That indicates that biodiversity and ecosystem processes can be explained in depth without necessarily referring to many individual species. This overall structure remains consistent even when excluding 10% of the outliers (Figure A1).

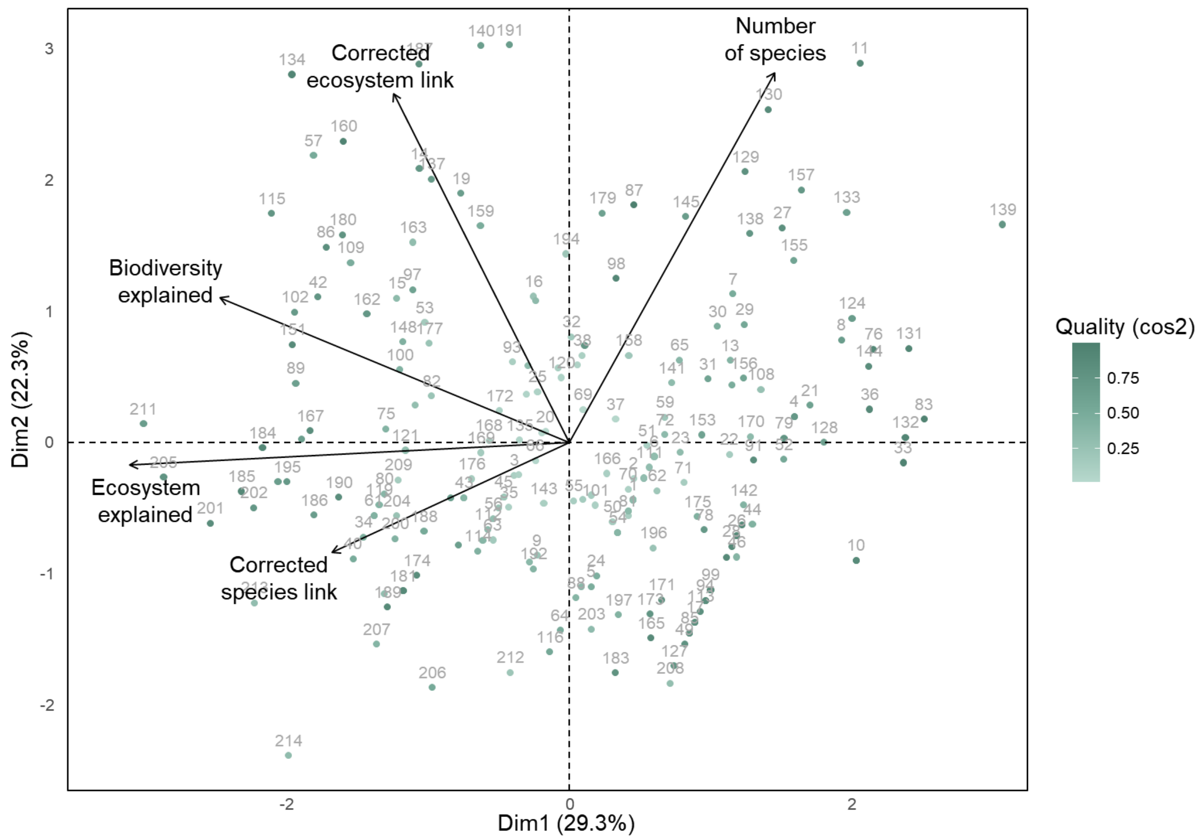

Figure 13. Relationship between explanation of ecosystem and biodiversity and number of species and their links to other species and ecosystem. Each dot represents a sign (Table A10). Number of species = number of species per sign, Corrected ecosystem link = Number of ecosystem links per sign / number of species per sign, Corrected species link = Number of species links per sign / number of species, biodiversity explained = level of biodiversity explanation, ecosystem explained = level of ecosystem explanation.

Oaks (Quercus ssp.)

As mentioned above, oaks occurred on nearly one third of the signs. Since oaks are often associated with high species diversity, it is of interest to examine whether their presence correlates with the depth of biodiversity and ecosystem explanations. Kruskal-Wallis rank tests revealed that signs containing oak species included significantly more species overall than signs without oak ($\chi^2 = 6.68, df = 1, p = 0.009$, Table 7) and significantly more intra species links ($\chi^2 = 16.00, df = 1, p < 0.001$). Similarly, signs contained more detailed explanations of biodiversity ($\chi^2 = 3.83, df = 1, p = 0.050$). In contrast, for ecosystem explanation between signs with and without oak no significant difference found ($\chi^2 = 0.05, df = 1, p = 0.828$).

Table 7. Kruskal-Wallis rank tests between signs with and without oak mentions.

Variable	Mean value for signs without oak (n= 204)	Mean value for signs with oak (n = 96)	χ^2	p-value
Number of species	13.60	16.70	6.68	0.009
Intra species links ratio	0.08	0.15	16.00	<0.001
Biodiversity explanation	0.70	0.90	3.83	0.050
Ecosystem explanation	1.29	1.26	0.05	0.828

Interpretation tools

The analysis of interpretation tools revealed a mean Läsbarhetsindex (LIX; i.e. readability index) of 41.9 (SD = 4.6), which indicates a moderate level of difficulty[4] (Figure 14a). On average, each sign featured 5.2 illustrations (SD = 2.3, Figure 14b). In terms of narrative techniques, direct address of the reader was the most common tool (50.7% of the signs), followed closely by thematic subheadings (48.7%, Figure 15). More engaging methods, such as calls-to-action or questions (21.7%) and storytelling (approx. 8.0%), were utilized less frequently (Figure 15).

Figure 14. Distribution of readability index (A) and number of illustrations (B). Figure 7A: Each dot represents the readability index calculated for each sign, ranging from 31 to 55 with a mean of 41.9 (SD = 4.6). Figure 7B: Each dot represents the number of illustrations recorded on a single sign ranging from 1 to 21 illustrations. On average, each sign contained 5.2 illustrations (SD = 2.3).

[4] LIX-classification ranges from <30 to >60 with lower values meaning better readability (lix.se, 2026)

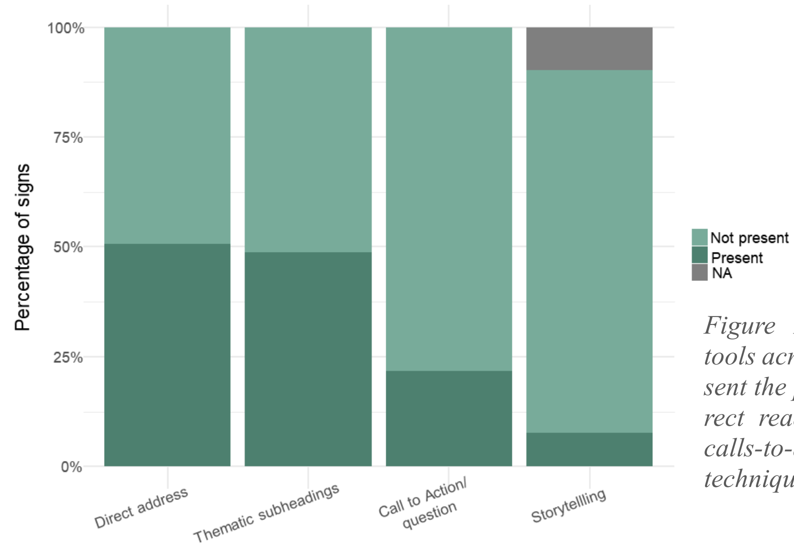

Figure 15. Recorded use of interpretation tools across the analyzed signage. Bars represent the percentage of signs incorporating direct reader address, thematic subheadings, calls-to-action or questions, and storytelling techniques.

Temporal analysis

On 159 signs (53%), the year of installation was noted on the sign, which ranged from 2001 to 2025. Notably, a majority of the signs were established between 2015 and 2020 (Figure 16).

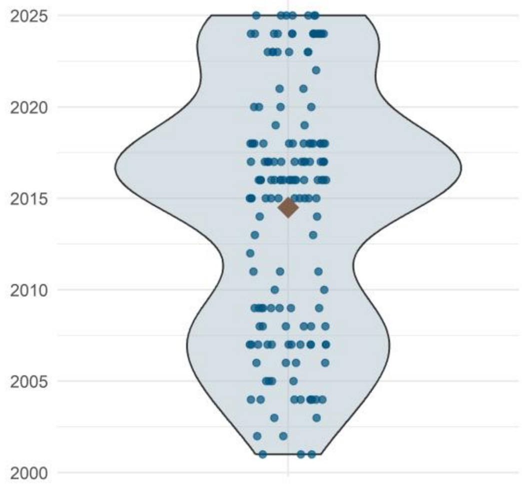

Figure 16. Distribution of the establishment years for the analyzed signage (n=159). Each dot represents the year of establishment of a single sign ranging from 2001 to 2025.

A temporal analysis of the signs (n=159) revealed distinct shifts in communication styles. Over time, the total number of words per sign increased (GLM; negative binomial; *$\beta = 0.02$, $z = 6.92$, $p < 0.001$*)), while the readability score decreased slightly (GLM; Poisson; *$\beta = -0.006$, $z = -3.02$, $p < 0.005$*). This suggests a trend towards longer but linguistically more accessible texts. Conversely, both the number of illustrations (GLM; Poisson; *$\beta = -0.012$, $z = -2.32$, $p < 0.05$*) and the number of species presented (GLM; negative binomial; *$\beta = -0.015$, $z = -2.21$, $p < 0.05$*) showed a downward trend over the years. Consequently, the text-to-illustration ratio (words per illustration) increased (GLM; negative binomial; *$\beta = 0.033$, $z = 6.71$, $p < 0.001$*), as did the number of words allocated per species (GLM; negative binomial; *$\beta = 0.026$, $z = 3.45$, $p < 0.001$*). Despite the reduction in visual elements, the use of interpretation tools such as direct address, storytelling (GLM; Poisson; *$\beta = 0.077$, $z = 1.85$, $p > 0.05$*), calls-to-action and questions has increased, with direct address showing the most significant growth (GLM; negative binomial; *$\beta = 0.097$, $z = 7.35$, $p < 0.001$*). Summary of the models can be found in Table A11.

