



# **Optimization of interpretive signage for the protection of an endangered species in the natural park Ammergauer Alpen in Germany**

A thesis submitted to the TUM School of Life Sciences  
Master's Program Sustainable Resource Management  
in partial fulfilment of the requirements for the degree of  
Master of Science

by

**Valentina Arros**

03736107

Supervisor:

**Dr. Klaus Pukall**

Chair of Forest and Environmental Policy, TUM

August, 2023

# Table of Contents

Abstract .....	6
1. Introduction.....	7
1.1. State of knowledge.....	12
1.1.1. Information content system .....	13
1.1.2. Graphic system .....	15
1.1.3. Perceptions and behavior in relation to signage.....	17
1.2. Research gap .....	19
1.3. Goal and research questions .....	20
2. Study area and Methods .....	22
2.1. Study area.....	22
2.2. Methods and data collection.....	23
2.2.1. Normative research.....	24
2.2.2. Descriptive research .....	25
2.2.3. Prescriptive research .....	26
2.2.4. Evaluative research.....	28
3. Results .....	30
3.1. Descriptive research.....	30
3.1.1. Attitudes and motivations towards parks, habitats, and wildlife.....	31
3.1.2. Attitudes and perceived behavioral control in relation to human activities that cause wildlife disturbance .....	34
3.1.3. Attitudes and relationship of visitors with signage .....	37
3.1.4. Gaps between lay people and expert knowledge.....	38
3.2. Prescriptive research.....	39

3.2.1.	Key principles for signage design.....	39
3.2.2.	Guidelines for the written content of signage .....	41
3.2.3.	Guidelines for the graphic and visual approach of the signage .....	45
3.2.4.	Signage designs.....	47
3.3.	Evaluative research.....	50
3.3.1.	Characterization of interviewees .....	50
3.3.2.	Aspects remembered in a short period of time.....	51
3.3.3.	Respondents' perceptions regarding signage .....	53
3.3.4.	Previous experiences and emotions .....	58
3.3.5.	Differences between participants related and non-related to nature	59
4.	Discussion .....	61
4.1.	Signage properties that generate greater visual attraction and better perception .....	61
4.2.	Signage factors that facilitate easier and more accurate understanding of the information provided.....	62
4.3.	Components of the written content on the signage that most effectively communicate the behaviors that cause or reduce disturbance to birds. ....	65
4.4.	Updated version of the signage.....	67
5.	Conclusions.....	68
	References .....	71
	Appendices.....	79
	Appendix A: Questionnaire for interview questions - Evaluative research on signage .....	79
	Appendix B: Informed Consent for Participation in Interview Research .....	81
	Appendix C: Signage designed based on the descriptive and prescriptive research.....	84

Appendix D: New version of the signage based on the evaluation .....	88
----------------------------------------------------------------------	----

## List of Tables and Figures

Table 1: Main aspects covered in the interview questionnaire.....	29
Table 2: Motivations of people to go to natural and national parks organized by categories.....	32
Table 3: Gaps between people's perceptions and scientific knowledge. ....	38
Table 4: Guidelines for the written content of the signage.....	41
Table 5: Guidelines for the narrative style of the message.....	43
Table 6: Recommendations concerning the presentation format of the message. ....	44
Table 7: Guidelines for the graphic and visual approach of the signage. ....	45
Table 8: Beliefs of the main message given by the interviewees after ten seconds of observation.....	53
Table 9: Positively valued aspects in each of the signs in terms of design and written content.....	54
Table 10: Negatively evaluated aspects in each of the signs in terms of design and written content. ....	56
Table 11: Emotions, feelings and reflections when observing each signage.....	59
Figure 1: Information-processing model of persuasion and behavioral change. Adapted from Marion and Reid (2007). ....	21
Figure 2: Dichotomous matrix for the design of signage alternatives. ....	28
Figure 3: Signage designed based on the descriptive and prescriptive research..	48
Figure 4: Translation into English of the messages implemented in the four signs. ....	49
Figure 5: Characterization of the participants interviewed. ....	51

Figure 6: Elements of the signage that were observed in the first place by interviewees..... 52

Figure 7: Elements that were observed by the interviewees in each signage. .... 52

Figure 8: Updated version of the signage ..... 68

## **Abstract**

Recreational activities in natural parks often disrupt species, prompting the need for effective communication strategies. This research studied the components attracting immediate attention to signage, enhancing information comprehension, and conveying disturbances to wildlife. The case study focused on Ammergaufer Alpen nature park, Germany, with the Common Sandpiper bird as the subject, vulnerable to human presence. Using the mental model's approach, information gaps between expert knowledge and public perceptions were identified. A literature review provided recommendations for signage design. Four signs were developed and tested with 21 participants. The results revealed that effective signage should prioritize visual communication to enable quick understanding of the message. Engaging and original illustrations are crucial in attracting attention, accompanied by concise and clear text. The message should strike a balance between conveying the disturbances without creating misinterpretations, while also presenting a cooperative call to avoid negative reactions. Providing alternatives to restrictions fosters a sense of cohabitation and encourages responsible behavior among visitors. Lastly, each signage section should have a clear purpose and be effectively conveyed to ensure a cohesive and meaningful message. These findings contribute to creating compelling signage, fostering empathy, and encouraging responsible actions in nature parks.

## 1. Introduction

There is currently an increasing trend in visits to natural and national parks worldwide (Gruas et al., 2020). Studies demonstrate that nature-based activities benefit individuals and communities by increasing pro-environmental behaviors through connectedness to nature, improving the mental and physical health of adults and children, decreasing mortality rates, enhancing family cohesion and solidarity, as well as providing economic opportunities for surrounding communities (Guo et al., 2015; Immoos & Hunziker, 2015; Larson et al., 2016, 2019; Marzano & Dandy, 2012; Richardson et al., 2022; Rosa & Collado, 2019). However, human presence conflicts with preserving biodiversity and natural habitats by increasing ecosystem pressure (Kopp & Coppes, 2020; Marion et al., 2016; Marzano & Dandy, 2012). According to Gruas et al. (2020)'s literature review, all previous studies show how recreational nature activities impact wildlife. This is particularly critical since these often occur in protected areas, seriously impacting wildlife (Larson et al., 2019). Larson et al. (2016) note that human recreation is the key factor in the endangerment of plants and animals, and is considered a severe threat to 188 bird species worldwide.

The pressure exerted on ecosystems can be classified in various ways. Marion et al. (2016) categorize human impacts on ecosystems into four types: exploitation, disturbance, habitat alteration, and pollution. Since the concept most used in the literature is disturbance, we will employ this term to refer to the impact generated by humans in the ecosystem. Disturbances can be defined as all events that occur either once or continuously and affect the ecosystem, such as soil compaction, soil erosion, habitat fragmentation, canopy loss, vegetation trampling, water quality degradation, and wildlife disturbance (Guo et al., 2015; Marzano & Dandy, 2012). In terms of impacts on wildlife, disturbances can be understood as events which can lead to physiological or behavioral responses, food conditioning, extra energy expenditure, elevated stress levels, increased flight and vigilance, reduced reproductive success, changes in spatial or temporal habitat use, habitat loss, decreased survival rate, altered species richness and community composition, and population declines (Allbrook & Quinn, 2020; Cremer-Schulte et al., 2017; Gruas et al., 2020; Kopp & Coppes, 2020; Larson et al., 2016, 2019; Marion, 2019; Marzano & Dandy, 2012; Taylor & Knight, 2003). The effects can be immediate responses such as behavioral

changes like flying, or long-term, including energy loss, reproductive levels, or death (Bath & Enck, 2003; Larson et al., 2016; Taylor & Knight, 2003).

Several studies have provided evidence for the impacts described above. For instance, Allbrook and Quinn (2020) found that Northern gannet birds with nests closer to visitors were more likely to fail breeding compared to those in more isolated areas. This is because visitors increase the birds' alertness, causing them to fly from their nests. This disrupted their energy levels, feeding and vulnerability of eggs or young (Marzano & Dandy, 2012). Similarly, Donnelly et al. (2021) found that mountain gorilla mortality increased with the transmission of human pathogens and that marine iguana immune capacity decreased due to high tourism levels.

The degree of impact will be determined by several variables, such as the type of recreational activity (e.g. walking, horse-riding, mountain-biking, camping, use of off-road-vehicles), area of influence, number and distribution of people, predictability of the action, frequency and magnitude, specific location, season of the year, and the time of day (Bath & Enck, 2003; Marion, 2019; Marion et al., 2016; Marzano & Dandy, 2012; Taylor & Knight, 2003). Site factors will also influence the type of impact, such as vegetation characteristics, soil type and climate, habitat structure and composition, and trail conditions affecting recreational activities (Marzano & Dandy, 2012). All these aspects also relate to each species' traits, considering the breeding period, nesting, rearing, among others (Marion et al., 2016). Each species also responds differently to a given human action. Some species become habituated, others avoid, and others are attracted to humans (Bath & Enck, 2003; Marion, 2019).

Actions undertaken by recreationists can be intentional or unintentional (Bath & Enck, 2003; Larson et al., 2016). This is determined primarily by individuals' knowledge and disposition (Marion & Reid, 2007). For instance, if visitors misjudge the appropriate distance to approach wildlife, they will unintentionally disturb the animals due to a lack of knowledge. This forces the animals to move to less suitable habitats, affecting their development (Taylor & Knight, 2003). While some environmental degradation from recreational use is inevitable (Marion & Reid, 2007), irresponsible behavior, such as going off marked trails, considerably exacerbates disturbance (Guo et al., 2015). This behavior is often accompanied by ignorance of the impact of these actions on wildlife. Marion and Reid (2007) classified these actions into five types:



1. Careless actions, like littering or picking wildflowers, thoughtless behaviors.
2. Unskilled actions, when recreationists perform inappropriate behaviors due to a lack of skills, such as building a low-impact campfire.
3. Uninformed actions, due to a lack of adequate information.
4. Unavoidable actions beyond one's knowledge or experience, such as trampling vegetation or compacting soil.
5. Illegal actions, understood as deliberate violations.

To strike a balance between visitor presence in parks and wildlife conservation, several visitor management measures are adopted, which may be direct or indirect, and channeled via communication or infrastructure. On the one hand, the direct methods (Juma & Khademi-Vidra, 2022; A. Kidd et al., 2015), also categorized as regulatory and prohibitory (Calori & Vanden-Eynden, 2015), aim to control people's behaviors. Through communication, the strategies consider rules and regulations to prohibit or incentivize specific actions through, for example, fines or licensing quotas (Donnelly et al., 2021; Goh, 2020; Guo et al., 2015). Within this category, there are also measures via infrastructure, such as reducing the use of a given spatial area temporarily or permanently, limiting the number of recreationists, modifying schedules or definitively closing its use, creating buffer zones, deploying warden systems, placing barriers like fences to keep visitors on trails, or building observation structures (Allbrook & Quinn, 2020; Bath & Enck, 2003; Cerri et al., 2019; Guo et al., 2015; Juma & Khademi-Vidra, 2022; Marion, 2019). While these measures can be effective for the protection of vulnerable species (Garrett & Martin, 2002), they tend to be costly to implement and maintain, and negatively impact the visitor experience by creating a perception of excessive regulation and diminishing support, especially if not accompanied by information explaining their rationale (Allbrook & Quinn, 2020; Cerri et al., 2019; Garrett & Martin, 2002; Marion & Reid, 2007).

On the other hand, there are indirect measures. These passive and educational measures aim to raise awareness among individuals of the consequences of their actions and motivate them to create attitudes and willingness to adopt low-impact practices. These measures do not intend to control people, but rather provide them with information enabling them to voluntarily implement responsible behaviors (Cerri

et al., 2019; Goh, 2020; Juma & Khademi-Vidra, 2022; Marion & Reid, 2007). Generally, these measures are more cost-effective (Cerri et al., 2019), and strive to enhance the experience of recreationists by promoting a deeper appreciation of nature (Marion & Reid, 2007). Considering the classification of negative actions by recreationists, these measures can only address unskilled, uninformed, and some careless actions, but not unavoidable and illegal actions (Marion & Reid, 2007).

Indirect measures via infrastructure such as the maintenance of good trails, encourage individuals to stay on the road. Indirect measures via communication can be delivered through personal and non-personal communication methods (Tsang et al., 2011). Personal measures via communication include guided tours, talks, performances, scheduled services, events, orientation of rangers and volunteers. Non-personal measures are different tangible objects and experiences that are usually self-communicating. These include digital media as websites, social media, mobile applications and videos, printed media as display boards, panels, signage, maps, flyers, brochures, and visitor or educational centers (Abrams et al., 2020; Allbrook & Quinn, 2020; Burns et al., 2021; Colquhoun, 2005; Cremer-Schulte et al., 2017; Gruas et al., 2020; Guo et al., 2015; Juma & Khademi-Vidra, 2022; A. Kidd et al., 2015; Smith-Jackson & Hall, 2002; Tsang et al., 2011).

The content of any given measure is contingent upon its intended objective. Some of these mechanisms convey expected codes of conduct, provide information regarding legal regulations, furnish details concerning the park, explicate park trails and routes, furnish factual data regarding the park's biodiversity, inform about potential effects on wildlife, communicate specific actions individuals should take to avoid disturbing the ecosystem, or appeal to visitor's emotional connections with nature (Gruas et al., 2020; Immoos & Hunziker, 2015; L. Kidd & Dayer, 2020; Taylor & Knight, 2003; Tsang et al., 2011).

Nature interpretation is one of the most frequently employed measures of conservation education. Tilden (1957) was among the pioneering individuals to introduce the concept in question, which he defined as *“an educational activity which aims to reveal meanings and relationships through the use of objects, by firsthand experience, and by illustrative media, rather than simply to communicate factual information”* (p. 8). The fundamental objective of interpretation is to foster visitors' interest and facilitate their acquisition of knowledge regarding physical, biological, cultural, and historical

attributes and their interrelationships. It aims to engage and enhance the recreational experience, and motivate visitors to care for park resources, thus being a combination of experience, education and persuasion (Abrams et al., 2020; Burns et al., 2021; Calori & Vanden-Eynden, 2015; Colquhoun, 2005; Garrett & Martin, 2002; Juma & Khademi-Vidra, 2022; Tilden, 1957). It is thus reasonable to assert that effective and adequate interpretation can lead to the preservation of the resource to be protected (Tilden, 1957; Tsang et al., 2011).

The use of on-site signage as a means of interpretation has been recognized as an accepted and effective strategy for achieving the objectives of conservation education. This cost-effective approach does not significantly impact people's recreational experience (Allbrook & Quinn, 2020; Choquette & Hand, 2021; Guo et al., 2015; L. Kidd & Dayer, 2020), it also has a broad scope and can reach many people due to its fixed location. Moreover, visitors can access signage repeatedly, free of charge and on their own time (Abrams et al., 2020; Ballantyne & Hughes, 2003; Colquhoun, 2005; Martin et al., 2015). Signage has been identified as one of the methods with the highest rate of use and acceptance by recreationists (Abrams et al., 2020; Juma & Khademi-Vidra, 2022; Tsang et al., 2011). A study reported that 88% of visitors to a park went off-trail when there was no signage in place (Goh, 2023). In addition, good interpretive signage can be as effective as an on-site volunteer in reducing depreciative behaviors (Marion & Reid, 2007). The inclusion of visual media in signage has a high potential given their ability to transform complex information into something easily understandable in a short time, as well as being less cognitively demanding than the use of narrative descriptions (Cerri et al., 2019; Hahn & Berkers, 2021; Juma & Khademi-Vidra, 2022; Jurin et al., 2010; Tsang et al., 2011).

The effectiveness of signage in achieving its intended purpose cannot be assumed by its mere presence (Choquette & Hand, 2021; Hahn & Berkers, 2021; Jurin et al., 2010; Martin et al., 2015). The effectiveness of a communicative message is dependent on the encoding and decoding process (Hahn & Berkers, 2021; Jurin et al., 2010), which involves not only the production of the sign but also the process of being noticed, read, understood, and accepted by visitors (Choquette & Hand, 2021). From the brain's point of view, for a message to be retained, it must initially be processed through the central pathway. Only then will the receiver be motivated to study the message in more detail and thus retain it. If the message is irrelevant, it will probably not even be perceived by

the target audience (Jurin et al., 2010). This means that despite the positive impact of signage, if the target audience does not receive it, then it will be rendered ineffective (L. Kidd & Dayer, 2020).

In addition, signage may have inherent limitations. It can only provide a limited amount of information as people tend to read very quickly, it does not allow for questions or clarifications, and as an indirect mechanism, visitors may not see the sign, may not be interested in reading it, or may misinterpret it (Ballantyne & Hughes, 2003; Guo et al., 2015). And if it is read but misunderstood, recreationists may be motivated not to comply with what is suggested, or to perform an action opposite to what is desired and thus have a counterproductive effect (Goh, 2023; Hughes et al., 2014; Winter et al., 2000). For instance, a sign depicting a rare species without clear information may attract visitors to approach the area to see the species more closely (Choquette & Hand, 2021). Effective signage is therefore crucial, which includes an attractive design, a relevant and understandable message, a clear structure according to the intended audience and consistent content (Ballantyne & Hughes, 2003; Burns et al., 2021; Jurin et al., 2010; Smith-Jackson & Hall, 2002). This increases the chances of the sign being noticed, read, and understood by recreationists, leading to their willingness to accept and carry out the suggested measures (Abrams et al., 2020; Gruas et al., 2020).

Based on the preceding discussion, the primary objective of this study is to conduct a comprehensive qualitative assessment of how people perceive interpretive signage in natural parks. The research will focus on the Common Sandpiper bird, which is disturbed by human activity in specific areas of the natural park Ammergauer Alpen in Germany. The signs have been specifically designed for this thesis, following the findings of previous studies, and building on the existing signage in the park. The study will utilize the mental model's approach and the theory of planned behavior as theoretical frameworks.

### **1.1. State of knowledge**

Previous studies have examined the efficacy of signage in natural and national parks, along with visitor management manuals and guides that offer design guidelines for diverse types of signage. According to Calori and Vanden-Eynden (2015), all types of signage consist of three systems that must be balanced: the information content system, which pertains to the message, how it is worded, and its placement within the

sign; the graphic system, which includes typography, symbols, colors, and their layout; and the hardware system, which pertains to the signage's support. Regarding the first two aspects, previous research findings and manual information are presented in the next sub-chapters, along with a literature review on people's perceptions and behaviors concerning signage.

### **1.1.1. Information content system**

Research has extensively explored the effectiveness of signage in communicating messages to visitors. According to Abrams et al. (2020), messages that emphasize the benefits of wildlife, rather than solely focusing on risks, and those that suggest personal benefits, rather than evoke fear, tend to be more effective. Additionally, proscriptive messages indicating what not to do (e.g., don't litter the environment) have been found to be less effective than prescriptive messages suggesting what to do (e.g., keep our environment free of litter) (Abrams et al., 2020; Ballantyne & Hughes, 2003; Winter et al., 2000). Furthermore, studies have found that messages with a more ethical and interpretive character are equally effective as those with threatening sanctions (Garrett & Martin, 2002; A. Kidd et al., 2015; Marion & Reid, 2007). It has been observed that threatening messages with punishment might lead to negative reactions towards park management, reduce the possibility of influencing behaviors, and even have counterproductive effects (Winter et al., 2000). In contrast, providing reasons for expected behaviors has been shown to be highly effective in influencing visitor behavior (Garrett & Martin, 2002; Hughes et al., 2014; Marion & Reid, 2007). Goh (2023) stresses the importance of including socially acceptable behavior messages, as visitors tend to follow instructions more closely when they observe others doing the same.

Several other recommendations can be consolidated based on studies carried out. Firstly, the tone of the message should adopt a conversational approach and use of familiar words, with limited jargon and technical concepts that may be difficult to understand (Ballantyne & Hughes, 2003; Hughes et al., 2014; Janeczko et al., 2021; L. Kidd & Dayer, 2020). Colquhoun (2005) also highlights the importance of creating connections through the message with relevant meaning for people. When the message is directed towards the general public, it is recognized that targeting an audience of 10 to 12 year olds is more effective, as it includes individuals with varying

educational levels (Ballantyne & Hughes, 2003; Hughes et al., 2014; Janeczko et al., 2021; U.S. Fish & Wildlife Service, 2019).

The use of active voice "we" and "you" is recommended over passive voice, as well as the use of verbs instead of nouns or adjectives derived from verbs (Ballantyne & Hughes, 2003; Colquhoun, 2005; Tilden, 1957). Several interpretive techniques, such as stories, questions, metaphors, analogies, humor, and suggestions, can be used to effectively convey information, and it is generally concluded that provocative topics, written memorably and provocatively, are more effective (Ballantyne & Hughes, 2003; Cremer-Schulte et al., 2017; Tilden, 1957).

The use of questions in signage is also typically presented as "did you know...?". However, Colquhoun (2005) suggests that such questions are uninteresting, as the answer is usually that people do not know. Instead, questions that people would ask themselves regarding the content should be used, such as "is this the biggest tree in the world?".

The title is crucial in effectively communicating a message through signage, as it is one of the first aspects that will capture people's attention. To achieve maximum impact, titles should be striking, engaging, and thought-provoking, rather than banal or cliché (Ballantyne & Hughes, 2003; Colquhoun, 2005; Davis & Thompson, 2011; Jurin et al., 2010).

The hierarchy of information is also a critical factor, as not all elements have equal importance. Proper use of hierarchy can enhance communication and enable observers to gain clarity and determine which level of information they want to delve into. The most significant information should be displayed more prominently, while more complex or specific data should be presented at lower levels of visibility (Ballantyne & Hughes, 2003; Calori & Vanden-Eynden, 2015; Colquhoun, 2005; Muekthong, 2021; U.S. Fish & Wildlife Service, 2019). Smith-Jackson and Hall (2002) conducted an experiment in which participants were asked to sort letters with different types of content based on their perceived level of importance, using their own criteria. The main sorting strategies were topic-based, meaning that the most valuable information related to the topic was placed first, and general-to-specific, meaning that more general information was presented before more specific details.

In conclusion, different variables are most appreciated by people when faced with a signage. Clarity stands out as the central variable, understood as adequate, understandable, simple and concise information (Ballantyne & Hughes, 2003; Calori & Vanden-Eynden, 2015; Colquhoun, 2005; Cremer-Schulte et al., 2017; Hahn & Berkers, 2021; Hughes et al., 2014; Janeczko et al., 2021; Kopp & Coppes, 2020; Marion & Reid, 2007; Mutiara et al., 2021; U.S. Fish & Wildlife Service, 2019). Also reality, facts, immediacy (time taken to understand the information), and being emotionally touched are also highlighted as important characteristics (Hahn & Berkers, 2021; Hughes et al., 2014). Other aspects emphasized are interesting, useful, and credible (Colquhoun, 2005; Hahn & Berkers, 2021; Jurin et al., 2010; Marion & Reid, 2007).

### **1.1.2. Graphic system**

Although several of the previous aspects apply to design, such as the clarity of information, there are specific considerations that warrant attention. The graphic system and design are essential in rendering the content tangible and facilitating effective communication. By imparting structure, form, and style to information, the design enhances its accessibility and comprehensibility (Calori & Vanden-Eynden, 2015; Jurin et al., 2010; Martin et al., 2015; Mutiara et al., 2021). Furthermore, visual elements can establish a more meaningful connection with individuals and foster more rapid comprehension (Colquhoun, 2005; Davis & Thompson, 2011).

Among the visual elements that are generally incorporated, we can find graphic elements; illustrations that allow to create the scene, give emphasis, identify species, explain processes or add art; diagrams that will enable to make comparisons or show timelines or complex processes; cartoons that provide a touch of humor and make critical things less heavy and more appealing; and photographs that allow to give a different perspective such as aerial views or provide examples (Colquhoun, 2005). Hahn and Berkers (2021) conducted a study that focused on artistic visualizations. They found that while they can be visually appealing, if they are too abstract or lack contextual information to clarify their meaning, they may be ineffective because people will not understand them. The use of photographs and images has also been studied. Poor-quality photos, images that are not relevant to the content, or images that are difficult to understand can all negatively impact the interest and credibility of signage (Hughes et al., 2014; Janeczko et al., 2021; Muekthong, 2021). Additionally, redundant

images or repeating the same image concept more than once should be avoided (Muekthong, 2021).

Color is a crucial factor to consider in designing effective signage. It differentiates or blends with the environment, draws attention to specific messages, distinguishes information, or adds decorative elements (Calori & Vanden-Eynden, 2015; Mutiara et al., 2021). Colquhoun (2005), also notes that color adds an element of surprise, provides variety, captures attention, and can maintain engagement.

Other relevant elements have been identified as suggestions based on previous studies. One of these is the inclusion of dead space or white space, which is the space without information. This element is related to legibility, clarity, and organized appearance, and it includes margins, spaces between words and other elements (Calori & Vanden-Eynden, 2015; Colquhoun, 2005). Other design elements include the use of consistent and few fonts, the use of adequate contrast between text and background, balance and unity in all components, avoiding placing text over images, using universal symbols to prevent misinterpretation, dividing space effectively, and applying creativity in a balanced way (Calori & Vanden-Eynden, 2015; Colquhoun, 2005; Jurin et al., 2010; Muekthong, 2021; Mutiara et al., 2021). Ballantyne and Hughes (2003) suggest that including novel elements, such as movement and multi-sensory experiences, can make signage more engaging and memorable. Similarly, Colquhoun (2005) highlights the importance of presenting information in an interesting and stimulating way, to avoid monotony and enhance readability.

Regarding the use of maps in signage, they can be challenging for people to interpret. Calori and Vanden-Eynden (2015) suggest that maps should be accompanied by informative content, a clear symbol indicating the observer's current location, and a choice between heads-up orientation or North orientation, clearly indicating which is being used. By following these guidelines, maps can become a valuable component of signage design.

Choquette and Hand (2021) conducted a study related to the attention to existing signage in a park. They found that only 25-50% of the recreationists read the signage due to the overwhelming amount of information presented. To address this issue, they recommend using short and concise messaging with 1 to 3 central points, a suggestion supported by other studies that highlight the importance of prioritizing a limited number



of topics (Burns et al., 2021; Colquhoun, 2005; Marion & Reid, 2007; Mutiara et al., 2021).

From an institutional perspective, the U.S. Fish & Wildlife Service (2019) visitor management guide, incorporates several of the previous recommendations, while emphasizing the importance of aligning signage with institutional guidelines and maintaining consistency throughout a park's range of signage. Signage should also be tailored to the visitors of a particular area, with institutional propaganda being avoided. Furthermore, this guide suggests evaluating the final content before implementing it.

### **1.1.3. Perceptions and behavior in relation to signage**

The interrelatedness of content and design with the evaluations made by people is evident. However, people's beliefs and perceptions about a given topic also play a crucial role. Several authors emphasize the significance of comprehending why individuals behave in a particular manner, how they process and filter information, and their response to particular stimuli and information (Cerri et al., 2019; L. Kidd & Dayer, 2020; Smith-Jackson & Hall, 2002; Tilden, 1957). Choquette and Hand (2021), observed, through field research, that messages with a prohibitive focus were ineffective and that visitors would have preferred messages that aligned with their values and beliefs.

In their research focused on indicating the safe distance to birds, Allbrook and Quinn (2020) found that using simple and clear signage impacted visitors' behavior towards bird colonies in terms of keeping a safe distance. Specifically, fewer people approached closer than the indicated meters, and many of the visitors stayed within the expected distance. However, the authors noted that all the individuals who ignored the signage were photographers, who were also responsible for 84% of the disturbances during the study. This finding is consistent with the results reported by Cerri et al. (2019), who indicated that photographers are the group with the lowest level of acceptance that their presence can cause disturbances, thus becoming the primary source of animal stress.

Davis and Thompson (2011) conducted a study to analyze the motivations that lead people to read interpretive signage. The authors found that respondents were motivated by the sign's location, interest in the topic, and the desire to seek specific information related to the environment. Similarly, Hughes et al. (2014) also explored

the issue and identified that the desire to learn about the topic and the opportunity to gain new knowledge were the most frequent motivations among respondents. Additionally, the authors found that attractive images and colors also influenced people to read the signage.

Some studies have explored how signage affects visitors' compliance with defined paths. Goh (2020) found that unclear or missing signage was the primary reason for deviating from the designated path. In the absence of clear signage, visitors rely on their past experiences to make decisions. Similarly, Marion and Reid (2007) reported that visitors struggled to comply with desired behaviors due to complex signage that was challenging to comprehend.

Another aspect examined in the studies is the effectiveness of interpretive signage regarding what information people remember after reading them. A. Kidd et al. (2015), analyzed whether particular signage was seen and comprehension was assessed. Less than half of the people saw the signage and of those who did, 75% were unable to recall the message, due to unclear messaging, small font size, and large images. About the information recalled, Hughes et al. (2014), discovered that scientific information about the species, and surprising or humorous phrases were the most remembered content. In contrast, poetry or deep thoughts were considered the least important. The authors also identified threats faced by animals, actions to take care of the environment, data on animal behavior, and scientific information as the most relevant information people would like to see incorporated into signage. Similarly, Price et al. (2018), found that people prefer conservation messages, information on what individuals can do to help, and what the organization does to support wildlife.

Regarding the time spent reading signage, studies have shown varying results. People generally spend 3 to 10 seconds examining a message, during which a well-designed signage should allow them to understand the main idea (Choquette & Hand, 2021; Colquhoun, 2005). Another study identified that the time spent reading depends on the type of recreational activity (Marion & Reid, 2007). Hikers spent an average of 22 seconds reading a sign, while riders spent 14 seconds. They also found that those who spent less time reading had lower retention of the information, and that retention decreased with an increase in the number of messages. These times, however, may vary depending on the person's interest or whether they find it attractive or interesting (Davis & Thompson, 2011; Hughes et al., 2014). There are also results associated with

the attention and time allocated, which will depend on variables other than the signage itself, such as the presence of other people reading the sign, the location of the sign, the environmental conditions and the time people have available (Burns et al., 2021; Davis & Thompson, 2011; Hughes et al., 2014; Juma & Khademi-Vidra, 2022).

## **1.2. Research gap**

As evident from the previous sections, several studies have been conducted to evaluate signage in parks. However, these studies have resulted in new recommendations due to varying degrees of success, and exploratory nature, thus requiring validation in further studies (Allbrook & Quinn, 2020; Burns et al., 2021; Choquette & Hand, 2021; Donnelly et al., 2021; Goh, 2020, 2023; Hughes et al., 2014; Juma & Khademi-Vidra, 2022; A. Kidd et al., 2015; Martin et al., 2015; Muekthong, 2021; Mutiara et al., 2021; Price et al., 2018; Tsang et al., 2011). This highlights the need for more conclusive and specific results to evaluate effective signage. Regarding visitor management manuals, although the parks have recommendations on the use of institutional guidelines and content and design suggestions in line with the studies mentioned earlier, there is not enough evidence of experimental research that tested the recommended measures (Colquhoun, 2005; U.S. Fish & Wildlife Service, 2019). Gruas et al. (2020) also emphasize the need for further experimental research to evaluate the effectiveness of previously recommended measures.