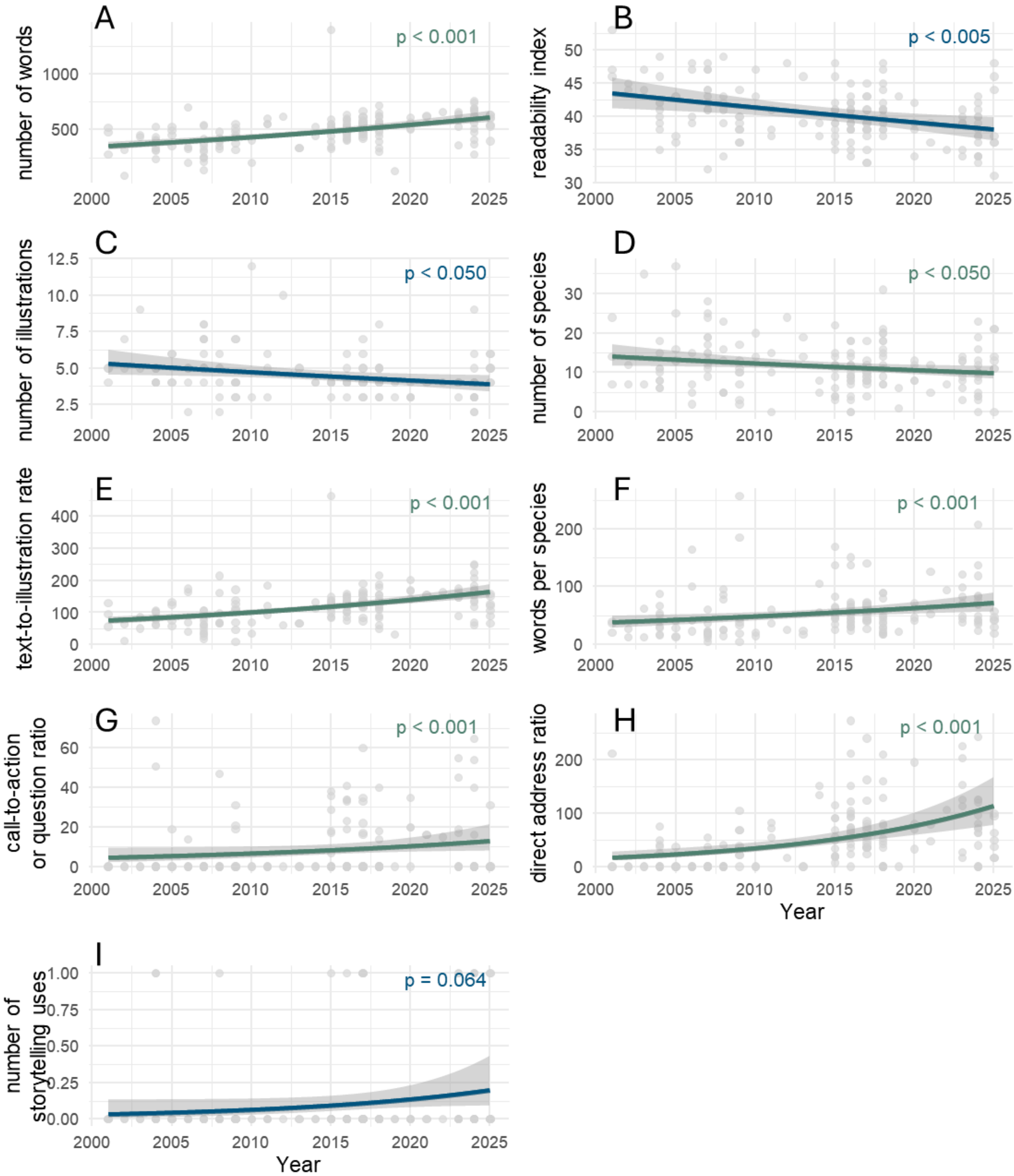

Figure 17. Temporal trends in signage characteristics. A: Numbers of words; B: Readability index (LIX); C: Number of illustrations; D: Number of distinct species; E: Text-to-illustration ration (Number of words / number of illustrations); F: Words per species (Number of words / number of species), G: Call-to-action or question (cq) ratio (Number of cq / number of words); H: Direct reader address ratio (Number of direct address / number of words); I: Number of storytelling elements. Blue lines indicate GLM with Poisson distribution and green lines indicate GLM with negative binomial distribution.

General information on signage

The assessment of general information offers insight into how features such as rules, language, and maps are standardized across the signage system. Regarding content and accessibility, the signage is highly standardized: 98.3% of the signs included regulatory information (rules), and 77.0% featured English translations. Visual aids were equally prevalent, with 98.0% of the signs incorporating a map. Most maps were technically detailed, with 96.0% including a scale, 73.0% displaying trails, and 47.0% highlighting specific activity spots, such as bathing areas or fireplaces (Figure 18).

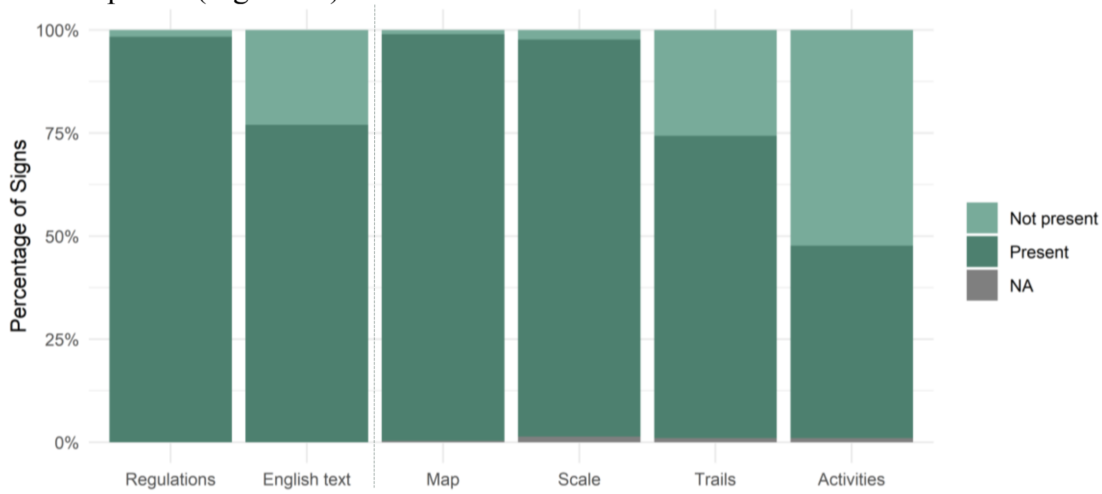

Figure 18. Inclusion of regulation, English text and map elements on nature reserve signs. Categories represent the presence of a regulations, English text, general map, map scale, marked trails, and activity spots (e.g., swimming or picnic areas).

Qualitative Observations from Signage Analysis

During the systematic review of the signage, several recurring patterns were observed that complement the quantitative data. A recurring theme across many signs is the focus on dead wood and its importance as a habitat for various species. In these instances, biodiversity and the ecosystem are often explained in detail. In other cases, however, species are merely listed by name without further context. On certain signs, specific categories like *signal species* are defined to explain the conservation value of the area. A notable pattern is that while the signage often emphasizes that high natural values must be conserved, the underlying ecological reasons, such as the role of biodiversity, frequently remain unexplained.

DISCUSSION

This study examined visitor interests and values in relation to nature conservation (RQ1), the representation of species, biodiversity and ecological relationships on interpretive signs (RQ2), and the extent to which existing signage aligns with visitor interests (RQ3).

Overall, the results show a high level of interest in ecological information among participants of the survey, alongside a very strong valuation of nature conservation. The content analysis further revealed that interpretive signs cover a wide range of species and ecological topics, with a strong emphasis on plants and site-specific biodiversity.

At the same time, the findings indicate that the way ecological information is structured influences how comprehensively biodiversity and ecosystem concepts are conveyed. In particular, the results suggest that detailed explanations are more closely associated with the inclusion of ecological relationships than with the number of species presented. Temporal analyses further revealed decline in number of species per sign and fewer illustrations per sign but increased used of interpretation tools such as direct address of the reader. Overall, the patterns observed in the signage analysis largely correspond with the interests expressed by visitors in the survey.

RQ1: What topics and conservation issues are visitors interested in, and what values underlie their attitudes toward nature conservation?

Reserve characteristics and participants characteristics

Participation in the survey was markedly higher in reserves near Gothenburg city center, despite a greater number of QR codes being installed in more remote sites. This is likely due to higher visitor numbers in urban-proximate reserves. This pattern aligns with previous documented distance-related declines in visitation to nature reserves or other recreation areas (Neuvonen et al., 2007; Tverijonaite et al., 2018).

The sample was dominated by frequent visitors, which could be explained by the assumption that frequent visitors encounter the QR codes more often and with that are more likely to notice and eventually scan the QR code. Frequent visitors may also feel a stronger connection to the site (Mandić et al., 2025) and therefore be more motivated to engage with the content and participate in the survey.

Most responses originated from forest or lake-forest reserves near cities, yet interest in different species did not vary significantly between locations or habitat types. The consistently high ratings across items suggest a ceiling effect[5], limiting the detection of differences between demographic groups or individual reserves. Comparable patterns have been observed in visitor studies (Ferguson et al., 2024). As the QR Codes were placed directly next to the signs, it is likely that respondents were already interested in reading signage. This self-selection bias may partly explain the overall high ratings, as participants were more likely to engage with and value the information presented.