Previous studies have primarily focused on evaluating the effectiveness of specific signage by conducting experiments that evaluate only one alternative, typically the current signage. These experiments assess the extent to which the signage generates awareness or behavioral change and how it is perceived by individuals (Choquette & Hand, 2021; Davis & Thompson, 2011; Martin et al., 2015; Muekthong, 2021; Mutiara et al., 2021). Some researchers have attempted to create new signage designs (Choquette & Hand, 2021; Hughes et al., 2014; A. Kidd et al., 2015; Price et al., 2018). However, the literature lacks evidence of an integrated application of the various content and design variables explored in the literature review, which could provide more definitive results on the optimal composition of signage and its efficacy in facilitating adequate reading and comprehension. In certain instances, studies have analyzed the degree to which individuals understood the signage or the resulting behavior, yet these studies have not examined the specific factors that contributed to this understanding and how it influenced the observed outcomes (Allbrook & Quinn,

2020; Davis & Thompson, 2011; Hughes et al., 2014; Janeczko et al., 2021; A. Kidd et al., 2015).

The majority of studies have focused primarily on evaluating the textual content of signage, but have overlooked the significance of design elements, which is what ultimately generates the first attraction to the signage (Allbrook & Quinn, 2020; Cerri et al., 2019; Choquette & Hand, 2021; Garrett & Martin, 2002; Goh, 2020; Janeczko et al., 2021; Muekthong, 2021; Smith-Jackson & Hall, 2002; Winter et al., 2000). A comparative analysis of alternative information delivery styles based on a broad range of sources has yet to be undertaken. Additionally, research has yet to be conducted to compare the immediate attraction and comprehension levels of signage based on different design alternatives. It is worth mentioning the work of Janeczko et al. (2021), which highlights that although several design guidelines are available, most of them are geared towards enclosed spaces such as museums and visitor centers. Therefore, the lack of research on outdoor interpretive signage in parks is a noteworthy gap in the literature.

In terms of method, most research has been based on quantitative approaches (Allbrook & Quinn, 2020; Cerri et al., 2019; Choquette & Hand, 2021; Donnelly et al., 2021; Goh, 2023; Juma & Khademi-Vidra, 2022; Martin et al., 2015; Mutiara et al., 2021; Tsang et al., 2011), which provide results that tend to generalize and interpret information. The use of qualitative methods of analysis, which provide a deeper understanding of individuals' perceptions, has not been widely implemented. Boase et al. (2017) corroborate this observation, specifically in their review of the mental models approach literature. They note that only a quarter of the studies utilizing this approach have utilized qualitative methods, highlighting the underutilization of this method. This is despite the numerous benefits of employing qualitative methods, such as anticipating effects and making necessary corrections during testing phases before dissemination (Boase et al., 2017).

### **1.3. Goal and research questions**

The process of internalization and processing of a signage goes through an ideal process that begins when the person is confronted with it, is interested, and subsequently reads, understands, contrasts, and accepts it, which leads to a certain attitude and behavior. This can be seen in the following diagram, adapted from Marion

and Reid (2007), based on the process in which a person interacts with a signage with a focus on reducing disturbances in wildlife:

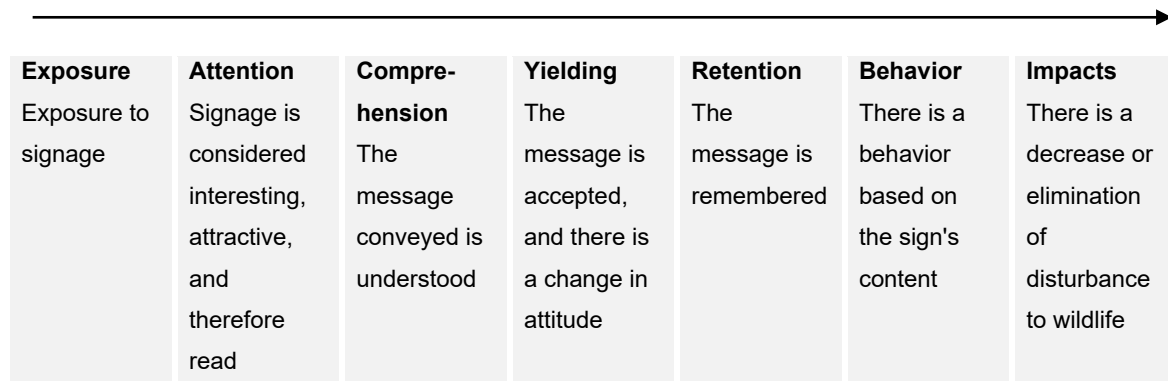


Figure 1: Information-processing model of persuasion and behavioral change. Adapted from Marion and Reid (2007).

Based on Figure 1, this research will focus on the first three phases and partially on the fourth phase for the elaboration of the content of the signs to be evaluated. The aim of this study is to identify the variables that generate greater attraction and facilitate a better understanding of interpretative signage oriented towards wildlife protection. The study will employ the mental models approach (Boase et al., 2017; Wong-Parodi & Bruine de Bruin, 2017). This approach involves defining the content of the signage based on current park information. Next, individuals' perceptions regarding the theme will be analyzed, and the message to be communicated will be adjusted based on the recommendations given in the literature. For this stage, the theory of planned behavior will be used, which will contribute to the organization of the literature due to its focus on the analysis of people's motivations (Ajzen, 1991). Subsequently, different signage alternatives will be designed, incorporating the guidelines established in previous studies. Finally, the signage will be evaluated using qualitative semi-structured interviews to explore people's perspectives in-depth.

The research will be conducted using the Ammergauer Alpen nature park in Germany as a case study. The Common Sandpiper, a bird that migrates from Africa and breeds in this park between March and August, will serve as a reference for the signage. This species is particularly vulnerable to disturbance by recreational activities, highlighting the need to establish protective measures and communication strategies to prevent individuals from approaching certain areas where the birds are present.

Based on the above, the following research questions are sought to be answered, taking as a basis that the mentioned signage refers to an interpretive signage aimed at reducing the presence of visitors in the bird's nesting area:

- What properties of the signage generate the most visual attraction and the best perception among individuals?
- What are the influencing factors of signage that facilitate easier and more accurate comprehension of the information conveyed?
- Which components of the written message on the signage are more effective to communicate the behaviors that cause or diminish disturbance to the bird?

## **2. Study area and Methods**

### **2.1. Study area**

The Ammergauer Alpen Nature Park is located in the Bavarian region of Germany and covers an area of 227 km<sup>2</sup>. It is characterized as Germany's nature park with the most significant natural contrasts, the widest range of altitudes, and the highest diversity of mountain species (Ammergauer Alpen GmbH, 2017). Approximately 51.1% of the park is covered by protected areas under the Nature Conservation Act, and there are also safeguarded natural monuments and geotopes (Ammergauer Alpen GmbH, 2017).

Various species inhabit this park, including endangered species such as the Common Sandpiper or the Capercaillie, and critically endangered species like the Golden Eagle or certain woodpecker species. Due to this reason, the park has implemented various measures for nature conservation and protection, while also coordinating an appropriate visitor management concept. One of these measures is the project "Dein Freiraum – Mein Lebensraum" (Your free space - My living space), which establishes relevant zoning for species protection (Ammergauer Alpen GmbH, 2017).

For this research, the area to be studied is in the district of Altenau, which is part of the municipality of Saulgrub. Access to the study area is possible using various public and private transportation means. However, it only attracts a small number of tourists, as the route commonly used by tourists goes in a different direction. Consequently, most people in the area are local residents who usually visit it because it is a recreational attraction area situated on the river's edge.

The Common Sandpiper (*Actitis hypoleucos*) temporarily inhabits this area between March and August for breeding, and it is the species prioritized for the current study. This migratory riverside bird is considered endangered and spends its winters in Africa, migrating to areas spanning from Western Europe to Eastern Asia for reproduction (Bayerisches Landesamt für Umwelt, 2023; Elas et al., 2023). The Common Sandpiper nests on the ground in riverbeds, utilizing sandy areas with low vegetation. In Europe, its population is estimated to range between 794,000 to 1,460,000 pairs. Still, there has been a decline in its numbers due to changing conditions resulting from climate change and disturbances in the area, such as intensive use of the land for recreation or energy management (Bayerisches Landesamt für Umwelt, 2023; Elas et al., 2023). Specifically regarding Sandpipers, Larson et al. (2016) conducted a literature review on the effects of recreation on these birds. They found that most studies indicate a negative impact, with almost no studies showing a positive or unclear effect.

One species conservation program was implemented in the Bavarian region in 2020. As part of the species mapping efforts under this program, 91 breeding pairs of the Common Sandpiper were identified in the first year, and 72 pairs were identified in the second year. Considering the areas where mapping was not conducted, it is estimated that there are 80 to 100 breeding pairs in total. Within this program, one of the measures established is the installation of uniform signage in areas where nesting birds have been identified, restricting access (Bayerisches Landesamt für Umwelt, 2023). This consists of a circular yellow sign with an illustration of the bird, the word "Stop," and a message indicating that entry is not allowed during a specific period.

In the case of the Ammergauer Alpen Nature Park, there is an additional larger A2-sized signage focusing on both regulatory and interpretive aspects (Calori & VandenEynden, 2015). This signage indicates the restricted area and aims to communicate information about the bird and the significance of its protection. It introduces the circular yellow signage mentioned earlier and is placed in various locations frequented by people. This signage, as described, is the primary focus of study in this research.

## **2.2. Methods and data collection**

The data collection process is theoretically based on the mental model approach. The main objective was to understand people's perceptions, reactions, and comprehension when confronted with signage, to develop solutions. This model allows the analysis to

focus on the reasoning, beliefs, and experiences of individuals, recognizing that it is through these mental models that they will perceive and understand different aspects of reality (Boase et al., 2017; Natalie Jones et al., 2011; Shome & Marx, 2009; Wong-Parodi & Bruine de Bruin, 2017). The use of this model enables the examination of similarities and differences among different individuals when facing a specific stimulus, integrating diverse perspectives for a comprehensive understanding of a system, identifying limitations of knowledge and misconceptions regarding a subject, or developing more robust knowledge on complex topics and thus creating a collective representation (Natalie Jones et al., 2011).

The mental models approach is structured following four distinct phases as presented below, which will be used for the research, data collection, and information analysis process (Boase et al., 2017; Wong-Parodi & Bruine de Bruin, 2017):

- Normative research: In this phase, the focus is on identifying the information that experts consider people should know to make informed decisions.
- Descriptive research: The investigation explores what people currently know about the topic and what information they lack when making decisions.
- Prescriptive research: This step involves developing a communicative message based on the comparison of the previous two phases, communicating what people still need to know to make an informed decision.
- Evaluative research: In this phase, the developed communication is tested to assess whether it effectively improves understanding of the conveyed message, thereby facilitating people in making informed decisions. The evaluation phase plays a crucial role, as it measures whether the previous process has successfully addressed the aims in an objective manner and confirms that the content aligns with the audience's perceptions, needs, motivations, and understanding (Ballantyne & Hughes, 2003; Bitgood, 2000; Jurin et al., 2010; L. Kidd & Dayer, 2020).

### **2.2.1. Normative research**

The expert information for this case is based on the prioritized signage, as indicated at the beginning of this chapter. This prioritization has been conducted in collaboration with the Ammergauer Alpen Nature Park administration. Currently, signage in place



already contains the key information to be conveyed, including a map and restricted area, the dates when entry is prohibited, essential information about the bird, and the appearance of the yellow sign directly located in the area. Therefore, this information will be used as expert knowledge to be presented to analyze people's perception and create new designs.

### **2.2.2. Descriptive research**

The understanding of people's perceptions regarding their relationship with the topic, including their motivations for engaging in nature-based activities, attitudes towards wildlife, and perceptions of themselves as disturbances to wildlife, was conducted through a literature review. The review focused exclusively on references written in English and utilized comprehensive literature search databases, particularly Scopus and Web of Science. Additionally, the catalog of the Technical University of Munich OPAC was consulted. Google Scholar and the Google search engine were also used to find material related to organizations, such as park visitor management manuals. The search was conducted between February and May 2023.

An initial phase of the search was conducted to identify the disturbances that do occur and impact wildlife. This part aimed to understand the actual occurrences of disturbances caused by human activities and their effects on wildlife populations and habitats. A second phase of the search focused on comprehending people's perceptions and beliefs regarding their relationship and impact on wildlife. This part aimed to explore how individuals perceive their interactions with wildlife, their attitudes towards nature protection, and their awareness of the consequences of their actions on wildlife and their habitats. The keywords for the first part of this research were: (disturbances OR impact OR effect OR consequences) AND (wildlife OR animals OR fauna) AND (national parks OR natural parks OR biodiversity OR outdoor recreation OR nature) AND (visitors OR tourists OR recreationists). The keywords for the second part of this research were: (disturbances OR effects OR impact OR consequences) AND (wildlife OR animals OR fauna) AND (national parks OR natural parks OR outdoor recreation OR nature OR protected area) AND (visitors OR tourists OR recreationists) AND (perceptions OR beliefs OR awareness OR knowledge OR education OR attitudes). Peer-reviewed scientific journal articles were included for results, followed by books, book chapters and reports. From the results obtained and after reviewing the abstracts, the most relevant bibliography for this research was selected, resulting

in 31 documents for further analysis. Citavi reference manager software was used to organize the references.

The gathered information was then structured and categorized following the theory of planned behavior (Ajzen, 1991). This approach allowed for identifying various gaps in knowledge concerning what needs to be communicated and how people perceive the topic. By employing this framework, the research aimed to better understand the factors influencing people's attitudes, intentions, and behaviors concerning wildlife conservation and disturbance prevention in the study area.

### **2.2.3. Prescriptive research**

The development of the communicative message involved two phases. The first phase focused on researching previous studies and guidelines on signage production and design. The second phase concentrated on designing the signage based on the descriptive and prescriptive research findings.

During the literature review, specific studies and guidelines focused on wildlife-related topics in parks were examined for recommendations and guidelines concerning effective and visually appealing signage design. Additionally, the search was expanded to include other areas of knowledge, as design guidelines, in general, can offer insights into attractive and positively perceived content and visualizations for people. The search was limited to references written in English and conducted using online databases, particularly Scopus and Web of Science, the Technical University of Munich OPAC catalogue, Google Scholar, and the Google search engine to find manuals and guides prepared by organizations. The search was conducted between March and May 2023.

The keywords for finding previous studies related to signage in parks were: (signage OR signs OR visualizations OR information boards OR interpretive OR display OR boards OR panels) AND (effective OR attractive OR communication OR optimization OR design) AND (parks OR nature OR environment OR wildlife OR endangered species). The keywords for finding current guidelines used by parks were: (visitor OR recreation OR tourism) AND (management OR policy OR guidelines OR handbook OR guides OR manual OR recommendations) AND (national park OR natural park OR park). Other keywords were used to complement the previous keywords and expand the results: (social marketing OR environmental communication OR effective

communication campaigns OR environmental graphic design OR communication measures OR visual communication OR signage design OR effective signage OR environmental graphics). The type of literature selected were peer-reviewed scientific articles in journals, followed by books, chapters of books, reports, visitor management guidelines, manuals, and guides. The gathered information was organized and categorized into two main aspects: written content and visual elements, including graphic design and visual approach. After a more focused selection based on the needs of this research, a total of 28 bibliographic references were prioritized for further analysis.