Interest in different topics

Contrary to the widely accepted recommendation that illustrations enhance communication and engagement (Janeczko et al., 2021; Jensen, 2006; Lundin, 2003; Mutiara et al., 2021; Spooner et al., 2024), interest in illustrations and pictures was rated the lowest of all items. This may be related to the wording of the question ("Which type of information do you think is interesting to read on signs?"), as respondents may not have considered illustrations as a "type" of information. This item was intentionally included to capture not only content preferences but also aspects of sign design. In contrast to illustrations, maps were rated highest and frequently mentioned in open-ended responses, highlighting the importance of orientation tools. This finding aligns with previous research emphasizing the central role of maps in visitor experience in reserves and parks (Juma & Khademi-Vidra, 2022; Spooner et al., 2024).

Species groups

Interest across major species groups was relatively evenly distributed, although previous research suggests that charismatic taxa (e.g. mammals or birds) often receive greater attention (Albert et al., 2018). Slightly lower interest in insects could be founded in general negative attitudes towards this group in the general public (Byrne et al., 1984; Kellert, 1993). Respondents expressed a significantly higher interest in uncommon species compared to common species. This aligns with previous findings that novelty and uniqueness can increase visitor interest and engagement (Albert et al., 2018; S. H. Ham & Weiler, 2007).

Valuation of nature conservation

The extremely high importance attributed to nature conservation suggests that visitors to reserves exhibit strong pro-environmental attitudes, which is consistent with previous research (Richardson et al., 2022; Soga & Gaston, 2016). Both anthropocentric and intrinsic values were rated equally high (Mean = 4.82, SD = 0.05) as reasons for nature conservation, indicating that respondents consider multiple value dimensions of nature conservation as equally important.

[5] „occurs when a measure possesses a distinct upper limit for potential responses and a large concentration of participants score at or near this limit" (Lewis-Beck et al.,2004)

Similarly, ecosystem services were consistently rated highly, suggesting that different benefits provided by nature are broadly appreciated. Consequently, small differences between specific items should be interpreted with caution, as they are unlikely to reflect meaningful distinctions in visitor preferences. Additionally, the uniformly high ratings across all items may partly be influenced by social desirability bias (Piedmont, 2014), as pro-environmental attitudes are widely socially accepted. At the same time, Europe has been underrepresented in studies on how visitors value nature in protected areas (Gross et al., 2023), highlighting the relevance of this study.

RQ2: How are species, ecosystems, and biodiversity represented on interpretive signs, and to what extent are ecological links communicated?

Species

Number of species and different species groups on signs - Which and how many species (groups) are presented?

A high number of species occurrences (4444) and a high number of distinct species (1265) were found on the 300 signs analyzed. The high number of distinct species presented on the signs, combined with the fact that more than 50% of the species were referred to only once, indicates high variety in species representation. This suggests that because so many different distinct species were presented and there were few overlaps, the signs seem to be designed specifically for the reserves. Such potential alignments with site-specific ecological characteristics corresponds with recommendations that effective interpretation should connect content directly to the ecological significance of the place (Ballantyne & Hughes, 2003; S. Ham, 2014; Hwang et al., 2005; Marschall et al., 2017; Tilden, 1957).

Plants in general account for a large proportion of occurrences on the signs. This is noteworthy given that the marginalization of plants in educational contexts is well documented (Stagg & Dillon, 2022). The tendency to overlook or undervalue plants, described as “plant blindness” (Wandersee & Schussler, 2001) or “plant awareness disparity” (Parsley, 2020), has been identified particularly in urbanized societies. In contrast to this broader trend, the signs give plants substantial visibility, suggesting that plant representation is not reduced within this interpretive context in nature reserves. Mammals are often of higher interest (Lindemann-Matthies, 2005) but they are not so often mentioned on the signs that could also be due to that plants are easier to see and mammals harder to see.

Trees were the most frequently mentioned group and as well highly represented under the Top 20 species (11 tree species), reflecting their structural and ecological importance in many reserves, particularly forested ones. As dominant and long-lived organisms, they visibly shape ecosystem structure and remain observable throughout the year, independent of season. Oaks, in particular, were presented on one- third of the signs. This can be understood in relation to the concept of keystone species (organisms with disproportionately large effects on ecosystem structure and function (Bond, 1994)). In temperate ecosystems, oaks are widely recognized as foundational species that provide habitat for a large number of associated organisms, including endangered species (Götmark, 2013). Observations indicated that oaks were frequently linked to explanations of biodiversity, particularly emphasizing the role of old trees. This pattern is also reflected in the quantitative data: signs featuring oaks contain significantly more species and intra-species links and show higher levels of biodiversity explanation. This represents a clear good practice example in the design of interpretive signs.

Birds made the second largest subgroups with 1080 occurrences but only 218 distinct species, which means that the distinct bird species are presented on several signs, suggesting that they might function as flagship species. This pattern can be contextualized by considering the strong and growing public interest in birds. Birdwatching has developed into a widely practiced leisure activity, supported by increasing environmental awareness and available leisure time

(Kjølsrød, 2019). Against this background, the frequent presentation of birds may reflect their potential to attract attention and facilitate engagement with broader ecological themes.

How species are represented: text, images, and interpretive depth

Species are presented primarily in the main text. Illustrations were used to visualize species, other tools to describe or present species were used comparatively rarely. This aligns with the observation that on some signs species were sometimes more listed in the main text and not further explained. While presenting many species can be a way to present biodiversity, it can be discussed what a good number of species on an information sign would be. Interpretation theory emphasizes that information should be meaningful and relevant to visitors (S. Ham, 2014; Tilden, 1957). Tilden's principle that interpretation should "present a whole rather than a part" (1957) suggests that isolated fragments of information, e.g. single listed species, may be less effective than content embedded in broader ecological contexts. Similarly, research on short-term memory indicates that adults can retain only around four pieces of information without rehearsal (Cowan, 2001). Given that visitors typically spend only a short time at interpretive sign, often ranging from a few seconds to less than a minute in comparable informal learning environments (Spooner et al., 2024), extensive species lists may exceed typical cognitive engagement spans. In this context, connecting species to ecological processes or to other species may increase relevance and coherence, consistent with Ham's (2014) emphasis on thematic interpretation. A suggestion would be to decrease the number of species on a sign and increase the ecological connections of it. An example could be:"[...] coastal meadows are important resting sites for migrating waterfowl and wading birds. The breeding bird fauna is rich, with characteristic species including the northern lapwing, common redshank, and common shelduck."

The use of scientific names in public communication is debated. On one hand, taxonomic naming has been proposed as a potential tool for promoting conservation concern, as naming can influence categorization and perceived values (New, 2008). On the other hand, interpretive guidelines frequently recommend avoiding jargon and overly technical language (Moscardo et al., 2004). Empirical findings are mixed, for example Kelemen et al., (2023) found that scientific labelling had little or even negative effects on conservation concern among children when unfamiliar insect species were presented. In the surveyed signs, scientific names are often positioned next to illustrations rather than integrated into the main explanatory text. This placement may allow taxonomic precision without interrupting reading flow, thereby balancing scientific accuracy with accessibility.

Approximately half of the illustrated species are not mentioned in the main text. In some cases, images were accompanied by short descriptive captions; however, these were not coded as "species in text" if they were not part of the main body text. Images play a central role in interpretive communication. They are often the most frequently recalled elements of educational signs (Spooner et al., 2024) and are important for attracting attention and generating initial interest (Moscardo et al., 2004). Even if illustrations and the main text could be indirectly connected, for example through descriptions of the ecosystem in which a species occurs, guidelines emphasize that illustrations should be clearly related to the accompanying text (Moscardo et al., 2004), suggesting that it may still be beneficial to explicitly mention illustrated species in the running text.

In absolute numbers, plants and vertebrates account for the majority of illustrations, reflecting their overall frequency of occurrence. However, when adjusted for total occurrences, invertebrates are proportionally more likely to be illustrated, whereas plants are underrepresented in images relative to their textual presence. This pattern may initially appear noteworthy, as invertebrates are often associated with negative perceptions (Byrne et al., 1984; Kellert, 1993). However, it is largely explained by the fact that the most frequently illustrated invertebrates were *Bombus* spp. and butterflies—groups that are generally well perceived and, in the case of butterflies, commonly used as flagship species for conservation (Preston et al., 2021). The tendency for plants to appear more often in text than in images corresponds with earlier observations that plants were sometimes presented in list-like formats within the main text.

Biodiversity, ecosystems, and conservation purpose

Explaining ecosystems and biodiversity in depth does not necessarily require naming a large number of species. As indicated in the PCA and supported by individual examples in the dataset, ecosystems and biodiversity can be communicated through functional descriptions and ecological relationships. The Swedish guide for signage in nature reserves suggests to group ecologically related species to create a more coherent and ecologically grounded representation of the area (Lundin, 2003).

The conservation purpose of the reserve was explained in the main text on around two thirds of the signs. This aligns with recommendations to clarify why an area is protected and what its management goals are (Lundin, 2003). Research further suggests that conservation concern can increase when species are described in terms of their functional roles—particularly when these roles are meaningful to audiences (Kelemen et al., 2023).

Taken together, the results suggest that deeper explanations of biodiversity and ecosystem processes are structurally associated with linking species to ecological functions rather than with increasing the sheer number of species mentioned.

Interpretive tools

Research on informal science communication suggests that interpretive texts should be accessible to readers approximately between 10 and 14 years of age (Ballantyne & Hughes, 2003; Lundin, 2003; Wandersee & Clary, 2007). In terms of the LIX readability index, this corresponds roughly to a range between 30 and 40, which is generally classified as easy to moderately difficult text (grundskoleboken.se, 2026; Karmi, 2024; Reichenberg, 2000; SKOOPI Halland, 2026). The mean LIX value found in this study is slightly above this recommended range, a pattern that is consistent with findings by Janeczko et al. (2021), who similarly reported that interpretive texts were often too linguistically demanding. At the same time, the temporal analysis shows a decreasing LIX index over the years, indicating a gradual development toward more accessible language.

In contrast to the decreasing readability index, the number of words per sign increases over time. Recommendations in the literature differ but a summary would be that it is suggested that interpretive signs should contain between 30 and 200 words (Colquhoun, 2005; Hapers ferry center, 2009; Spooner et al., 2024). The signs examined in this study often exceed these values (number of words per sign ranged from 87 to 1349). Given, that visitors typically spend only a short time at interpretive signs, often only a few seconds to half a minute in comparable settings (Spooner et al., 2024), longer texts may limit the likelihood that the full content is read.

Direct address and thematic subheadings were the most frequently applied interpretation tools, whereas storytelling and explicit calls to action were used less often. Over time, the number of interpretation tools increased, although they remain unevenly distributed across the signs.

The relatively frequent use of direct address corresponds with recommendations in interpretive research, which emphasize engaging visitors directly to increase involvement and personal relevance (Ballantyne & Hughes, 2003; S. Ham, 2014). Similarly, the use of thematic subheadings aligns with guidelines suggesting that texts should be clearly structured through paragraphs and headings to facilitate comprehension and cognitive processing (Moscardo et al., 2004). These structural elements support what Wandersee & Clary (2007) describe as meaningful learning, in which new information is organized in ways that can be integrated into existing knowledge frameworks.

In contrast, storytelling and explicit calls to action were less common, even though interpretive theory highlights the importance of presenting coherent, meaningful wholes rather than isolated fragments (Tilden, 1957). Asking visitors questions, another tool recommended to stimulate active engagement (Ballantyne & Hughes, 2003; Moscardo et al., 2004), was also not widely implemented.

Overall, research describes effective interpretation as the integration of relevant, site-specific content (Ballantyne & Hughes, 2003; S. Ham, 2014; Hwang et al., 2005; Marschall et al., 2017; Tilden, 1957) with accessible language and visual media that attract attention and enhance understanding (Janeczko et al., 2021; Jensen, 2006; Lundin, 2003; Zhu et al., 2021). The observed decrease in LIX values and the increasing use of interpretation tools suggest movement toward these principles. At the same time, the rising word counts introduce a structural tension, as longer texts may challenge the goal of concise, accessible communication.

RQ3: To what extent do existing interpretive signs align with visitor interests and conservation values?

Participant interest was high across a wide range of topics and species groups, with particularly strong interest in uncommon and protected species. The signage analysis shows that a broad range of species and ecological information is presented, with uncommon species partly highlighted, indicating a good overall alignment with visitor interests.

For general topics, maps received the highest interest ratings, which strongly corresponds with the signage analysis, as 98% of the signs included maps. Maps were also frequently mentioned in open-ended responses, often with requests for additional features such as “You are here” markers or clearer trail indications. At the same time, discussions with Västkuststiftelsen indicated that such markers are sometimes removed due to vandalism. During the signage analysis, it was also observed that some maps were comparatively small. Given the high interest in orientation, increasing map size and clarity could further improve their effectiveness.

Interest in species groups was more differentiated. Insects, fish, reptiles, amphibians, and other small animals showed lower levels of interest and were also less frequently represented on the signs. In contrast, mammals were highly rated in the survey but appeared less often on signage, while birds showed both high interest and relatively frequent representation, indicating strong alignment. Plants constituted the largest group on the signs and were also of high interest, although not the highest.

These patterns highlight a central challenge for interpretation: balancing visitor interests with educational goals. While it is important to include species that visitors are already interested in to ensure relevance (S. Ham, 2014), focusing only on familiar or popular species may limit opportunities for learning. Previous research shows that appreciation for less well-known species can increase through knowledge and exposure (Lindemann-Matthies, 2005). A promising approach, also observed in the signage, is to combine charismatic species (e.g. birds) with less familiar groups (e.g. insects or lichens) to both capture attention and broaden understanding.

The strong interest in uncommon species presents both opportunities and challenges. While highlighting rare or unique species can increase engagement, research in recreation ecology points to a potential paradox: promoting sensitive or rare features may increase disturbance risks, such as trampling or wildlife harassment (Marion, 2019). Concerns raised by organizations such as Västkuststiftelsen are therefore well supported by existing literature, emphasizing the need to carefully balance information disclosure with conservation goals.

Insects received the lowest interest ratings in the survey, which may reflect generally negative attitudes toward this group. At the same time, their inclusion on signs, particularly through illustrations, may help to increase familiarity and reduce aversion. Notably, frequently depicted insect groups included butterflies and bumblebees, which are generally more positively perceived by the public (Preston et al., 2021) and may function as entry points for engaging with less familiar taxa.

The conservation purpose of the reserves was communicated on almost all signs, aligning with the very high importance attributed to nature conservation in the survey. However, this alignment should be interpreted with caution. It is possible that exposure to conservation messaging on the signs influenced survey responses, while at the same time, individuals with stronger pro-conservation attitudes may have been more likely to engage with the signs and participate in the survey.

Both anthropocentric and intrinsic reasons for nature conservation were rated equally high, suggesting that multiple value perspectives resonate with visitors. Similarly, different ecosystem services were consistently valued. However, given the overall high ratings across respondents, these results likely reflect a sample that is already strongly supportive of conservation. Conducting surveys exclusively in nature reserves may therefore introduce a bias, as such locations are more likely to attract visitors with pro-environmental attitudes (Richardson et al., 2022; Soga & Gaston, 2016). Future research should aim to include more diverse audiences to better capture a wider range of perspectives.

Limitations and future directions

This study is subject to several limitations. First, the use of QR codes placed directly next to the signs may have introduced a sampling bias, as participation was more likely among visitors who were already interested in interpretive signage. As a result, the sample may overrepresent individuals with a pre-existing interest in ecological information and nature conservation.

Second, the content analysis was conducted by a single researcher. Although a structured coding matrix was used to minimise subjectivity, some degree of interpretative bias cannot be excluded. Future studies could strengthen reliability by involving multiple coders and assessing inter-coder agreement.

Third, readability indices such as LIX should not be interpreted as comprehensive measures of communicative quality. As emphasised by Reichenberg (2000), such formulas capture linguistic complexity but do not account for conceptual structure, coherence, or relevance. In this study, LIX is therefore used as an indicative measure, suggesting that older signs may contain more linguistically demanding text and that readability is a relevant consideration when updating signage.

In addition, sign size was not systematically recorded, as the analysis was based on digital copies. Future studies could include this variable, as well as characteristics such as ecosystem type and reserve size, to allow for comparisons between different types of reserves.

Future research should incorporate complementary methods such as on-site surveys and systematic observations to capture a broader range of visitors, including those who pass by signs without engaging. Recording how many visitors stop to read signs, how long they interact with them, and how many pass without noticing them would provide valuable insights into actual visitor behaviour. Furthermore, experimental approaches could be used to test different sign designs, content, and layouts in order to assess how these factors influence attention, engagement, and duration of interaction.

CONCLUSION

Survey participants showed a high interest in species, particularly uncommon species, and rated the importance of nature conservation very highly. The signage analysis confirms that these topics are well represented. A large number of distinct species was recorded on the signs, with plants constituting the largest proportion. At the same time, the results show that communicating biodiversity effectively does not depend on the number of species presented, but rather on how ecological relationships are conveyed. Signs that link species to broader ecological contexts provide more meaningful explanations than those that primarily list species.

Overall, the findings suggests that the signs communicate ecological information that is both relevant to visitors and grounded in the local context. Temporal trends further indicate a shift in communication strategies, with an increasing use of interpretation tools and improved readability, but also longer texts and fewer illustrations.

Finally, the findings highlight both strengths and limitations of current interpretive practice. While signs successfully cover relevant ecological content, there is potential to further improve communication by focusing on ecological connections and using interpretation tools strategically. Future research should complement these findings with on-site observations to better understand how visitors engage with interpretive signs in practice.

ACKNOWLEDGEMENT

Firstly, I would like to sincerely and warmly thank my supervisor, Julia, for her support and enthusiasm throughout this project. It was a pleasure working with her, and I always felt supported and motivated by her. Her way of introducing me to the world of research made me feel confident and inspired.
I would also like to thank my examinator Anne and the course coordinator Catharina for making this project possible.
Many thanks to Västkuststiftelsen and Länsstyrelsen for providing digital copies of the signage, without which this project would not have been possible. I am especially grateful to Christina and Catharina at Västkuststiftelsen for sharing valuable insights into their work.
I also thank Ola and Martin for their feedback during the development of the survey.
A special thank you to my friend Bigna, who spend hours of driving around Västra Götaland with me to put up the QR Codes. I am also very grateful to my friends who shared the time at university and made long days feel shorter with either stretching sessions or fika breaks.
Finally, my heartfelt thanks go to my partner, Bastian, for his constant support, patience, and encouragement throughout this journey.

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Appendix

Popular science summary

"Welcome to this nature reserve" – this is how almost every information sign in a Swedish nature reserve begins. You may have seen one before, often recognizable by its characteristic blue frame. Standing at the entrance of a reserve, these signs are usually the first point of contact between visitors and the landscape. They introduce the area, explain what makes it special, and guide visitors through both nature and rules. Information signs typically present a mix of content: descriptions of habitats and species, historical background, conservation regulations, and maps to help visitors find their way. Previous studies suggest that well-designed signs can do more than just inform – they can enrich visitors' experiences, increase awareness of biodiversity, and even strengthen support for nature conservation. But what kind of information is actually presented? How are species and ecosystems described? And what do visitors really want to read? These are the central questions of this study.