The second phase of the prescriptive research involved the creation of signage. To achieve this, a dichotomous matrix of four variables was used to guide the design and development of four alternative signage options (Figure 2). The vertical axis of the matrix focused on the message, while the horizontal axis focused on the design. For the vertical axis, one side aimed to address the prioritized gaps identified in the descriptive research, while the other side focused on providing purely informative information. For the horizontal axis of the design, one side emphasized a simple design with minimal elements and composition, while the other side focused on a more complex design with an emphasis on addressing the gaps related to the design. By utilizing this matrix, the research explored different combinations of message content and design elements to create signage that effectively communicates information and captures the visitors' attention.

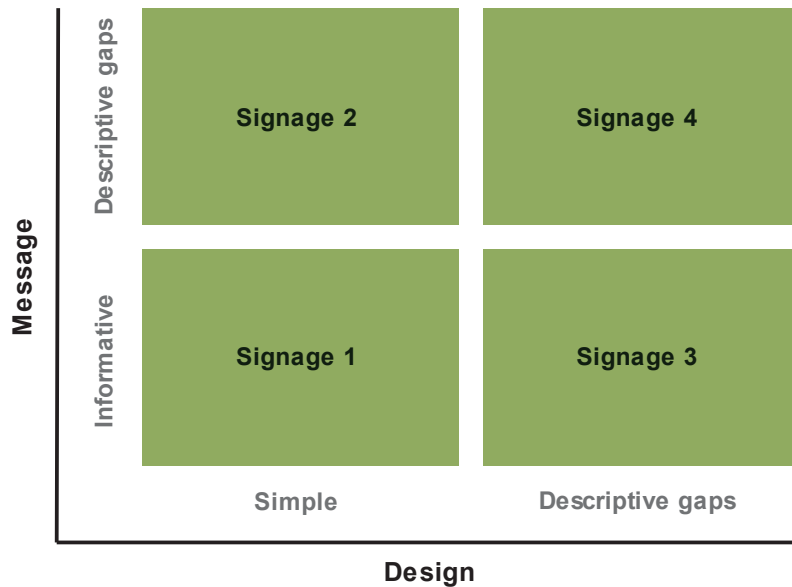


Figure 2: Dichotomous matrix for the design of signage alternatives.

Based on this matrix and the recommendations obtained from the literature, two different texts and various visual elements were created to develop four distinct signs. The signs are in German language and an A2 format. The author of this research solely crafted the entire design of the signs.

#### 2.2.4. Evaluative research

The four designed signs were evaluated through qualitative research, employing individual semi-structured interviews to gather in-depth information (Jurin et al., 2010). The target audience consisted of representative German individuals since they are most likely to observe the signage in the study area. No differentiation was made based on gender, age, occupation, or field of study, but the focus was on individuals aged 20 years and older.

A communicative message requesting support for the research was drafted and shared through various online communication channels and social media to reach this audience. In total, 21 people expressed interest in being interviewed, all of whom were interviewed. One of these interviews was conducted as a pilot, allowing adjustments to the questionnaire's questions, and finalizing a version that was used for the remaining 20 participants. A point of saturation was established to determine the appropriate number of interviews. The saturation point is reached when no additional issues or insights are identified in the data, and data repetition occurs, indicating that

an adequate sample size has been obtained (Hennink & Kaiser, 2022). The saturation point was determined after the 21st interview, and it was decided not to conduct further interviews.

During each interview, every participant observed two different signs. Two pairs of signs were prepared, corresponding to signs 1 - 4, and 2 - 3, as indicated in Figure 2. This arrangement allowed each participant to view one informative text and one text addressing the gaps, as well as a simple design and another focused on the gaps. The signs' presentation order was intentionally adjusted for each participant to avoid biases based on information obtained while observing the first sign.

The interview followed a pre-structured questionnaire that included variables related to attractiveness, comprehension, and effectiveness in conveying the message. The main aspects of the interview are presented in Table 1.

Table 1: Main aspects covered in the interview questionnaire.

Section of the interview	Description
Introduction	The participants were introduced to the research, and any general doubts were resolved while clarifying how the interview process would be conducted.
Ten seconds test – first signage	The first signage was presented for ten seconds, and questions were asked regarding the participants' initial impressions, the visual elements they remembered, and the main message conveyed.
Think out loud method and in-depth questions about the sign	The same signage was presented again, and the participants were asked to describe what they observed out loud. Subsequently, questions were asked about any confusing or unclear aspects, attractive or interesting features, the message they understood after examining the signage in detail, whether the signage reminded them of previous experiences, and the emotions and reflections evoked by looking at the signage.
Ten seconds test – second signage	The second signage was presented for ten seconds, and the same questions were applied as before.
Think out loud method and in-depth questions about the sign	The second signage was shown again, and the same questions were asked as in the previous round.
Comparison	Both signs were presented together, allowing participants to indicate which aspects drew their attention the most. If they were to create a

	new signage combining both, they were asked which elements they would choose, and which would not.
Suggestions	The participants were asked if they had any additional recommendations or suggestions concerning the signage to explore alternative ideas not presented in the shown designs.
Categorization of the study group	General questions were asked about age, occupation, or field of study to categorize the study group used for further analysis.

As the interviews were semi-structured, although participants were asked the same questions, emerging questions were asked based on their responses to delve deeper into their analyses. The interview questionnaire can be found in Appendix A.

The interviews were conducted between June and July 2023. The duration of each interview ranged from 30 to 45 minutes, which aligns with the timeframe mentioned by Jurin et al. (2010), who stated that such interviews typically take between 30 minutes to an hour. Some interviews were conducted online using the Zoom platform, while others were conducted in person. All interviews were recorded for subsequent transcription and analysis. The interviews were transcribed using the Whisper Transcription Model, an advanced speech recognition system that utilizes deep learning techniques to convert spoken language into written text (Radford et al., 2022). Each participant agreed to be interviewed and signed an informed consent form, which can be found in Appendix B.

After transcribing the interviews, they were manually analyzed, and the information was categorized by signage and across variables to obtain key results associated with each analyzed aspect.

### **3. Results**

#### **3.1. Descriptive research**

To deliver information that resonates with visitors and is accepted and assimilated, the key is to understand the target audience. This involves connecting design and messaging with the perceptions, needs, knowledge, experiences, and beliefs of individuals, understanding their behaviors, how they respond to certain stimuli, and the cognitive processing of such stimuli (Abrams et al., 2020; Ballantyne & Hughes, 2003; Bath & Enck, 2003; Cerri et al., 2019; Colquhoun, 2005; Goh, 2023; Jorgensen &

Bomberger, 2015; L. Kidd & Dayer, 2020; Marion & Reid, 2007; Price et al., 2018; Rosa & Collado, 2019; Smith-Jackson & Hall, 2002). This point aligns with the dimension of the mental model in which understanding people's perceptions is defined as the next stage (Boase et al., 2017; Wong-Parodi & Bruine de Bruin, 2017). Given the diversity of individuals, each audience type will analyze, understand, and judge information differently depending on their beliefs and concerns (Jurin et al., 2010; L. Kidd & Dayer, 2020).

The results of the literature review are organized based on the theory of planned behavior (Aas et al., 2023; Ajzen, 1991). In this way, attitudes, and motivations towards recreational activities in parks, wildlife and habitats are analyzed, as well as the perceived behavioral control when confronted with their potential disturbing effect on wildlife concerning the desired activity to be performed. The relationship and attitudes towards signage are also analyzed following this model. Drawing from the preceding information, this section identifies gaps that exist between public perception and expert evidence. From these gaps, it will be indicated which ones will be addressed for the design of the signs to be evaluated.

### **3.1.1. Attitudes and motivations towards parks, habitats, and wildlife**

The reasons why individuals choose to visit natural or national parks are manifold. However, reasons have been identified in the literature which permit an understanding of the specific activities engaged in by individuals, as well as their motivations for participating in such activities within parks.

Among the activities commonly performed, hiking stands out as one of the most common (Arnberger et al., 2012; Gruas et al., 2022; Gundersen et al., 2015; Levêque et al., 2015; Marion, 2019). More traditional activities are also mentioned, such as sightseeing, fishing, hunting, camping, bird watching, photography and boating (Gundersen et al., 2015; Marasinghe et al., 2021; Marion, 2019). More recent activities are also identified such as mountain biking, bouldering, climbing, cable car use, kiting, paddle boarding, skiing, and windsurfing, with mountain biking being one of the most mentioned in this category (Arnberger et al., 2012; Gruas et al., 2022; Gundersen et al., 2015; Marion, 2019; Taczanowska et al., 2019). Walking with the dog is also presented as a frequently performed activity (Levêque et al., 2015; Sterl et al., 2008).

Regarding the motivations for visiting a park and engaging in desired activities, for this research, a categorization has been made based on previous studies. Table 2 identifies each category, briefly describes them, and the source from which the motivation was derived. The list is not presented in order of relevance, as different studies have obtained different results regarding the frequency and importance attributed to each motivation by individuals. Instead, the list is ordered based on the number of studies that mention each motivation.

Table 2: Motivations of people to go to natural and national parks organized by categories.

Category	Description of the motivation	Source
<b>Contact with nature</b>	Being immersed in nature, appreciating the environment, and observing certain species.	(Bath & Enck, 2003; Carrascosa-López et al., 2021; Gruas et al., 2022; Gundersen et al., 2015; Haukeland et al., 2013; Marasinghe et al., 2021; Sterl et al., 2008; Taczanowska et al., 2019)
<b>Recreation</b>	Pleasure to enjoy, relax and have fun in a natural environment.	(Carrascosa-López et al., 2021; Cremer-Schulte et al., 2017; Haukeland et al., 2013; Marasinghe et al., 2021; Sterl et al., 2008)
<b>Scenery appreciation</b>	Observe and admire the beauty and uniqueness of the landscape.	(Gundersen et al., 2015; Haukeland et al., 2013; Le Corre et al., 2013; Marasinghe et al., 2021; Taczanowska et al., 2019)
<b>Physical activity</b>	Physical exercise and improvement of physical performance.	(Cremer-Schulte et al., 2017; Haukeland et al., 2013; Immoos & Hunziker, 2015; Taczanowska et al., 2019)
<b>Escape from routine</b>	Peaceful space that allows you to disconnect from the daily routine and escape stress.	(Carrascosa-López et al., 2021; Gruas et al., 2022; Gundersen et al., 2015; Le Corre et al., 2013)
<b>Social interaction</b>	Interpersonal relationships to interact with family or friends.	(Bath & Enck, 2003; Carrascosa-López et al., 2021; Marasinghe et al., 2021)
<b>Self-discovery</b>	Intrinsic psychological motivation for self-knowledge, self-development, personal growth, or self-renewal.	(Carrascosa-López et al., 2021; Cremer-Schulte et al., 2017; Gundersen et al., 2015)
<b>Learning and experience</b>	Learning new things, having new experiences, and exploring the unknown.	(Bath & Enck, 2003; Carrascosa-López et al., 2021; Marasinghe et al., 2021)



<b>Leisure</b>	There is no greater motivation, but to use the free time or need to walk the dog.	(Høyem, 2020; Marasinghe et al., 2021; Sterl et al., 2008)
<b>Conformity to social norms</b>	Join a social discussion, current events, or follow other people's interests.	(Carrascosa-López et al., 2021)

Although several authors mention contact with nature, it is only sometimes a priority among people's motivations. While it is mentioned, it is only by a portion of the respondents (Carrascosa-López et al., 2021; Gundersen et al., 2015; Marasinghe et al., 2021; Sterl et al., 2008; Taczanowska et al., 2019). Høyem (2020), explicitly surveyed visitors about their relationship with nature, and found that most respondents could not explain it and only described the recreational activity they were engaged in. His conclusion suggests that few people focus on nature and are unable to explain the relationship and meaning that nature has for them.

In terms of the knowledge that people have about the area they visit, the wildlife present there, and the situations that can disturb them, it has been found that generally, local people and those who visit the same place frequently have greater knowledge about both species and the measures in place for their protection (Jorgensen & Bomberger, 2015; Le Corre et al., 2013). Similarly, among tourists who visit a site, those with higher levels of education have greater knowledge, and therefore, the local socioeconomic context plays an influential role in this regard (Le Corre et al., 2013). In other studies, visitors' knowledge about the area they are visiting has been investigated. In a study conducted by Nikoleta Jones et al. (2011), in a protected area in Greece, it was found that only 25% of tourists knew it was a protected area, and very few knew about the impacts of tourism on wildlife. In another study by Le Corre et al. (2013) in France, it was identified that 65% of the surveyed tourists knew it was a protected area, and of them, 38% knew why. In this same study, which had a specific focus on birds, visitors were asked about the species present in the park, and only 50% were able to mention 1 or 2 species, usually the most common ones, and species in a conservation status were rarely mentioned (Le Corre et al., 2013).

Regardless of the level of knowledge about the parks and the wildlife that inhabit them, people tend to agree on the importance of protecting habitats and wildlife (Aas et al.,

2023; Arnberger et al., 2012; Choquette & Hand, 2021; Haukeland et al., 2013; Høyem, 2020; Nikoleta Jones et al., 2011; Kopp & Coppes, 2020; Le Corre et al., 2013). However, the intention to protect nature is not always reflected in the actions of recreationists, as they may prioritize their desired activities over conservation measures (Arnberger et al., 2012; Choquette & Hand, 2021). This implies that although people may claim to be concerned about nature, their behavior may not necessarily be determined by this intention, but by other variables related to desires to achieve something, the actions of others, and their own perceived ability to do it, finding in line with the theory of planned behavior (Aas et al., 2023; Ajzen, 1991).

### **3.1.2. Attitudes and perceived behavioral control in relation to human activities that cause wildlife disturbance**

Various studies have concluded that the willingness to accept information and eventually modify an attitude depends on the activity being performed (Gruas et al., 2022; Immoos & Hunziker, 2015; Le Corre et al., 2013). People engaged in non-exploratory recreational activities such as swimming, fishing, exercising, or relaxing are less receptive to information and less willing to accept that their activity generates an impact on the environment (Immoos & Hunziker, 2015; Le Corre et al., 2013; Martin et al., 2015). This is because accepting such information could mean giving up activities they wish to do, and about which they perceive the ease and opportunity to do so (Cremer-Schulte et al., 2017).

A group that has been particularly identified as resistant to accepting their role in disturbing wildlife are photographers, who are often the primary source of animal stress (Aas et al., 2023; Allbrook & Quinn, 2020; Cerri et al., 2019). This is consistent with other studies that have identified that those with more knowledge and experience in nature or who visit these places more frequently are often more resistant to accepting that they disturb wildlife (Aas et al., 2023; Gruas et al., 2020; Jorgensen & Bomberger, 2015; Levêque et al., 2015). The reason for this could be derived from their frequent contact with nature and observing low levels of disturbance, leading them to assume that there is no impact (Gruas et al., 2020; Marzano & Dandy, 2012), as well as balancing their impact with the benefits of being in nature and positive effects such as support for the local economy (Goh, 2020). Furthermore, those who visit more frequently are often less interested in seeing new signage and less receptive to further information (Gruas et al., 2020).

Studies have shown that local residents who rely on tourism for income are less likely to accept that both their and tourists' impact are disturbances to wildlife (Gruas et al., 2020). They may also be less willing to accept new restrictions and measures because it affects what they are used to do, compared to non-local tourists who are easier to guide through management measures due to their lack of knowledge on the subject (Gruas et al., 2022; Gundersen et al., 2015).

A recurring aspect is the contradiction of people who know that tourism can have a negative impact on wildlife but at the same time believe that their presence, in particular, does not have negative effects on wildlife (Cremer-Schulte et al., 2017; Gruas et al., 2020; Le Corre et al., 2013; Levêque et al., 2015; Marzano & Dandy, 2012). In a study by Sterl et al. (2008), only 12% of those surveyed indicated that their presence causes disturbance to wildlife. Some studies have even shown that visitors do not believe that recreation has an impact on wildlife and instead believe it to be positive (Taylor & Knight, 2003). In the literature review by Gruas et al. (2020), it was found that although all studies on nature-based recreational activities impact wildlife, only one indicated that recreationists are in line with these results. This implies that many visitors are unaware of the disturbance they generate in wildlife and underestimate the impact they can cause (Cremer-Schulte et al., 2017).

The reasons why people fail to recognize disturbances in wildlife are summarized as follows:

- Visitors do not see disturbance and therefore assume there is none (Cremer-Schulte et al., 2017; Le Corre et al., 2013; Levêque et al., 2015; Marzano & Dandy, 2012; Sterl et al., 2008). This tendency is attributed to people's propensity to detect only readily apparent visual damage, such as fires, rather than their disturbances or those that affect non-human entities, such as animals (Levêque et al., 2015). In the case of birds, a specific investigation has revealed that visitors observing certain species habituated to human presence are inclined to presume that all birds behave similarly (Le Corre et al., 2013). Conversely, individuals who have experienced disturbances are more likely to recognize their occurrence (Gruas et al., 2020).
- Visitors assume that there is no disturbance because they have sufficient experience and prior knowledge to avoid disturbance before it occurs. Studies

have shown this to be the case with experienced photographers or birdwatchers who have high self-confidence in their actions (Aas et al., 2023; Allbrook & Quinn, 2020; Cerri et al., 2019).

- People believe that other types of activities, different from those they engage in, cause disturbances. Responsibility for the disturbance is transferred to other groups (Gruas et al., 2020; Le Corre et al., 2013; Levêque et al., 2015; Marzano & Dandy, 2012; Sterl et al., 2008).
- Recreationists see others acting and normalize it as correct, even if it causes a disturbance to animals (Goh, 2023; Marion & Reid, 2007; Marzano & Dandy, 2012).
- In recreational contexts, individuals often prioritize their desired activities over measures intended to protect the environment, viewing such measures as obstacles to their freedom (Cremer-Schulte et al., 2017; Gruas et al., 2022; Gruas et al., 2020; Immoos & Hunziker, 2015; Jorgensen & Bomberger, 2015; Le Corre et al., 2013; Martin et al., 2015). For instance, Le Corre et al. (2013), observed that individuals engaged in kitesurfing were resistant to restrictions on the sport, arguing that it did not disturb the environment and that measures were excessive, unsupported by scientific evidence. This illustrates a general tendency for individuals to prioritize their leisure activities over environmental concerns.
- Inadequate knowledge about the factors that lead to disturbance in wildlife is a common issue, such as the appropriate distances that should be maintained to avoid causing disruption. People often underestimate the distance required and believe they can get closer than animals can tolerate (Marzano & Dandy, 2012; Taylor & Knight, 2003). Sterl et al. (2008), compared the perception of experts and tourists regarding the impact of human activities on wildlife in a specific park and concluded that lay people perceive less impact from their actions compared to what experts indicate. Although all experts noted that wildlife is affected by human presence, only 40% of tourists believed that disturbance might exist.
- It is believed that the animals' own surveillance system prevents disturbance (Sterl et al., 2008).

A recurring aspect in various studies is that the awareness or knowledge in individuals does not necessarily lead to pro-environmental behavior (Gruas et al., 2020; Høyem, 2020; L. Kidd & Dayer, 2020; Marzano & Dandy, 2012; Rosa & Collado, 2019). Even individuals with solid conservation values may disconnect their concern for the environment from their outdoor behaviors (Høyem, 2020; Marzano & Dandy, 2012). Therefore, a series of complex variables must be considered for behavior change (Rosa & Collado, 2019), which will require, among other things, that information be reflected upon and internalized by each person (Høyem, 2020). In this regard, the perception of individuals regarding their ability to influence is relevant to consider. If a person believes that their actions do not generate any change or influence, they will be less convinced to adopt actions, and therefore, even though they may agree with a specific value, they may not take any action (Jurin et al., 2010).

### **3.1.3. Attitudes and relationship of visitors with signage**

The significance of signage clarity has been reiterated in the literature, as it has been found that unclear signage or its absence can lead individuals to make erroneous decisions. This is attributed to the reliance on past experiences and preconceived notions that may not always be substantiated by reliable evidence (Goh, 2020, 2023; Hughes et al., 2014; Kopp & Coppes, 2020). In some instances, individuals have deemed going off the road as a safer option due to signage that was deemed unclear (Goh, 2020, 2023).

From the perspective of individuals, a study by Burns et al. (2021), found that the majority preferred not having more signage as they deemed it intrusive in a natural setting and a distraction from the landscape. This is consistent with the findings of Gruas et al. (2020), who noted that frequent visitors may be less interested in new signage since they do not consider that it would provide them with further information. However, the study by Jorgensen and Bomberger (2015), presented a contrasting view, as visitors with greater knowledge of species considered educational efforts to be appropriate. These findings indicate that perceptions are influenced by the area and the type of information conveyed, as previously observed, signs that focus on restricting actions are likely to be less accepted than purely educational signs. This assertion is supported by Levêque et al. (2015), who concluded that educational programs, such as information boards, were the most widely supported management measure among individuals, with 90% of respondents agreeing with this approach.

According to research, people are more likely to comply with recommendations on signage if they comprehend the benefits of wildlife conservation, the threats to animals, animal behavior, recommended actions, and scientific information (Hughes et al., 2014; Taylor & Knight, 2003). In addition, people highlight the importance of information being quick to read and easy to understand (Smith-Jackson & Hall, 2002), which aligns with various studies regarding effective signage (Allbrook & Quinn, 2020; Ballantyne & Hughes, 2003; Calori & Vanden-Eynden, 2015; Colquhoun, 2005; Hahn & Berkers, 2021; Hughes et al., 2014; Janeczko et al., 2021; Kopp & Coppes, 2020; Marion & Reid, 2007; Mutiara et al., 2021; U.S. Fish & Wildlife Service, 2019). This is particularly crucial as individuals are often distracted or engaged in activities, resulting in diminished cognitive resources to process information (Smith-Jackson & Hall, 2002).

Attention capacity is a critical aspect to consider in this context. Three essential elements are pertinent to note: (a) attention is selective, and individuals can only concentrate on one thing at a time; (b) attention has a focusing power, where a person's level of motivation determines the extent to which they can concentrate on a particular task or activity; (c) attention capacity is finite, and prolonged effort or duration can cause a decline in attention span over time (Bitgood, 2000).

### 3.1.4. Gaps between lay people and expert knowledge

Based on the literature review regarding people's attitudes and perceptions of their relationship with wildlife when engaging in wilderness activities, the following gaps between these perceptions and scientific knowledge are identified:

Table 3: Gaps between people's perceptions and scientific knowledge.

Category	Gap
<b>Awareness of disturbances in wildlife</b>	People are unaware of or do not believe that their recreational activities can cause disturbances to wildlife, or they assign responsibility to other groups. This is despite widespread recognition of their importance.
<b>Acceptance of measures in recreational activities</b>	Recreationists are unwilling to accept management measures that could limit or affect the development of their activities, even if those measures are necessary to protect wildlife and their habitats.
<b>Social influence</b>	Recreational participants are inclined to perceive actions conducted by others as appropriate behavior. When observing an individual

	either adhering to or deviating from a given prompt, they will emulate the same conduct.
<b>Perceptions of experienced people</b>	Recreationists with prior knowledge and experience in nature tend to perceive their actions as less impactful and are less inclined to adhere to behaviors for minimizing disturbance to wildlife.
<b>Interest in nature protection</b>	Recreationists, who engage in physical exercise or sightseeing, exhibit disinterest in conserving natural resources.
<b>Knowledge about species</b>	People visiting natural areas are unaware of the species present in the area, their behaviors, and the threats they face.
<b>Human cognition and attention</b>	People have limited attention capacity due to inherent cognitive limitations, resulting in decreased ability to process information when visiting a park.
<b>Motivation to read signage</b>	Recreationists often lack the interest and motivation to read signs containing information about protected species and actions to be taken to protect them.
<b>Signage and landscape</b>	Recreationists do not agree with intrusive signage that disrupts the landscape where they are located.

In alignment with the research questions of this study, the gap related to the awareness of disturbances on wildlife was prioritized for the next step of signage design. This involves communication that effectively conveys the impact of recreational activities on wildlife and promotes a sense of personal responsibility in undertaking these activities. For the purposes of signage design, gaps related to human cognition and attention, and the motivation to read the sign were specifically considered for the design addressed in the prescriptive research.

### **3.2. Prescriptive research**

An extensive review and synthesis of existing literature and guidelines was carried out to combine the main guidelines for designing effective signage. The following sub-chapters present the main results of this research.

#### **3.2.1. Key principles for signage design**

Based on the literature, signage should comply with the following maxims:

- **Simple:** To ensure optimal visitor engagement, the sign should be simple, clear, and concise. Saturation of content and graphics, and the inclusion of

unnecessary information should be avoided. This approach is intended to reduce the cognitive and mental effort required of visitors, allowing them to maintain their motivation and attention span (Ballantyne & Hughes, 2003; Bitgood, 2000; Burns et al., 2021; Cairngorms National Park, 2009; Calori & Vanden-Eynden, 2015; Choquette & Hand, 2021; City of Surrey, 2021; Colquhoun, 2005; Cremer-Schulte et al., 2017; Janeczko et al., 2021; A. Kidd et al., 2015; Marion & Reid, 2007; Mutiara et al., 2021; National Park Service, 2009; Tilden, 1957; U.S. Fish & Wildlife Service, 2019; Vaughan, 2020; Wong-Parodi & Bruine de Bruin, 2017).

- **Quality:** Given the limitations of signage as a non-interactive medium, the information presented should be accurate, credible, and firmly grounded in scientific evidence. To this end, particular care must be taken to ensure that the content is reliable and that any claims made can be substantiated (Colquhoun, 2005; Marion & Reid, 2007; Shome & Marx, 2009; Wong-Parodi & Bruine de Bruin, 2017).
- **Relevant:** The information on signage should be relevant, engaging, and helpful to visitors, to captivate their interest and enhance their overall experience. As such, signage should be designed to spark visitors' curiosity and arouse their interest (Ballantyne & Hughes, 2003; Bitgood, 2000; City of Surrey, 2021; Colquhoun, 2005; Jurin et al., 2010; Marion & Reid, 2007; National Park Service, 2009; Smith-Jackson & Hall, 2002; Tilden, 1957; Wong-Parodi & Bruine de Bruin, 2017).
- **Comprehensible:** Effective signage must be easily comprehensible to its intended audience, requiring minimal decoding effort to properly understand the conveyed message. As such, the signage should be designed with clarity in mind, to facilitate accurate and rapid message interpretation (Bitgood, 2000; City of Surrey, 2021; Colquhoun, 2005; Goh, 2023; Muekthong, 2021; Smith-Jackson & Hall, 2002; Tilden, 1957; Vaughan, 2020; Wong-Parodi & Bruine de Bruin, 2017).
- **Attractive:** Signage should be designed to capture visitors' attention, inspire interest, and elicit a positive response. To achieve this, signage should incorporate visually appealing and creative elements that are distinctive, salient,



and capable of provoking thought or emotion (Ballantyne & Hughes, 2003; Bitgood, 2000; Cairngorms National Park, 2009; City of Surrey, 2021; Colquhoun, 2005; Cremer-Schulte et al., 2017; Marion & Reid, 2007; Martin et al., 2015; National Park Service, 2009; Price et al., 2018; Smith-Jackson & Hall, 2002; Tilden, 1957; Vaughan, 2020).

### 3.2.2. Guidelines for the written content of signage

The recommendations regarding the content to be included in the message are as indicated in Table 4.

Table 4: Guidelines for the written content of the signage.

Category	Description	Source
<b>Desired behaviors</b>	Signage should explicitly state the intended behavior as a call to action to encourage visitors to take desired actions. This can be achieved by combining injunctive messages, which specify what actions to take, with proscriptive messages, which define what actions to avoid.	(Abrams et al., 2020; City of Surrey, 2021; Hughes et al., 2014; A. Kidd et al., 2015; L. Kidd & Dayer, 2020; Kopp & Coppes, 2020; Marion & Reid, 2007; National Park Service, 2009; Province of Nova Scotia, 2008; Winter et al., 2000).
<b>Audience's personal experience</b>	Effective signage should aim to connect with visitors' individual experiences, thoughts, and aspirations. This may involve establishing links to the visitor's current activities or addressing local environmental issues to help the individual make sense of the conveyed message. To do this, asking people to think about something for a moment or make them reflect on these experiences would be an alternative.	(Abrams et al., 2020; Colquhoun, 2005; Gruas et al., 2022; Høyem, 2020; Hughes et al., 2014; Price et al., 2018; Shome & Marx, 2009; Tilden, 1957; U.S. Fish & Wildlife Service, 2019; Vaughan, 2020)
<b>Positive approach</b>	Signage should adopt a positive approach that encourages voluntary changes in behavior and promotes a positive visitor experience. Negative messages have the potential to induce fear, disempowerment, and annoyance, which can create resentment towards management.	(Ballantyne & Hughes, 2003; City of Surrey, 2021; Cremer-Schulte et al., 2017; Province of Nova Scotia, 2008; Winter et al., 2000)

<b>Rationale behind expected behaviors</b>	To provide a clear rationale for the recommended actions, highlight why certain behaviors are expected. This may include an explanation of the short-term and long-term impacts of inaction.	(Gruas et al., 2022; Hughes et al., 2014; Marion & Reid, 2007; Shome & Marx, 2009)
<b>Recognition for performing the desired behavior</b>	To recognize the contributions, emphasizing that individual actions can make a meaningful difference for the targeted species. It is important to convey that each contribution, no matter how small, can have a cumulative impact and how it will benefit the species.	(Goh, 2023; L. Kidd & Dayer, 2020; Taylor & Knight, 2003)
<b>Knowledge about species</b>	Include information on the species, such as: the behavior of the animals in the presence of humans, the benefit of the species, the threats they face, scientific information and data on their habitat.	(Abrams et al., 2020; Hughes et al., 2014; Taylor & Knight, 2003; U.S. Fish & Wildlife Service, 2019)
<b>Social factor</b>	Target other reference groups to influence socially accepted behaviors, mentioning the desired behavior and its social acceptability.	(Goh, 2023; L. Kidd & Dayer, 2020; Shome & Marx, 2009)
<b>Avoiding park management propaganda</b>	Avoid institutional propaganda, excessive logos, or oversized logos in signage, as these elements can be visually distracting and may overwhelm the visitor. Such information may not be relevant to the intended message of the signage.	(National Park Service, 2009; U.S. Fish & Wildlife Service, 2019)
<b>Avoiding unnecessary information</b>	Avoid unnecessary information in signage, such as excessive data, obvious or redundant phrases, and unnecessary use of space. It is not a sales pitch, so avoid using language to make the place meaningful. Additionally, avoid information that could change over time.	(National Park Service, 2009; Province of Nova Scotia, 2008; Vaughan, 2020)

Recommendations related to the narrative style of the message are summarized in Table 5.

Table 5: Guidelines for the narrative style of the message.