The study consists of two parts. In the first part, a survey was conducted in 16 nature reserves in Västra Götaland County in Sweden. A total of 122 respondents participated, most of whom were frequent visitors to nature reserves and predominantly over 45 years old. The results showed a strong interest in ecological information, and nature conservation was rated as highly important. Many visitors expressed curiosity about species and their relationships, suggesting that signs can play an important role in shaping how people understand nature. The second part of the study focused on the signs themselves. Around 300 information signs were analyzed to examine both what is communicated and how it is presented.

In total, 4,444 species mentions were recorded, representing 1,265 different species. Plants were the most frequently presented group and also dominated visual illustrations. Interestingly, invertebrates were proportionally more often illustrated than mentioned in the text, highlighting a difference between visual and written communication. A particularly effective example of communication is the use of oaks (Quercus spp.). These appeared on nearly one-third of the signs and were often used to connect individual species with broader explanations of biodiversity. By linking a familiar tree to many associated species, the signs helped illustrate ecological relationships in an accessible way. The analysis also revealed changes in communication over time. Texts have become longer, while readability has decreased. At the same time, the number of illustrations and the number of species mentioned per sign have declined. In contrast, the use of interpretation tools – such as storytelling, comparisons, or explanatory framing – has increased.

Overall, the patterns identified in the signage analysis largely correspond with the interests expressed by visitors in the survey. This suggests that many signs already address what visitors are curious about. However, the study also highlights opportunities for improvement. Strengthening the focus on ecological connections and combining clear language with engaging visual elements could make information signs even more effective. In this way, they can continue to support both meaningful visitor experiences and a deeper understanding of biodiversity.

Table A1: Survey questions

Overall category	Question	Question type
Interest in different types of information	1. Are you interested in signs in nature reserves?	Likert-scale 1-5
	2. What type of information about the nature reserve are you interested in reading on signs? a. Map b. Recreation and activities c. Regulations d. Pictures / illustrations e. Local history f. Environment and sustainability g. Nature management / conservation h. Plants and animals i. Protected species and why they are important	Likert-scale 1-5
	2b. Was something missing in the list? What would make you stop and read on a sign?	Open question, voluntarily
Interest in different types of species	3. How interesting do you think it is to read about the following groups of organisms on a sign? a. Tree and other plants (shrubs, herbs) b. Mosses, lichen, fungi c. Mammals (e.g. deer, fox, squirrel, mouse) d. Birds e. Fish f. Amphibians (e.g. frogs), reptiles (e.g. snakes) and other small animals (e.g. snails, spiders, worms) g. insects	Likert-scale
	4. How interesting do you think it is to read about the following groups of organisms on a signs? a. Uncommon species b. Common species	Likert-scale
	4b. Are there any other organisms or special species that you living in this nature reserve and that you think should be on the signs?	Open question, voluntarily
Importance of nature protection	5. How important do you think it is to protect nature?	Likert-scale (1-5)
	6. Why do you think it is important to protect nature? a. For natures own sake – nature has a value independent of what humans get from it b. Because nature is important for us humans	Likert-scale (1-5) Only if you rate higher than 2 at question 7
	6b. Are there any other reasons why do you think it is important to protect nature?	Open question, voluntarily Only if you rate higher than 2 at question 7

	7. How important do you think the following reasons to protect nature are? a. Food, water, medicine and other resources b. Clean air, clean water, stable climate, pollination c. Protection against illness and nature catastrophes d. Natures cycle and soil regeneration e. Natures beauty and meaning f. Recreation	Likert scale (1-5) Only if you rate higher than 2 at question 7
	8. Why do you think it is not important to protect nature? a. Nature is going to regulate itself b. Human needs first	Likert scale (1-5) Only if you answer 1 or 2 at question 7
	8b. Is there any other reason why do you think it is not important to protect nature?	Open question, voluntarily Only if you answer 1 or 2 at question 7
Information about nature reserve	10. In which nature reserve are you right now?	Choose one option
	11. How much do you like the sign from which you scanned the QR-Code to the survey?	Rating 1-5 stars
	12. How can the signs be improved?	Open question, voluntarily
Demographic data	13. How old are you? c. Under 18 d. 18-30 e. 31-45 f. 46-60 g. Older than 60	Choose one option
	14. Which gender do you identify yourself with? a. Woman b. Man c. Non-binary / other d. Prefer not to say	Choose one option
	15. How often do you visit nature reserves or protected natural areas? a. A few times a week b. A few times a month c. A few times a year d. Less than once a year	Choose one option
	Thank you for your time. If you are interested in further information, please write your e-mail address.	

Table A2. Documented variables for each sign

Column	Explanation	Data type
Reserve	Which reserve	Text
Sign-ID	Name of the pdf document	Text
Year	The year that was written on the sign	Numeric
Year_grouped	before or after 2014	Binary
LIX	Läsbarhetsindex (readability index)	index
Number_words	Number of words on the sign	Numeric
Number of illustrations	Number of illustrations	Numeric
Text_to-illustration-ratio	Number of words divided by Number of illustrations	Ratio
Call_to_action/ question	Number of calls-to-action or questions	Count
Direct address	Number of direct addresses of the reader	Count
Storytelling	Number of uses of storytelling	Count
Subheadings	Presence of absence of thematic subheadings	Binary
Map	presence or absence of map	binary
Map trails	presence or absence of map	Binary
Map activities	presence or absence of activities marked in map	Binary
Map scale	presence or absence of map scale	Binary
Rules	presence or absence of rules	Binary
English	presence or absence of English text	Binary
Conservation purpose	0 = no explanation 1 = at the edge 2 = explained in the text	Ordinal scale
Ecosystem	0 = no explanation 1 = ecosystem(s) named and explained shortly 2 = explained more detailed	Ordinal scale
Biodiversity	0 = biodiversity/species richness not named or described 1 = biodiversity/species richness named or described 2 = how multiple species are connected to each other 3 = why biodiversity/species richness is important	Ordinal scale
Number_species	Number of species named	count

Table A3. Documented variables for each species

Column	Explanation	Data type	Example
Reserve	Which reserve	Text	
Sign_ID	name of pdf	Text	
Species	Common name of the species	Text	
Taxonomic group		Text	
Broad species category	Fungi-lichen-moss plants vertebrates invertebrate	Text	
Scientific_name	scientific name	Binary	
Species_shown	if the species is shown	Binary	
Species_description	Presence or absences of species description / fun fact about the species	Binary	
Species_uncommon	if species is described as uncommon	Binary	
Species_species_connection	Presence of connection between another species explained/named	Binary	
Species_ecosystem_connection	0 = no connection 1 = in which ecosystem / landscape the species lives 2 = specific description of how the species is connected to the ecosystem	Ordinal	**1 =** Knärot, Goodyera repens, är en knappt decimeterhög orkidé som växer i mossrika barrskogar. **2 =** Att trumgräshoppan trivs vid Bölets ängar är ett mycket gott betyg. Den svårflirtade gräshoppan har en rejäl kravlista. Det ska vara soligt, torrt och välhävdat – annars får det vara. Det är krav som rimmar ganska illa med det moderna jordbrukslandskapet. Följaktligen har trumgräshoppan försvunnit från stora områden i landet. Nu är hon sällsynt och hotad.

Table A4. Swedish translation

Column	Explanation	Example
Call-to-action question	Number of calls-to-action or questions	”Tittar man noga på backnejlikan...”
Direct address	Number of direct reader address	“Vill du uppleva rariteter får du sitta still i denfuktiga granskogen och vänta på järpen.”
Storytelling	Number of uses of storytelling	”Körsbärsträdens blom bäddar in landskapet vid Bolums lider på våren. Det är som att mjuka moln har strandat bland backarna. Humlor surrar i krontaket och gullvivor och backsippor sträcker på sig.”
Conservation purpose	0 = no explanation 1 = at the edge 2 = explained in the text	1 = Naturreservat avsätts för att bevara områden med värdefull natur och för att trygga tillgången på mark för friluftsliv. (written in the corner of the sign) 2 = Ålstadnäset blev naturreservat 2019. Syftet är att restaurera det gamla odlingslandskapet och dess naturvärden. Granskog avverkas och betesmarker återskapas genom röjningar. De gamla, värdefulla lövträden ska åter få ljus och utrymme. Samtidigt formas ett landskap som är attraktivt för oss människor att ströva i.
Ecosystem	0 = no explanation 1 = ecosystem(s) named and explained shortly 2 = explained more detailed	1 = Det finns åtskilliga ålderstigna tallar och ekar i naturreservatet. Vackra och ståtliga träd, väl värda en stunds betraktelse och beundran. Ekarna och tallarna trivs fint i anslutning till den bitvis dramatiska sandstensklev som löper genom området. 2 = Attebo naturreservat består i huvudsak av gammal och orörd barrskog, men här och var gör lövskog och fuktstråk inbrytningar. En bäck har också mejslat väg genom områdets sydvästra del. I de fuktiga partierna trivs den vackra missnen, medan den sällsynta sotlaven föredrar torrare marker.
Biodiversity/ Species Richness	0 = not named or described 1 = named or described 2 = how multiple species are linked to each other 3 = why biodiversity/species richness is important	1 = I lövlundarna trivs många olika växter, I de grunda vattnen söder om Älgön finnsstråk av ålgräsängar, som är en viktiguppväxtmiljö för fiskar 2 = Gamla lövträd är ovanliga i dag. Och de är värdefulla! Engammal ek kan vara livsmiljö för hundratals växt- och djurarter. Lavar och mossor på stam och grenar. Småkryp på barken, i veden och inne i murkna stammar. Andra lövträd, som alm och lönn, har på samma sätt en lång rad arter som är knutna till dem.

Table A5. Number of responses per reserve

Reserve	Number of responses
Änggårdsbergen	27
Sandsjöbacka	27
Säveån	15
Stora Amundö	12
Vrångöskärgården	12
Guddehjälm	8
Österplana hed och vall	5
Svartedalen	4
Brobacka	3
Höjentorp-Drottningkullen	3
Rya Åsar	3
Ramsvikslandet	2
Halle Hunneberg	1
Fegen	0
Havstensfjorden	0
Kråkebo	0

Table A6. Demographic characteristics of the respondents.

Demographic data	n	percentage
Gender		
Female	63	51.60
Male	56	45.90
Non-binary	1	0.82
Prefer not to say	2	1.64
Age		
<18	1	0.82
18-30	20	16.40
31-45	27	22.10
46-60	45	36.90
60+	28	23.00
NA	1	0.82
Visit frequency		
Few times a week	60	49.10
Few times a month	38	31.10
Few times a year	19	15.60
Less than once a year	5	4.10

Participants are categorized by gender and age group. 'n' indicates the number of participants in each category (n total = 122), and '%' represents the proportion of the total sample.

Table A7. Answers to open questions.

Saknades något i listan? Vad skulle få dig att stanna och läsa på en skylt? (Frivilligt)	I vilket naturreservat befinner du dig?
Ännu tydligare markeringar.	Änggårdsbergen
Clearer signs where biking is forbidden	Änggårdsbergen
Fler uppgifter om avstånd till olika deletapper på de olika stigarna området.	Änggårdsbergen
Flerspråkig information	Änggårdsbergen
Information om kollektivtrafik och om inte bara bilparkering. Information om hur människa och stad hotar de naturtyper som skyddas i reservatet. Tips på vad man kan göra/ändra i sin vardag för att minska hotet.	Änggårdsbergen
Leder och spår	Änggårdsbergen
Någonting där jag själv eller barna kan bli aktiv, t.ex. en qr-kod med länk till en virtuell tipspromenad eller dylikt. Eller någon form av träningspromenad där det rekommenderas alla 100 m någon aktivitet såsom tex 10 grodhopp mfl.	Änggårdsbergen
Om det finns historiska lämningar. Om det finns kulturbevarande miljöer. Flora och fauna. Speciella arter?	Änggårdsbergen
Questions to reflect yourself or informations to take in your daily life	Änggårdsbergen
Skulle vara bra med lite information om området som ansluter till naturområdet. För att få en lite tydligare uppfattning om var man hamnar eller kan påbörja sin vandring.	Änggårdsbergen
Tack	Änggårdsbergen
Tydlighet i att man EJ får ha lösspringande hundar i naturreservat.	Änggårdsbergen
Visa nivåer av rödlistning NT, VU, EN etc med vad det står för.	Änggårdsbergen
Karta över området och förslag på vägar och stigar med längd och hur markeringarna ser ut längs vägen	Brobacka
Mer historia	Brobacka, Alingsås
När faktaskyltar interagerar med saker på ett pedagogiskt sätt. Ex skylten i Brobacka som beskriver olika bergarter och där större stenar visar de olika exemplen. Att skyltarna är uppdaterade och underhållna så att de går att läsa på ett enkelt sätt. Skyltarnas tillgänglighet i text och utformning. Att möjliggöra att för så många som möjligt kan ta del av informationen på skyltarna. Är det mer omfattande text dela in det i olika stycken med underrubriker. Att skyltarna är tydliga och att de är logiska att ta till sig att ex den bilden tillhör den texten som är närmast. Finns mycket på detta område som kan göras för att tillgängliggöra för personer med neuropsykiatriska funktionsvariationer.	Brobacken
Promenadslingor på kartan med angiven längd på slingan.	Guddehjälm
Att hundar måste hållas kopplade. Att cykling inte är tillåten på lederna. Att det inte är en uppställningsplats för husbilar och campare.	Höjentorp-Drottningkul-len
De är viktigt att kartbeskrivning stämmer	Höjentorp-Drottningkul-len
Tydligare kartor ch avståndsuppgifter på ledmarkeringen	Kinnekulle. Utsiktstornet

Lagom med text nu. Mer text på infotavlorna gör nog att det inte blir läst. Hänvisa till hemsida för ytterligare info!	Österplana hed och vall
Intressant bild	Rya Åsar
Avstånd på vandringslederna hade varit bra så man vet hur långt man går om man väljer olika spår.	Sandsjöbacka
Avståndet	Sandsjöbacka
Det är riktigt bra med den digitala quizen. I Sandsjöbacka 11 stationer. Jag tror att det vore bra att byta frågor oftare, kanske varje månad	Sandsjöbacka
Längdindikering (km) av motionsspår, specifika skyltar som påminner om allemansrättens skyldigheter samt förhållningsregler för hundar.	Sandsjöbacka
Reklam	Sandsjöbacka
Språk. Även engelsk text behövs pga många invandrare som behärskar svenska språket.	Sandsjöbacka
Vart det finns papperskorgar Markering ”här är du” saknas ofta utsatt på kartan, tex här i sisjön	Sandsjöbacka
Viktigt att det är tydligt med var det är ok/inte ok att elda, tälta osv. Inför gärna förbud på bärbara högtalare.	Sandsjöbacka
Kunde vara mer information runt kraftverken och hur fiskarna kan komma förbi turbinerna.	Säveån
Tydligare info om kopplad hund. Detta eftetlevs mycket dåligt På stolparna räckerna mindre skylltar 4x4 cm ca	Säveån
Väg och stigöverskikt	Säveån
vandringsled, cafe, dricksvatten, vindskydd	Säveån
Roligt med digital tipspromenad där frågorna byts oftare	Sisjön
En skylt där det står uttryckligen att man skall plocka upp bajs från sina hundar.	Stora Amundö
Gärna info om betande djur och hur man ska förhålla sig till dem. Och kontaktuppgifter till ansvarig ifall man vill rapportera konstiga saker (trasiga staket, sjuka djur, nedskräpning etc).	Stora Amundö
Hade velat ha nån form av skylt med info om längden på de olika vägarna på ön. Km.	Stora Amundö
Markerade stigar	Stora Amundö
Uppdaterad information om var vindskydd finns samt sträckan och stigningen att promenera till dessa.	Svartedalen
Drönarfoto tillåts eller ej?	Vrångöskärgården
Karta med var intressanta grejor finns.	Vrångöskärgården
Kartorna måste bli bättre, leder tydligt utmärkta, eller hänvisa bättre till nätlänk.	Vrångöskärgården
Vad är unikt med platsen, historia, natur, djurliv och skötsel	Vrångöskärgården
Hur kan skyltarna förbättras? (Frivilligt)	**I vilket naturreservat befinner du dig?**

Add info - building fires forbidden - clearer where biking is forbidden - also - you need to dig up the growth in the water areas - as some ponds are being choked by too much growth - risk of losing our water areas	Änggårdsbergen
Fler kartor och koppeltvång	Änggårdsbergen
Fler språk	Änggårdsbergen
Generellt är skyltarna i reservatet fallfärdiga. Vissa har ramlat planscherna i spruckna solblekta på vissa ställen av gnagda och kompletterande på ett sådant sätt att sammanhanget inte syns.	Änggårdsbergen
Göra de enkla att fotografera av eller med qr- kod publicera dem som pdfer att ladda ner så att man kan ta med sig informationen på sin promenad. Kanske göra en interaktiv karta så att telefonen plingar till när man närmar sig ngn kategori av saker som man har fått ange intresse för? Kanske länka till ljudfiler med fågelsång för aktuella arter eller filmer och texter som fördjupar informationen.	Änggårdsbergen
Har länge saknat tydlig skyltning var ridning inte är tillåtet, tex ljungheden och runt mossarna. Blir ibland utskälld av ryttare, eller så låtsas de att de inte har en aning.	Änggårdsbergen
Jag tycker rubriken för förbud var lite missvisande eller i alla fall inte helt tydlig.	Änggårdsbergen
Mer regelbundet underhåll så de inte blir lika slitna som nu.	Änggårdsbergen
Några leder är inte utmärkta (cykelleder). Den gulsvartas leden står inte med förklarad	Änggårdsbergen
Området runt naturområdet, så att det blir lättare att hitta in och ut	Änggårdsbergen
Se på de nya föredömliga infoskyltarna somm Mölndalskommun nyligen har ställt up. Kopiera gärna dessa även på Göteborgssidan.	Änggårdsbergen
Se till att kartans plats syns tydligt på kartorna. Ingen av de kartor jag passerade hade någon symbol där kartans plats markerades.	Änggårdsbergen
Tydligare om hur området förvaltas och vart man ska vända sig om man märker att reglerna överträds (ridning och cykling på otillåtna stigar bland annat)	Änggårdsbergen
Tydligare i terrängen	Brobacka
En stor hjälp för utländska gäster/vänner skulle vara en QR-kod bredvid skylten med svensk text. Åtminstone Tysk o Engelsk text.	Brobacka, Alingsås
Se tidigare svar punkt 3	Brobacken
Skyltarna om att blå led är stängd sitter fortfarande uppe om man går vänstervarv från parkeringen	Guddehjälm
Information om; Att hundar måste hållas kopplade. Att cykling inte är tillåten på lederna. Att det inte är en uppställningsplats för husbilar och campare.	Höjentorp-Drottningkul-len
Vandringsleden var inte korrekt på kartan	Höjentorp-Drottningkul-len
Lagom med text som det nu är. Håll den uppdaterad och använd modernt språk så folk begroper	Österplana hed och vall
Såg inga skyltar som visade vägen till martorpsfallet, så det efter några kilometer vände vi om och åkte hem istället	Österplana hed och vall
Även en skylt på engelska för turister	Rya Åsar
Det borde vara obligatorisk att det är markerat på kartan var på kartan informationstavlan är. Som det är nu är det väldigt oklart	Rya Åsar