Category	Description	Source
<b>Tone of the message</b>	To adopt a conversational tone that utilizes simple and familiar language. This can help enhance the message's clarity and understandability, while limiting the use of technical jargon or complex terminology that may be difficult for the average visitor to comprehend.	(Ballantyne & Hughes, 2003; Center for Research on Environmental Decisions, 2009; Hughes et al., 2014; Janeczko et al., 2021; L. Kidd & Dayer, 2020; National Park Service, 2009; U.S. Fish & Wildlife Service, 2019)
<b>Interpretive techniques</b>	Use writing techniques such as storytelling, metaphors, analogies, humor, and suggestions. These approaches can add interest and intrigue to the message, making visitors more likely to read and retain the information. Additionally, utilizing descriptive language that creates vivid visual imagery can enhance the memorability and impact of the message.	(Ballantyne & Hughes, 2003; Center for Research on Environmental Decisions, 2009; Colquhoun, 2005; Cremer-Schulte et al., 2017; National Park Service, 2009; Province of Nova Scotia, 2008)
<b>Broad target audience</b>	Focus on a 10- to 12-year-old audience when writing the message. This allows to include individuals with different educational levels.	(Ballantyne & Hughes, 2003; Hughes et al., 2014; Janeczko et al., 2021; Province of Nova Scotia, 2008; U.S. Fish & Wildlife Service, 2019)
<b>Use of active voice</b>	Utilize an active communication style that employs pronouns such as "you" or "we". This approach creates a more direct and relatable message that encourages the visitor to act. It is advisable to use action-oriented verbs rather than noun or adjective derivatives of verbs.	(Ballantyne & Hughes, 2003; National Park Service, 2009; Province of Nova Scotia, 2008; Tilden, 1957; U.S. Fish & Wildlife Service, 2019)
<b>Use of questions</b>	Use engaging and thought-provoking questions. Questions should be relevant to the topic and designed to elicit further exploration or reflection. By challenging visitors to consider new perspectives or question their assumptions, signage can promote a deeper understanding and engagement with the subject matter.	(Ballantyne & Hughes, 2003; Colquhoun, 2005; Davis & Thompson, 2011; Hughes et al., 2014; Tilden, 1957)

<b>Provocative tone</b>	Write provocatively and memorably to capture attention and leave an impression. Using intriguing, exciting, and imaginative language can create a sense of wonder and promote engagement. By utilizing creative writing techniques and evoking emotional responses, signage can be transformed into an engaging and memorable experience for visitors.	(Ballantyne & Hughes, 2003; Colquhoun, 2005; Price et al., 2018; Tilden, 1957)
-------------------------	--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------	--------------------------------------------------------------------------------

Finally, recommendations related to the presentation format of the written content are presented in Table 6.

Table 6: Recommendations concerning the presentation format of the message.

<b>Category</b>	<b>Description</b>	<b>Source</b>
<b>Title</b>	The title must be attention-grabbing, thought-provoking, and distinctive, as it is the first aspect that draws people's attention. The title not only introduces the topic but also gives a sense of the content, stimulates curiosity, and encourages interest.	(Ballantyne & Hughes, 2003; City of Surrey, 2021; Colquhoun, 2005; Davis & Thompson, 2011; Jurin et al., 2010; National Park Service, 2009; Province of Nova Scotia, 2008; Vaughan, 2020)
<b>Information hierarchy</b>	Arrange messages according to their level of importance, with the most critical information given more prominence, while complex or detailed information is relegated to a lower level of visibility. This facilitates the process of information acquisition and enables people to follow information more efficiently. This order of information should be related to cognitive processing procedures.	(Ballantyne & Hughes, 2003; Calori & Vanden-Eynden, 2015; Colquhoun, 2005; Muekthong, 2021; National Park Service, 2009; Province of Nova Scotia, 2008; Smith-Jackson & Hall, 2002; U.S. Fish & Wildlife Service, 2019; Vaughan, 2020)
<b>Extension</b>	It is recommended to capture the message's essence and limit the text's length to 1 to 3 essential points, written in sentences. Since visitors typically have a limited attention span, the main idea	(Burns et al., 2021; Choquette & Hand, 2021; City of Surrey, 2021; Colquhoun, 2005; Guo et al., 2015; Marion & Reid, 2007; Mutiara et al., 2021;

	should be conveyed in just a few seconds. However, it is crucial to ensure that text reduction does not compromise the message or explanations, resulting in poorly written content.	National Park Service, 2009; Province of Nova Scotia, 2008; Tilden, 1957; Vaughan, 2020)
--	--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------	------------------------------------------------------------------------------------------

### 3.2.3. Guidelines for the graphic and visual approach of the signage

Concerning the design and graphical aspects of the signage, the following recommendations are obtained from the literature, which are organized according to the different elements to be taken into consideration:

Table 7: Guidelines for the graphic and visual approach of the signage.

Category	Description	Source
<b>Images and visuals</b>	Visuals have the power to convey messages more effectively than text alone, and individuals often begin by processing visual information. Consequently, it is essential to include one or a few high-quality images or illustrations that are relevant and appropriately aligned with the text. Achieving a harmonious balance between the text and the image is critical for optimal communication.	(Bitgood, 2000; Cerri et al., 2019; City of Surrey, 2021; Colquhoun, 2005; Davis & Thompson, 2011; Hahn & Berkers, 2021; Hughes et al., 2014; Janeczko et al., 2021; Jurin et al., 2010; A. Kidd et al., 2015; Muekthong, 2021; National Park Service, 2009; Province of Nova Scotia, 2008; Vaughan, 2020)
<b>Symbols</b>	To minimize interpretation errors, employ universal symbols consistent with the accompanying text and proportionate to other design elements.	(Calori & Vanden-Eynden, 2015; Colquhoun, 2005; Gibson, 2009; Muekthong, 2021; Mutiara et al., 2021)
<b>Color</b>	The use of a color scheme that is attractive and harmonious. White color should be avoided in large spaces as it can cause glare for the sun. Colors should be applied strategically to draw attention to focal aspects or differentiate between elements.	(Calori & Vanden-Eynden, 2015; Colquhoun, 2005; Gibson, 2009; Mutiara et al., 2021; National Park Service, 2009; Province of Nova Scotia, 2008; Vaughan, 2020)

	Colors should be distinguishable and not create confusion.	
<b>Integration with the environment</b>	To make the signage less intrusive and enhance the connection with the environment, creating a composition that aligns with the surroundings is preferable. But at the same time, add elements that distinguish it and draw attention to it.	(Calori & Vanden-Eynden, 2015; Colquhoun, 2005; Gibson, 2009; Mutiara et al., 2021; National Park Service, 2009)
<b>Empty spaces</b>	To enhance legibility, clarity, and organized appearance, make use of white space that corresponds to the area without information. The margins should neither be too broad nor too narrow, and there should be appropriate spaces between lines and letters to facilitate reading.	(Calori & Vanden-Eynden, 2015; Colquhoun, 2005; Gibson, 2009; Jurin et al., 2010; Province of Nova Scotia, 2008)
<b>Typography</b>	Ensure consistency in the font choice across all signage, with a focus on legibility and readability. Employ larger font sizes to enhance ease of reading. Use fonts that adhere to accessibility standards, such as Arial or Helvetica. Avoid using capital letters, while ensuring uniformity in font size for related content.	(Cairngorms National Park, 2009; Calori & Vanden-Eynden, 2015; Colquhoun, 2005; Hughes et al., 2014; Jurin et al., 2010; Muekthong, 2021; Mutiara et al., 2021; National Park Service, 2009; Province of Nova Scotia, 2008; Vaughan, 2020)
<b>Contrast</b>	The contrast between the background, text, and images should be balanced to achieve unity and enhance legibility and clarity. Text placed over images should be avoided.	(Ballantyne & Hughes, 2003; Cairngorms National Park, 2009; Calori & Vanden-Eynden, 2015; City of Surrey, 2021; Colquhoun, 2005; Muekthong, 2021; Mutiara et al., 2021)
<b>Composition</b>	Divide the space effectively and avoid overloading it with too many elements. In this case, less is often more, so each included element should have a clear purpose and value.	(Burns et al., 2021; Calori & Vanden-Eynden, 2015; Muekthong, 2021; Mutiara et al., 2021; National Park

		Service, 2009; Vaughan, 2020)
<b>Maps</b>	When adding maps, it is crucial to include only the essential information and use color to distinguish between elements. A symbol should indicate the observer's current location. The text should be placed on the map itself, and the orientation should be decided based on what the observer sees in front of them or whether it's north oriented.	(Calori & Vanden-Eynden, 2015; Colquhoun, 2005; Gibson, 2009; National Park Service, 2009; Province of Nova Scotia, 2008)
<b>Interactive elements</b>	The use of interactive elements, such as mobile, multisensory, or three-dimensional elements, can attract visitors' attention.	(Ballantyne & Hughes, 2003; Bitgood, 2000; Colquhoun, 2005; Davis & Thompson, 2011; National Park Service, 2009; Province of Nova Scotia, 2008)

### 3.2.4. Signage designs

Utilizing the recommendations identified, four signs were designed, employing a dichotomous matrix of four variables, as previously introduced in the Study Area and Methods section (Figure 2). The vertical axis is centered around the message, while the horizontal axis pertains to the design. Figure 3 illustrates the four signage designs developed based on the employed matrix. For a more detailed examination of the signs, please refer to Appendix C.



Descriptive gaps

**Betreten vom 15.3.-10.8. verboten**

**STOP!**  
Hier dürfen Sie nicht spazieren gehen, weil die Vögel hier ihre Jungen aufziehen.

An dem Schild nicht vorbeigehen!

Hier bist Du

**DU BIST VERANTWORTLICH FÜR DIE ZUKUNFT DES FLUSSUFERLÄUFERS**

**Deine Anwesenheit kann den Unterschied zwischen dem Überleben und dem lokalen Aussterben dieser Vögel ausmachen.**

Wenn du sie störst, verlassen sie ihre Nester und die Jungen sterben. Wenn du sie respektierst, schützt du ihr Zuhause und hilfst ihrem Überleben.



Sei bereit, hier Deinen Freiraum einzuschränken, um den Lebensraum des Flussuferläufers zu schützen.



**DU BIST VERANTWORTLICH FÜR DIE ZUKUNFT DES FLUSSUFERLÄUFERS**



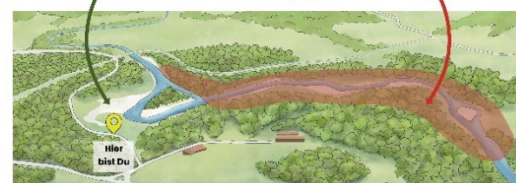
Deine Anwesenheit kann den Unterschied zwischen dem Überleben und dem lokalen Aussterben dieser Vögel ausmachen.

Wenn du sie störst, verlassen sie ihre Nester und die Jungen sterben. Wenn du sie respektierst, schützt du ihr Zuhause und hilfst ihrem Überleben.

Hier kannst du auf der Kiesbank lagern und den Wildfluss genießen, ohne die Vögel zu stören.



**Betrete nicht den markierten Bereich vom 15.3.-10.8.**



Message

**Signage 2**

**Betreten vom 15.3.-10.8. verboten**

**STOP!**  
Hier dürfen Sie nicht spazieren gehen, weil die Vögel hier ihre Jungen aufziehen.

An dem Schild nicht vorbeigehen!

Hier bist Du

**VERANTWORTUNGSVOLL IN DER NATUR UNTERWEGS**

**Hilf den Flussuferläufer zu schützen!**

Auf den Kiesbänken lebt der Aussterben bedrohte Flussuferläufer. Von April bis August kommt er aus Afrika, um seine Jungen auf den spärlich bewachsenen Kiesbänken auszubrüten und aufzuziehen.

Wenn sie gestört werden, verlassen sie ihre Nester und verlieren Ihren Nachwuchs.

Hilf uns, ihr Zuhause zu schützen und sie nicht zu stören.



**Signage 1**

**Signage 4**

**VERANTWORTUNGSVOLL IN DER NATUR UNTERWEGS**

Hier bist Du



Hier kannst du auf der Kiesbank lagern und den Wildfluss genießen, ohne die Vögel zu stören.

**Betrete nicht den markierten Bereich vom 15.3.-10.8.**



**Hilf den Flussuferläufer zu schützen!**

Auf den Kiesbänken lebt der Aussterben bedrohte Flussuferläufer. Von April bis August kommt er aus Afrika, um seine Jungen auf den spärlich bewachsenen Kiesbänken auszubrüten und aufzuziehen.

Wenn sie gestört werden, verlassen sie ihre Nester und verlieren Ihren Nachwuchs.

Hilf uns, ihr Zuhause zu schützen und sie nicht zu stören.



**Signage 3**

Simple

Design

Descriptive gaps

Figure 3: Signage designed based on the descriptive and prescriptive research.



Regarding the message on the vertical axis, an informative message was developed and applied to signs 1 and 3. For signs 2 and 4, a message aimed at addressing the prioritized gaps from the descriptive research was implemented, specifically concerning how to effectively communicate the impact of recreational activities on wildlife while promoting a sense of personal responsibility. Below are the messages presented on each of the four signs in English, following the order from top to bottom, and from left to right:

<p>Forbidden to enter from 15.3. - 10.8. Do not pass the sign!</p> <p><b>YOU ARE RESPONSIBLE FOR THE FUTURE OF THE SANDPIPER</b></p> <p>Your presence can make the difference between the survival and local extinction of these birds.</p> <p>If you disturb them, they abandon their nests and the young die. When you respect them, you protect their homes and help their survival.</p> <p>Be willing to limit your space here to protect the habitat of the sandpiper.</p>	<p><b>YOU ARE RESPONSIBLE FOR THE FUTURE OF THE SANDPIPER</b></p> <p>Your presence can make the difference between the survival and local extinction of these birds.</p> <p>If you disturb them, they abandon their nests and the young die. When you respect them, you protect their homes and help their survival.</p> <p>Here you can stay on the gravel bank and enjoy the wild river without disturbing the birds.</p> <p>Do not enter the marked area from 15.3. - 10.8.</p>
<p>Forbidden to enter from 15.3. - 10.8. Do not pass the sign!</p> <p><b>WALK RESPONSIBLY IN NATURE</b></p> <p>Help to protect the sandpiper!</p> <p>The endangered sandpiper lives on the gravel banks. From April to August, it comes from Africa to hatch and raise its young on the sparsely vegetated gravel banks.</p> <p>If disturbed, they abandon their nests and lose their offspring.</p> <p>Help us to protect their home and not disturb them.</p>	<p><b>WALK RESPONSIBLY IN NATURE</b></p> <p>Here you can stay on the gravel bank and enjoy the wild river without disturbing the birds.</p> <p>Do not enter the marked area from 15.3. - 10.8.</p> <p>Help to protect the sandpiper!</p> <p>The endangered sandpiper lives on the gravel banks. From April to August, it comes from Africa to hatch and raise its young on the sparsely vegetated gravel banks.</p> <p>If disturbed, they abandon their nests and lose their offspring.</p> <p>Help us to protect their home and not disturb them.</p>

Figure 4: Translation into English of the messages implemented in the four signs.

The informative message was centered around providing information about the bird, mentioning its habitat, origin, the consequences of disturbance, and the request not to disturb it. The message related to the prioritized gaps aimed to have a more direct appeal to the individual, emphasizing personal responsibility by indicating that human actions can have influence between the bird's survival or potential demise.

Regarding the design of the signs, represented along the horizontal axis, signs 1 and 2 feature a simple design, utilizing essential elements arranged in a straightforward composition. In contrast, signs 3 and 4 exhibit a more complex design, aiming to visually address the identified gaps related to optimizing visitors' attention and increasing their motivation to read and retain the information presented. The yellow signage was consistently incorporated due to its significance in being near the riverbank where the bird is found. However, its location and size within the overall signage may vary. Efforts were made to maintain uniformity in colors, font type, font size, and general style to ensure coherence and minimize variation across the results.

Signs 1 and 2 include a two-dimensional map and an aerial map indicating the restricted areas, accompanied by an illustration of the bird with its eggs. Signs 3 and 4 adopted a design approach to convey the message through visualizations. For this purpose, a three-dimensional illustrated map was created, oriented to the viewer's perspective. Signage 3 and 4 highlight the restricted area and an area where visitors are allowed to access. Sign 3 combines the map with the illustration, visually distinguishing the visitor's area and the bird's habitat. Signage 4 employs a storytelling-style representation, portraying a direct cause of the disturbance. It depicts a couple casually walking and a loose dog running freely. In the foreground, the frightened bird is fleeing, leaving its eggs behind.

### **3.3. Evaluative research**

The main results obtained from the interviews are presented below. Given the many opinions and recommendations, those considered most in line with the research were selected.

#### **3.3.1. Characterization of interviewees**

A total of 21 individuals were interviewed, including a pilot interview conducted to refine the questionnaire. Among the interviewees were 16 females and 5 males, with ages

ranging from 25 to 50 years with an average age of 32 years. Figure 5 displays the main characteristics of the interviewed participants, including gender, whether the individual is a student or employed, and if their field of study or occupation is related to nature, such as conservation of nature, sustainable resource management, environmental management, landscape planning, wildlife, and protective area management.

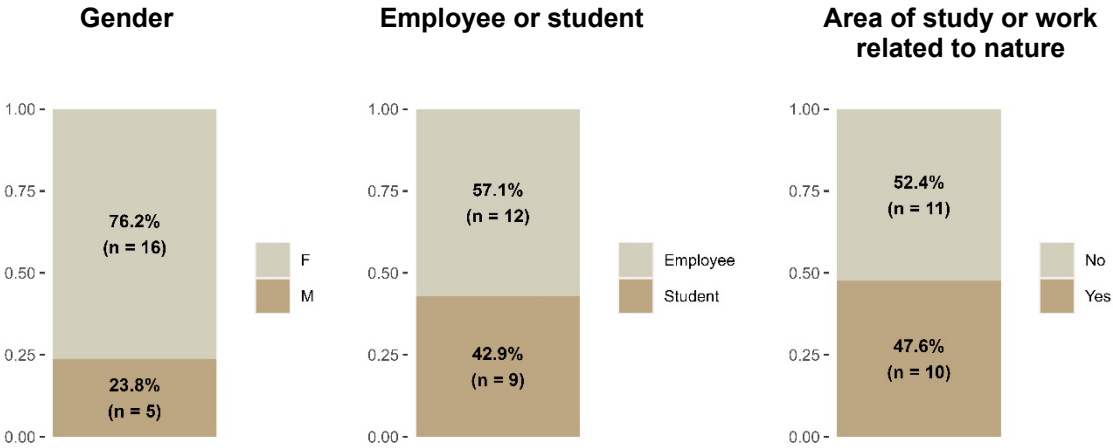


Figure 5: Characterization of the participants interviewed.

**3.3.2. Aspects remembered in a short period of time**

Participants were initially presented with each sign for ten seconds, after which they were asked questions to assess their recollection of specific elements. The following results exclude the pilot interview, considering 10 responses for each sign to facilitate comparison. The first question asked after the ten-second observation was regarding what participants noticed first. The results are depicted in Figure 6. Participants were subsequently asked if there were any other elements that they remembered. These results can be seen in Figure 7.

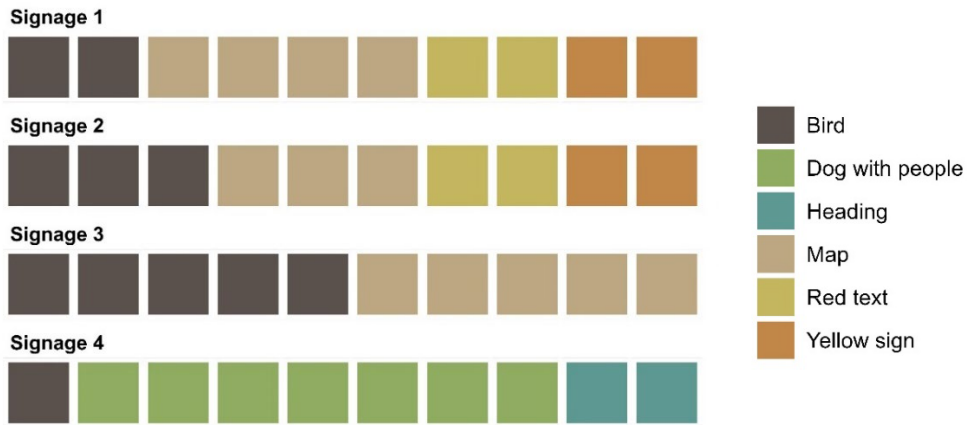


Figure 6: Elements of the signage that were observed in the first place by interviewees.

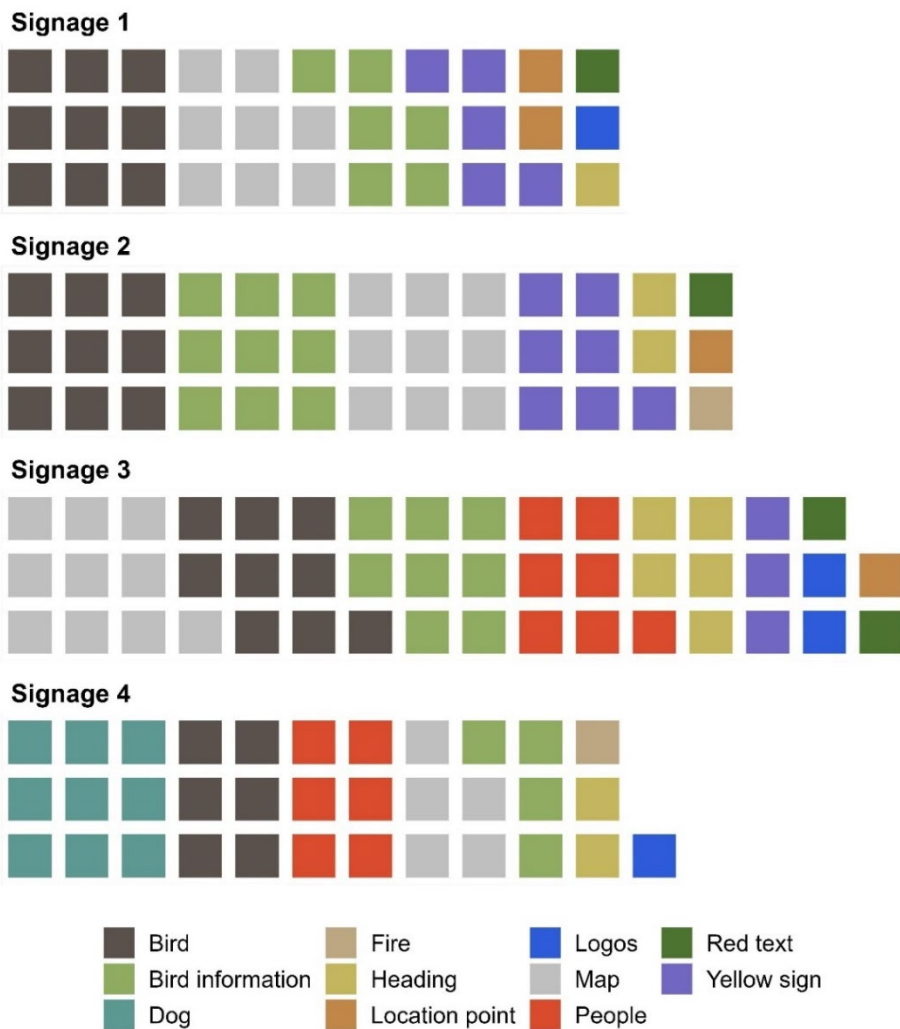


Figure 7: Elements that were observed by the interviewees in each signage.

In Figure 7, it is important to note that in two of the signs, two different participants identified the element “fire”, when it is a non-existent element in the signs.

Regarding the question about the perceived main message of the signage, all participants provided accurate responses regarding the purpose of the signs, indicating successful communication of the message across all four alternatives. However, certain nuances in how participants approached the message could be relevant for the analysis. Table 8 summarizes the main ideas expressed by participants, indicating the number of mentions associated with each message within parentheses.

Table 8: Beliefs of the main message given by the interviewees after ten seconds of observation.

Signage 1	Signage 2	Signage 3	Signage 4
<ul style="list-style-type: none"> <li>• Be careful to go to an area because birds are nesting (7)</li> <li>• Information about a bird (2)</li> <li>• Saving a bird (1)</li> </ul>	<ul style="list-style-type: none"> <li>• Do not enter a particular area (4)</li> <li>• Do not enter an area for bird protection (3)</li> <li>• I am responsible for the survival of a bird (1)</li> <li>• Act responsibly (1)</li> <li>• Moral message (1)</li> </ul>	<ul style="list-style-type: none"> <li>• Not entering the area because birds are breeding (9)</li> <li>• There is space for birds and for people (1)</li> </ul>	<ul style="list-style-type: none"> <li>• Bird that needs protection (3)</li> <li>• Personal responsibility for the bird (3)</li> <li>• How to behave well (2)</li> <li>• Do not enter (1)</li> <li>• Do not leave the paths (1)</li> </ul>

**3.3.3. Respondents' perceptions regarding signage**

In the second phase of the interviews, participants were instructed to verbally describe all the elements they observed on the signage. A prevailing pattern emerged among the respondents. The descriptions began from the top of the signage, proceeding downward and mentioning the more prominent elements. Visual elements are also usually aspects that are initially described, such as illustrations. This pattern was particularly evident in signs 1 and 2, where the map consistently took precedence as the initial focus of the description, followed by the bird illustration and the yellow signage.

In sign 3, due to the larger image positioned at the top, participants frequently mention this element first during their description, followed by additional details about the restricted entry area and accompanying elements, such as the depiction of the bird.

In sign 4, a contrasting trend emerged. Participants began their descriptions by addressing the scenario involving the dog, people, and bird. Despite not being the uppermost or most significant element, the visual prominence of this scenario had a more substantial impact on participants, becoming the primary focal point of their descriptions. Some interviewees noted the challenge of establishing a precise sequence for describing the elements in sign 4 due to the absence of an explicit visual hierarchy guiding the order of information presentation.

Regarding the participants' opinion on what they evaluate most positively and negatively, the answers obtained in the individual analysis of each signage and the questions asked when comparing the two signage are presented in the following sections.

**3.3.3.1. Positively valued aspects**

Table 9 summarizes the most significant positive aspects mentioned for each sign. The first section of comments pertains to design, followed by comments related to the text. In the case of sign 4, no comments were related to the text.

Table 9: Positively valued aspects in each of the signs in terms of design and written content.

Signage 1	Signage 2	Signage 3	Signage 4
<ul style="list-style-type: none"> <li>• Bird realistic illustration</li> <li>• Map, and a clear red area</li> <li>• Colors</li> <li>• Yellow sign</li> </ul> <hr/> <ul style="list-style-type: none"> <li>• Text is nice and easily written</li> <li>• Bird information</li> <li>• Reasons why not to disturb them</li> </ul>	<ul style="list-style-type: none"> <li>• Colors</li> <li>• Bird realistic illustration</li> <li>• Map reminds Google Maps or Komoot</li> <li>• Yellow sign</li> <li>• Red area on map is eye-catching</li> </ul> <hr/> <ul style="list-style-type: none"> <li>• Reasons why not to go to the area</li> </ul>	<ul style="list-style-type: none"> <li>• It shows a complete story</li> <li>• Clear composition</li> <li>• Map</li> <li>• Detail drawings</li> <li>• Colors</li> <li>• Friendly approach</li> <li>• Text connected with visuals</li> </ul> <hr/> <ul style="list-style-type: none"> <li>• Message in red</li> </ul>	<ul style="list-style-type: none"> <li>• Illustration catches the attention and explains without text</li> <li>• Illustration conveys emotions</li> <li>• Map</li> <li>• Area where it is possible to be</li> <li>• Colors</li> <li>• Location point</li> <li>• Short text</li> </ul>

- |                                                                                                                                                                          |                                                                                                                                   |                                                                                                                                                        |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------|
| <ul style="list-style-type: none"> <li>• Positive message</li> <li>• Mix of education and restriction</li> <li>• Length of the text</li> <li>• “You” approach</li> </ul> | <ul style="list-style-type: none"> <li>• “You” approach</li> <li>• It has all the key information: why, what, and when</li> </ul> | <ul style="list-style-type: none"> <li>• Informative and nice message</li> <li>• Cohesive information</li> <li>• Text is easy to understand</li> </ul> |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------|

An aspect recurrently mentioned in signage 3 and 4 is the area where it is allowed to be, which provides an alternative for coexistence. One participant reinforces this: *“That’s interesting for me to make space for people in nature because often we have this image that nature must be pristine and untouched. So, to have a picture where you have both with the river and this protected area, but you also have a different area where you can stay and where you can take a rest and be. So, no need to invade this red area. You can stay here and enjoy the savage river without disturbing the birds.”*

Another recognized aspect is the explanation of why not to enter the area. The inexistence of an explanation could increase the levels of frustration and eventually not following the instructions. In the words of one interviewee: *“I think if you understand the reasons behind it, then nobody would really complain about not being allowed to enter an area, for example, because I think if the area would just be blocked, people might be frustrated or confused why they are not allowed to go there”*.

A final general aspect to be reinforced from Table 9 is about the design of the signage itself. Almost all participants mentioned the importance of well-designed signage. Despite certain distinctions and greater appreciation for signage 3, all were generally well evaluated in terms of their design. The relevance of the design, would fall not only on an aesthetic issue, but the perception towards it would be of greater attention and consideration. In the words of one participant: *“In nature, I often encounter signs that tell me that you’re not supposed to get in here because of breeding birds. So that’s a regular thing I see, but this is totally different because most of the time it’s just a piece of paper being laminated and just hanging there without love. People probably won’t take it seriously because it doesn’t look too official. So, this is really good”*. This is complemented by another participant: *“I feel like it’s a different kind of sign, because when you go to a national park or something, usually signs look quite old, they’re not*

*well maintained, and it looks like there was not a lot of effort put into the designing part”.*

In line with the visual aspect, the importance of the illustration and visual elements being able to convey the message without the need to read is also highlighted. In the words of another participant in relation to signage 4: *“I like that you have the illustration first. So you already know what it's about. So you don't even have to read. If you're just walking around and see the picture of the dog chasing the bird, you already know what's not supposed to happen. You know that it's probably about some distress for nature and animals. And it's kind of obvious. You will read the text, but the message is already in the picture”.* To summarize, the following quote from an interviewee sums up the general importance of visualizations, especially in the context of parks: *“It's a whole sign, you know, people should also read the text and not only look at the pictures. But from my experience, I would say that if you are walking in a natural area and then there is the first sign, you are still very motivated, and you read everything. And then there is so much information on all the signs and many next signs, then you don't read everything. You read maybe the heading and eventually, you only look at the pictures. So I think the pictures are very important, because not always people read everything on the sign”.*

### **3.3.3.2. Negatively evaluated aspects**

Regarding the aspects mentioned as confusing, unclear, or recommended for changes, Table 10 summarizes the most relevant aspects. Most of the comments were focused more on design and graphic elements rather than on the text. Sign 2 received more negative feedback related to the text than other signs. In signs 1 and 3, the recommendations for the text were more focused on avoiding a purely informative approach and to include a sense of urgency.