Ännu mer tydligt kring vilka regler som gäller. Men också mer inbjudande till att läsa och titta på skyltarna.	Sandsjöbacka
Bättre design, mer informativ med information i punktform eller mindre stycken med tydliga rubriker. Dagens skyltar känns uråldriga och har stora illustrationer som inte tillför något, och en lång löptext som ingen orkar läsa	Sandsjöbacka
Bättre regelbundet undrhåll	Sandsjöbacka
Bra med kartor. Gärna med tydlig markering av var man är;-). Uppskattar verkligen de fantastiska områdena och uttnyttjar dom flera gånger i veckan för löp, promenad, vandring mm. Tror områdena sköts bla av Västkuststiftelsen. Hade gärna lärt mig mer lm den och om man kan stötta på nåt sätt	Sandsjöbacka
Den är bra, tydlig och informativ som de är. Det var ju så i Sandsjöbacka men ofta i andra områden är skyltningen ofullständig speciellt i Göteborgs kommun. Skändlaberget behöver en rejäl uppdatering angående spår och information av historie- och naturkunskap, Hisingsparken är också efterbliven och det är synd för det rör sig mycket folk i parken.	Sandsjöbacka
Det är viktigt att informationen även är engelska eftersom det finns många invandrare som inte behärskar svenska språket. Var särskilt tydlig med var man kan elda och informationen om detta eftersom det eldas överallt med skador på berghällar. Detta problem har ökat senaste åren.	Sandsjöbacka
Info om förbud mot motorfordon och lösa hundar. Just här fattas även en av två skyltar	Sandsjöbacka
Mer interaktiv info	Sandsjöbacka
Tätare uppdatering. Skyltarna slits av väder och vind. Vissa skyltar svåra att läsa pga slitage.	Sandsjöbacka
Tycker de är toppen redan.	Sandsjöbacka
Vart det finns papperskorgar Markering ”här är du” saknas ofta utsatt på kartan, tex här i sisjön.	Sandsjöbacka
Visa mer av omgivningen. Nu är det bara streck	Sandsjöbacka
Designas om från grunden	Säveån
Förnyas och auktalliseraS	Säveån
Markera på tydligt infoskyltar vad som gäller montainbike-cykling på gångstigarna. Är det tillåtet? Är det förbjudet? Och konsekvent skyltat för alla infarter till naturreservatet.	Säveån
Med en QR-kod som länkar till relevant sida för att felanmäla saker i området.	Säveån
Tydligare om vaf man EJ får göra Vilket är självklart för de flesta!!!!	Säveån
Ange att inte bilar, eldrivna mopeder, sparkar mm är tillåtna. Idag står bara arr cykel inte är tillåten. Kanske inte sätta alla ovanför varandra kan vara svårtolkat ex dom vid bron till Amundön. Där står Max 10 km cykelförbud och maxbikt på samma stolpe. Inget står om bil/mopeder/ elsparkar etc.	Stora Amundö
Clickbait	Stora Amundö
Den satt löst och kommer blåsa bort när vinden ökar och åka i vattnet och bidra till nedskräpning	Stora Amundö
Skyltplakatet lutar (mindre skönhetsfel som inte stör mig men kan störa andra som tycker det ser ovårdat ut). Skylten sitter intill Göteborgs Stads skylt och det är ju staden som sköter reservatet, men enligt skylten så är det GU och Västkuststiftelsen som ska förbättra informationen. Vem har ansvaret egentligen, hur kommer staden in kan man undra.	Stora Amundö

Ange delsträckornas avstånd samt hur kuperad terrängen är, typ av stig etc så att man kan avgöra tidsåtgången och svårighetsgraden för att ta sig till ett ställe. Märk ut alla vindskydd.	Svartedalen
Den ser lite gammal ut och har inte så mycket information	Vrångöskärgården
En prick med var jag är på kartan	Vrångöskärgården
Förnya, bättre kartor,	Vrångöskärgården
Skriva till utländska turister att de inte får skräpa ner och respektera allemansrätten	Vrångöskärgården
Tydligare karta, gärna information på flera språk om regler gällande tältning, etc	Vrångöskärgården
Finns det någon annan anledning till varför du tycker att det är viktigt att skydda naturen? (Frivilligt)	**I vilket naturreservat befinner du dig?**
Bevarande av dem biologiska mångfalden. Bevarande till kommande generationer.	Änggårdsbergen
Grönområden behövs i stadsmiljö som "lungor", rekreationsområden, syrebärsre, luftrenare, och inte minst för att ge plats åt avrinning vid regn och skyfall och motverka översvämningar.	Änggårdsbergen
Naturen är jordens lunga	Änggårdsbergen
Our well being is dependent on the well being of the nature around us. We are responsible to care for our nature for now and generations forward	Änggårdsbergen
Viktigt med natur nära städer så att innevånare inte tappar kontakt med och förståelse för naturen.	Änggårdsbergen
För framtiden	Brobacka
För att det kan påverkar våra ekosystemtjänster och även påskynda klimatförändringar mycket fortare och samtidigt kan vi skydda oss genom olika bevarande av miljöer och expandera/utveckla miljöer där det finns förutsättningar för detta.	Brobacken
Klimatet är väl svar nog. Även välmående för djur o människor	Guddehjälm
Det är vår framtid och rekreation	Höjentorp-Drottningkul-len
Bibehålla länken mellan människa natur. Annars riskerar naturen att bli något främmande och skrämmande	Rya Åsar
Alla mår bra av naturen	Sandsjöbacka
Det är en lyx att ha tillgång till naturen som vi har i Sverige.	Sandsjöbacka
För att vi människor ska överleva	Sandsjöbacka
För den är så himla fin vi behöver naturen för rekreation, önskar att alla människor fattar det! Naturen fanns innan människan kom och förstör och stör den.	Sandsjöbacka
Höja kunskapsnivån i samhället om vårt ekosystem	Sandsjöbacka
Naturen är ju en resurs	Sandsjöbacka
Vår existens	Sandsjöbacka

Viktig plats för rekreation	Sandsjöbacka
Balans i ekosystemet	Säveån
Utan naturen kan inte människan finnas	Säveån
Vi lånar bara den och den skall bevaras till kommande generationer.	Säveån
För våra efterkommande	Stora Amundö
Hälsa (avslappning, motion), social samvaro (både gamla bekanta och nya man råkar träffa). Om reservatet o informationen sköts väl så kan det också ge goodwill till förvaltare/reservatsansvarig och en förståelse av vikten med reservat och natur och vart skattepengarna går/behövs till.	Stora Amundö
Natur i tätbebyggda städer är unika och Amundön är en av de miljöer som bör bevaras.	Stora Amundö
För framtiden och framtida generationer	Vrångöskärgården
Jordens framtid	Vrångöskärgården
Oerhört viktig för vår mentala och fysiska hälsa, källa till glädje och vila, motvikt till allt som sker i världen, en gång borta så går den inte att återskapa. Ovärderlig.	Vrångöskärgården
Finns det andra organismer eller speciella arter som du vet finns i det här naturreservatet och som du tycker borde finnas med på skyltarna? (Frivilligt)	**I vilket naturreservat befinner du dig?**
Ev rödprickadd arter och hur man kan underlätta miljöerna för dessa	Änggårdsbergen
Gärna utritad, speciella utsiktspunkter och avståndsberäkningar och svårighetsgrad och gå. Försök hålla hästar och cyklister borta.	Änggårdsbergen
Nej	Änggårdsbergen
Tack	Änggårdsbergen
Det som är unikt för området i fråga	Brobacka
Olika sorters lav hade varit intressant och mossa	Brobacken
Vattensalamander, om dem inte har dött ut vill säga.	Österplana hed och vall
- Mikroorganismer, hur de hänger ihop - Symbioser mellan olika växter	Sandsjöbacka
Fästningar	Sandsjöbacka
Liten hackspett. Lom.	Sandsjöbacka
Vattensnok	Sandsjöbacka
Kungsfiskare	Säveån
Nope	Säveån
Jag tycker det är väldigt synd att snorkellefen inte finns kvar!! En sån unik grej som är synd att den inte finns kvar.	Stora Amundö
Uppmärksamma gärna även främmande invasiva arter, utsedda landskapsarter (folk verkar intresserade av dem) och allra helst ekologiskt viktiga arter.	Stora Amundö

Table A8. Summary of the variables on each sign.

Variable	mean	SD	0	1	2	3	NA
Year	2015	7					141
Number of species per sign	15	9					
Number of illustrations	5	2					
Number of words	478	152					11
Words per species	45	37					11
Text to illustration ratio	105	55					11
Readability index (LIX)	41.8	4					11
Ecosystem explained			32	96	94		78
Biodiversity explained			120	126	54	0	
Conservation purpose			20	91	189		
Thematic subheadings (yes / no)			154	146			
Direct address (yes / no)			148	152			
Call to action / question (yes / no)			235	65			
Storytelling (yes/no)			248	23			29
English (yes/no)			69	231			
Rules (yes/no)			5	295			
Map			3	296			1
Map activities			157	140			3
Map scale			7	290			3
Map trails			77	220			3

Table A9. Species Occurrences and Richness with Swedish common name.

Group	Count	Richness	Subgroup	Count	Richness	Top 3 Species	Count
Plant	2339	508	*Flowering	1188	299	blåsippa	54
						ljung	34
						gullviva	26
			Tree	671	48	ek	96
						tall	80
						gran	52
			*Non-flower-ing	312	125	tuvull	15
						darrgräs	12
						gullpudra	11
			Orchid	144	30	ängsnycklar	17
						knärot	16
						korallrot	9
			Shrub	24	8	pors	8
						skogstry	6
						getapel	3
Vertebrates	1306	306	Bird	1080	218	mindre hackspett	42
						tjäder	38
						spillkråka	32
			Fish	127	48	öring	14
						havsöring	11
						gädda	10
			Mammal	78	27	rådjur	13
						älg	11
						bäver	9
			Amphibian	15	8	mindre vattensala-mander	3
						större vattensalaman-der	3

			Reptile	6	5	strandpadda	2
						hasselsnok	2
						huggorm	1
						orm	1
Mosses and lichen	389	187	Lichen	212	90	lunglav	28
						blylav	9
						kattfotslav	8
			Moss	177	97	fällmossa	11
						vitmossa	11
						vedtrappmossa	9
Invertebrates	244	160	Insect	166	111	humla	8
						makaonfjäril	8
						guldvinge	5
			Mollusk	40	24	blåmussla	7
						flodpärlmussla	5
						grynsnäcka	3
			Crustacea	19	12	havstulpan	3
						sandräka	3
						krabba	2
			Other inverte-brate	19	13	sjöstjärna	4
						havsborstmask	2
						sandmask	2
Fungi	130	91	Fungi	130	91	kandelabersvamp	8
						svavelticka	4
						ekskinn	3
Aquatic plants and algae	36	14	Aquatic plant	31	10	ålgräs	10
						näckros	5
						vit näckros	4
			Algae	5	4	sockertare	2
						blåstång	1
						brunalg	1

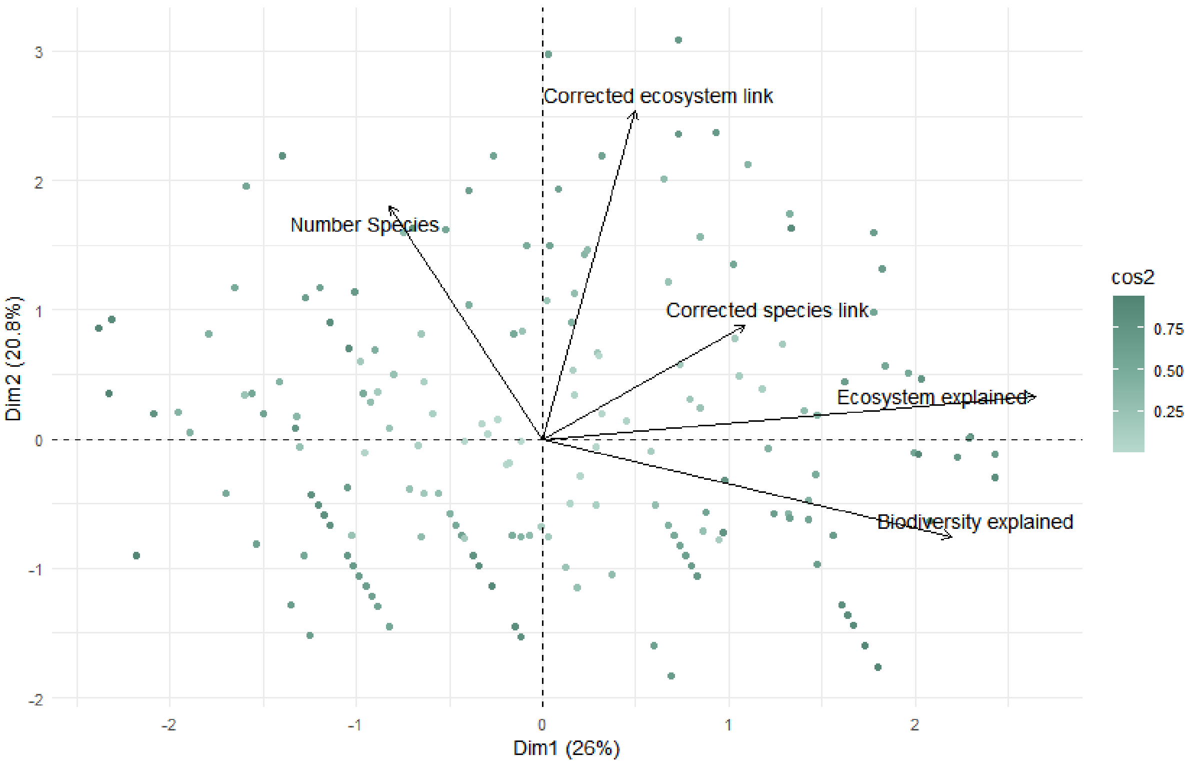

Figure A1. PCA with 10% Outliers

Table A10. List of reserves from PCA.

ID	reserve	ID	reserve	ID	reserve	ID	reserve	ID	reserve
1	Älgöleran	41	Ekedalen	81	Linnés bokar	121	Bäckagården	161	Ranneberget
2	Bäckedalen	42	Norra Båsane	82	Väggårdsskogen	122	Borgehalll	162	Sydbillingens platå
3	Brokvarn	43	Skallstadens domänreservat	83	Osten	123	Gåran	163	Valekleven
4	Eahagen Öglunda ängar	44	Nolberget	84	Lerstugesjön	124	Hästhagen	164	Jonsereds strömmar
5	Fårdala	45	Bråtaskogen	85	Stipakullen Vartofta-Åsaka	125	Klosterängen	165	Healedet
6	Hene-Skultorp	46	Torpanäset	86	Sunnersiken	126	Lerdala Hassel-lund	166	Havstensfjor-den
7	Höjentorp-Drottningskullen	47	Karsmossen	87	Mellomsjömyren	127	Skansen Läckö	167	Norra Fågelås ekhage
8	Hullsjön	48	Grinnsjö domän-reservat	88	Aplagårdsskogen	128	Stigfjjorden	168	Grevagården
9	Jättenekärret	49	Folkeberg	89	Ökull-Borregården	129	Vägeröd	169	Kärna bokskog
10	Kalven	50	Gullspångsälven	90	Näsaviken	130	Sörknatten	170	Kockholmen
11	Kalvön	51	Hovet	91	Silverfallet-Karlsfors	131	Hyltenäs kulle	171	Frö-storpabäcken
12	Kleven	52	Parkudden	92	Öjemossarna	132	Hökensås	172	Marstrand
13	Knätte	53	Östra och västra fågelön	93	Mårbykärret	133	Näsbokrok	173	Djupadalen Dala
14	Korsviken	54	Frugårdsudde	94	Stora Röå	134	Nöddökilen	174	Grevbäcks ek-hagar
15	Kynnefjäll	55	Strömsholm	95	Melldala	135	Bratteforsån	175	Surö bokskog
16	Lärkemossen	56	Smula ås	96	Stora Bjursjön	136	Hällsö	176	Härön
17	Moghult	57	Österplana hed och vall	97	Sandgärdet	137	Rånna Ryd	177	Store Mosse
18	Mollungen	58	Ålleberg	98	Tösse skärgård	138	Södra Harska	178	Onsö
19	Näverkärr	59	Lugnås kvarn-stesgruvor	99	Kållands skärgård	139	Otterön	179	Verleskogen
20	Nolheden	60	Borgundaberget	100	Syltängarnas domänreservat	140	Skarsdalsbergen	180	Klev
21	Nordre älvs	61	Skålltorp	101	Stockesundet	141	Svankila	181	Ettaks strömmar
22	Norra Öddö	62	Sätuna utmark	102	Ruderskogen	142	Harsholmarna	182	Håketjärnarna
23	Öjemossen	63	Ingasäter-Rödegården	103	Hökaberg	143	Lammevadskärret	183	Halla
24	Orrevikskilen	64	Djuppedalssgrotta	104	Garparör	144	Stömmarna	184	Hulta hagar
25	Pater Noster	65	Lindberga	105	Skogastorp	145	Yttre bodande	185	Röå alsumpskog
26	Råssö	66	Nolgården Näs	106	Göddered-Hakered	146	Kallsågsmossen	186	Ålstadnäset
27	Rished	67	Sjöängen	107	Linhult	147	Sunninge sund	187	Kednäs
28	Saltö	68	Heråmaden	108	Logården	148	Ödsmåls Kile	188	Blängsmossen
29	Svanvik	69	Mularpabäckens dalgång	109	Tidans kvillar	149	Öjersbyns gam-melskog	189	Sjöamad
30	Tingvallmossen	70	Baremosse	110	Bockaskedeåsen Toran	150	Munkakängarna	190	Lena borg
31	Tjurholmen	71	Vallholmen	111	Hadängs lövskog	151	Mariedalsån	191	Klåverön
32	Toftenäs	72	Dättern	112	Hångers udde	152	Ragnerudsjöns branter	192	Brömm skärgård
33	Trälebergs kile	73	Uvviken-Kyrkogårdsön	113	Furnäsudde domänreservat	153	Ranebo na-turskog	193	Nordön
34	Uggleberget	74	Letebo	114	Myrhulta mosse	154	Kedholmen	194	Oxeklkev
35	Vänersnäs	75	Valstad	115	Tovaberget	155	Valdalsbergen	195	Loringaskogen

36	Vargö	76	Klyftamon	116	Löjtnantsholm	156	Hulan	196	Valön
37	Kleva klintar	77	Sjöryd	117	Strömslund	157	Ramhultafallet	197	Bölets ängar
38	Gunniltorp	78	Kullagården	118	Grimmestorp	158	Lycke	198	Sparresäter
39	Dätterstorp	79	Nordsjömyren	119	Levene äng	159	Vallebygden		
40	Attebo	80	Ore backar	120	Kviström	160	Kycklingkullen		

Table A11. Summary of the models for temporal analysis

Variable	Model type (GLM)	Estimate	z-value	p-value
Number of words	Negative binomial	0.023	6.919	<0.001
LIX	Poisson	-0.006	-3.024	0.002
Number of illustrations	Poisson	-0.013	-2.320	0.020
Number of species	Negative binomial	-0.015	-2.206	0.027
Text-to-illustration ratio	Negative binomial	0.033	6.706	<0.001
Words per species	Negative binomial	0.026	3.453	<0.001
Call to action / question ratio	Negative binomial	0.046	10.8	<0.001
Direct address ratio	Negative binomial	0.079	7.350	<0.001
Number of storytelling uses	Poisson	0.077	1.853	0.064