Table 10: Negatively evaluated aspects in each of the signs in terms of design and written content.

<b>Signage 1</b>	<b>Signage 2</b>	<b>Signage 3</b>	<b>Signage 4</b>
<ul style="list-style-type: none"> <li>• Text inside the yellow sign, is too small</li> <li>• Symbology, difficult to read.</li> </ul>	<ul style="list-style-type: none"> <li>• Map, not clear, too much information, and looks dangerous</li> </ul>	<ul style="list-style-type: none"> <li>• No clear purpose of the yellow sign</li> <li>• Yellow sign too small</li> </ul>	<ul style="list-style-type: none"> <li>• Illustration is strong and can diverge attention on the map</li> </ul>



<ul style="list-style-type: none"> <li>• Location point not easy to see</li> <li>• The illustration of the bird could have more emotion or active behavior.</li> <li>• Heading in white with green background not visible.</li> </ul>	<ul style="list-style-type: none"> <li>• Dark colors affect balance</li> <li>• No clear purpose of the yellow sign</li> <li>• Disconnection of the different visual elements</li> <li>• Long title</li> <li>• Location point</li> </ul>	<ul style="list-style-type: none"> <li>• Red message too small</li> <li>• Location point and where to be are too close</li> <li>• White paths not too visible</li> <li>• People are without background, lacking context</li> <li>• Light color of the red area</li> </ul>	<ul style="list-style-type: none"> <li>• Gives the idea that dogs are the main problem</li> <li>• No clear purpose of the yellow sign</li> <li>• Not immediately clear that it is about the bird.</li> <li>• Different styles of illustrations</li> <li>• Lack of realism in illustration</li> <li>• Map should be on the top</li> <li>• Everything is the same size, difficult to know what to read first</li> </ul>
<ul style="list-style-type: none"> <li>• Too informative, not about a dangerous situation</li> </ul>	<ul style="list-style-type: none"> <li>• Not a nice message, aggressive approach.</li> <li>• Too strong prohibition that can cause wish to go there</li> </ul>	<ul style="list-style-type: none"> <li>• Too informative, sign could have elements to make it more urgent</li> </ul>	

Among some more overarching aspects, the recurring mention of the yellow signage is worth highlighting. The concept of having this sign in the location helps to clarify the restricted area while walking. Some participants pointed out that the yellow color allows the signage to be visible from a distance, and due to the use of the word "Stop," which tends to capture attention. However, regarding the color choice, it was also mentioned that yellow is typically associated with informative rather than restrictive purposes, as would be the case with the color red. The purpose of the yellow sign within the evaluated signage was generally not understood, suggesting a need for clarification.

Regarding the texts, the messages in signs 2 and 4 were not particularly highlighted as positively as they were in signs 1 and 3. However, for signs 1 and 3, participants also mentioned that they perceived the texts as informative and educational, which aligns with the intended informative approach when designing the texts. As one participant put it: *"I think this (sign 4) is putting the focus on the people and their behavior, is better to make the people recognize that they have to change something. And I think this other (sign 1) looks more like just an information sheet"*.

Regarding sign 2, there were diverse comments about the text. On the one hand, participants mentioned individual freedom. A highly prohibitive message may lead to

consequences such as a stronger desire to go to the prohibited area or frustration due to the perceived loss of freedom. In the words of one interviewee: *“The message stop don't go beyond this sign, is really confrontative. In some people, they might feel bad and maybe don't respect the sign after this because they're like nah, I'm not letting my freedom be taken by any signs”*. Additionally, the message was perceived as aggressive, assuming that the person did something wrong and conveying the feeling of being unwanted in that area, suggesting it would be better for them not to visit the park. As a participant mentioned about sign 2: *“I don't like it, me personally. The text is too aggressive for me. Too threatening, too responsible. Sure, we all have responsibilities, but I think that's the wrong way to get people moving”*. Another aspect mentioned was the placing of responsibility on the individual, which was considered demanding and frightening. It could even generate delegitimization due to the questioning of whether my action will cause the bird's survival. In the words of one interviewee: *“You are responsible on it, it's quite dramatic with, yes, you are responsible, if they survive, or not, and the question is, is it, is it really us? I think, the wording could be a bit, perhaps, a little bit different”*.

Finally, it is worth noting in signage 4, that the illustration of the dog had a high weight and could eventually take away the focus of attention on the key message. In the words of one interviewee: *“I think there might be too much attention on the dog and missing out a little bit on the part that the people are also. Because the dog looks threatening to the eggs, and the people don't really look like they're threatening their existence. I would say, okay, I have no dog. I'm good. If I go without a dog, it might not be as bad.”*

#### **3.3.4. Previous experiences and emotions**

Participants were asked if the signage reminded them of any previous experiences. For signs 1 and 2, the majority indicated that they recalled seeing similar signs in other parks, while another group mentioned not having any specific recollections upon viewing them. In the case of sign 3, four participants said that it appeared to be a more professional and innovative sign compared to others they had seen before. Additionally, there were various responses regarding memories of seeing areas with birds, sitting in nature, or walking in similar places. For sign 4, almost all participants recalled instances of dogs running without a leash, and two participants remembered situations related to wildlife protection. While many people connected with the concept of seeing other signage, one participant noted that getting a person to remember

particular signage in future makes a big difference: *“I still remember the signs I saw three years ago about mushrooms in our forest, someone did a very big sign and explained all the mushrooms which are dangerous, which are not, which are for the animals, which are for the people and so on. I still remember it very clearly because I think this is where your illustration can do a lot of connection and touch people in the heart, not only in the brain”.*

Subsequently, participants were asked if they experienced any emotions, feelings, or reflections upon seeing the signage. Table 11 provides a summary of the main words and ideas mentioned, with the number of mentions associated with each concept indicated in parentheses. As can be seen, emotions are highly correlated with the positive and negative aspects presented in the previous sections.

Table 11: Emotions, feelings and reflections when observing each signage.

Signage 1	Signage 2	Signage 3	Signage 4
<ul style="list-style-type: none"> <li>• Responsibility and respect (5)</li> <li>• Neutral, too informative and objective (5)</li> <li>• Happiness, friendly (3)</li> <li>• Concern about the animals (2)</li> <li>• Calm (1)</li> </ul>	<ul style="list-style-type: none"> <li>• Need for bird protection (6)</li> <li>• Aggressive, confrontative, threatening (6)</li> <li>• Contradiction and disorientation (2)</li> <li>• Uncomfortable (2)</li> <li>• Prohibition (2)</li> <li>• Sad not able to go to the area (1)</li> <li>• Cute bird (1)</li> <li>• Non-harmonic (1)</li> </ul>	<ul style="list-style-type: none"> <li>• Need for bird protection (7)</li> <li>• Nice and happy, positive feelings (7)</li> <li>• Soft and relaxed (2)</li> <li>• Nice area (2)</li> <li>• Beautiful sign (1)</li> <li>• Cooperative (1)</li> </ul>	<ul style="list-style-type: none"> <li>• Empathy for the bird, feeling sorry for them (5)</li> <li>• Danger, risk (3)</li> <li>• Informative and neutral (2)</li> <li>• Feeling accused (1)</li> <li>• Good reminder when having a dog (1)</li> </ul>

**3.3.5. Differences between participants related and non-related to nature**

Regarding people's levels of knowledge about nature, individuals from other occupational or study areas lack information that the signage assumes as foundational

knowledge. An illustrative example of this relates to actions that may cause a disturbance. The message indicates that birds should not be disturbed. However, the concept of "not disturbing" may be subject to multiple interpretations. One participant suggested that walking through the area calmly would not be an issue, but upon being informed that human presence could cause a disturbance, the participant responded with the following: *"People don't really think about what disturbs them (the birds). If I walk through the forest and I'm quiet, because that is somehow what we learn as children very much: don't scream in the forest, don't go off tracks, just be quiet. So I would probably say, ok, if I just walk through, I'm not disturbing them. But this is actually not the case. So maybe emphasize even more on telling people that their whole, like even being there, just walking quietly through it disturbs them"*. Another example involves a participant who, after reading the phrase requesting not to disturb the birds, understood that disturbing the birds would include actions like touching their eggs: *"I wouldn't really think of touching the eggs of the bird"*.

Another type of knowledge implicitly conveyed by the signage may not be fully understood, such as information about the birds. Some participants are unaware that birds can nest on the ground, and therefore, they do not comprehend the illustration and the restriction of entering the area by the river. For example, one participant expressed: *"Is that really realistic? Are the eggs really on the ground? Because that is something that I wouldn't expect, to be honest. I expect nests to be in trees"*. Additionally, there may be a lack of knowledge about the bird's name. In this case, the bird's name in German is "Flussuferläufer," where "Fluss" means river. Thus, upon first observation of the name on the sign's heading, it is not immediately evident that it refers to a bird. As one participant put it, *"I didn't understand like very fast or like when I looked at it, that Flussuferläufer was the name of the bird, you know, like then I saw the image of the bird, and then I thought, yeah, okay. Because Flussuferläufer could also be the riverbank, I don't know, I wasn't sure what was meant or if you want to protect like just the area of the riverbank"*.

Someone with a closer connection to nature addressed the situation as mentioned earlier from their perspective: *"Most of the times when you're in nature, people will be like, oh, I want to go everywhere because I want to see it myself. And they don't really see that there will be an impact of their behavior on the wildlife as well. So I think sometimes it's hard for people to accept that there are parts of nature where they're*

*not supposed to go. And it's hard for them to understand why. It's important to show people what their impact is and that I think it's quite a big gap of people and their knowledge about how they impact nature and what they should and should not do in wildlife parks”.*

Individuals with a closer connection to nature expressed interest in having more information on the signage to learn more about the birds. Some even suggested including information about other species living in the area: *“I don't know the area specifically, but probably there are many other species who might also need protection. And that would be something which would be interesting”.* Additionally, these individuals mentioned that they frequently read the signs placed in parks, but at the same time, they are the ones most aware of actions that could cause a disturbance.

## **4. Discussion**

The design of the four signs was based on the prioritized gaps identified in the descriptive research, as indicated in Table 3. Additionally, the design followed the recommendations from the prescriptive research and was synthesized in Tables 4, 5, 6, and 7. In this regard, a noteworthy aspect is that, according to the evaluation conducted through interviews, the guidelines provided by the literature for effective sign design were highlighted and positively regarded. Therefore, these guidelines serve as fundamental criteria for developing signs that adhere to the principles outlined in section 3.2.1, concerning the key objectives for effective and appealing signage.

The four created signs were well-received, as they adhered to the guidelines. However, there were nuances and specific aspects that did not work as intended, providing insights into further exploring factors that can precisely address the research questions of this study. Below, we analyze the obtained results, emphasizing additional aspects beyond those derived from prescriptive research.

### **4.1. Signage properties that generate greater visual attraction and better perception**

In the case of signage 1 and 2, the observed trends upon initial inspection were similar, which can be attributed to their similarity in design and composition. It is well-known that people tend to notice more prominent or upper elements first (Ballantyne & Hughes, 2003; Calori & Vanden-Eynden, 2015; Colquhoun, 2005; Muekthong, 2021).

The same occurred with signage 3, where half of the participants first noticed the map, occupying nearly half of the composition and the upper zone of the sign, or the bird located in the upper part. Furthermore, all participants remembered seeing the map in signage 3, likely due to its substantial size. An interesting aspect, in this case, is that signage 3 also achieved the most remembered elements, indicating that it strikes a balance between capturing immediate attention with its two key aspects while allowing people to observe more elements in a few seconds. The hierarchy of components in this sign was likely appropriate, the number of elements was correct, and the complete composition was cohesive, allowing the viewers to grasp the unity and its parts.

A different pattern emerged with signage 4. In this case, the previous logic did not apply as most people tended to notice the dog and the people first, elements that were not the largest in the signage. The reason behind this could be that unexpected or unconventional elements tend to be more attractive, which aligns with what various authors have mentioned about the inclusion of memorable or surprising elements (Ballantyne & Hughes, 2003; Colquhoun, 2005; Cremer-Schulte et al., 2017; Tilden, 1957). Additionally, the dog's expressive illustration generated emotional resonance among the viewers, adding to its attractiveness.

Illustrations were also mentioned as a standout element. Participants noted that they usually see signs with photographs, which makes them more conventional. Illustrations were regarded as a distinctive element that attracted attention and interest, encouraging people to examine them in detail. For instance, the illustrated perspective map particularly captured attention due to its novelty and realism. This is particularly important as the individuals who typically read these signs are already interested in the subject matter, but to attract a broader audience, it would be essential to include distinctive elements using appealing colors and images (Davis & Thompson, 2011).

#### **4.2. Signage factors that facilitate easier and more accurate understanding of the information provided**

The comprehension of the message in signage 2 showed more dispersion among participants. Both in signage 1 and 2, some individuals noted that the design appeared more informative as the visual elements were relatively static and lacked a clear connection between different parts. This was the intended purpose of their initial design. Consequently, the message was not immediately evident at first glance, unlike

signage 3 and 4, where the visual elements were more elaborated, facilitating a better understanding of the conveyed message. The focus on personal responsibilities was explicitly mentioned by some participants in signages 2 and 4, which shifted the emphasis away from the restriction of entering the area for the bird's protection, as it highlighted the responsibility aspect.

As discussed in the previous chapter, effective and precise comprehension of signage connects with creating visually appealing designs. Additionally, it requires achieving a balance between providing information about the expected action and highlighting the impact simply and concisely.

Selective attention, associated with a person's motivation to concentrate on specific elements, is time-limited (Bitgood, 2000). Typically, individuals spend no more than 3 to 10 seconds scanning the information on signs (Choquette & Hand, 2021; Colquhoun, 2005; Marion & Reid, 2007). Considering this context, as mentioned in the literature, the visual aspect is significant since many people may only glance at the images. Therefore, comprehending the message solely through visual elements within a few seconds is crucial. In the case of signage 3, people could understand the message more quickly than the other signs. Selecting a maximum of three key messages, as recommended by the literature (Burns et al., 2021; Colquhoun, 2005; Marion & Reid, 2007; Mutiara et al., 2021), is complemented by the capacity to transform these messages into a clear and cohesive visualization.

Based on the main messages that the signage intends to convey and the improvement aspects to consider, the following is established:

- The restricted and permitted area: a better visualization of the map might include universally recognized icons associated with restriction and permission, using appropriate colors (Calori & Vanden-Eynden, 2015; Colquhoun, 2005; Jurin et al., 2010; Muekthong, 2021). Colors play an essential role as they create mental associations (Calori & Vanden-Eynden, 2015). For instance, green is usually associated with permission, while red indicates prohibition. Since yellow signage is already established with its color, and yellow is generally associated with informative aspects according to the interviews or used to draw attention, it would be relevant to accompany the marked red area with a red icon representing restriction, making it even more evident that the signage refers to

a restricted area. Because the map is illustrated, it allows prioritizing what aspects to include or exclude to facilitate understanding. The perspective view of the map was appreciated as it is more relatable to what people would observe, resembling the expected landscape. However, a traditional top-down view was sometimes considered a good option as people are accustomed to it, but it was mentioned that reading maps is not always easy.

- Yellow signage that helps orient people regarding the restricted area when walking in the area: People did not understand the purpose of this element, but upon explanation, they valued that this sign would facilitate orientation when walking. This highlights a significant aspect: all signage elements must have a clear purpose, which should be conveyed to the reader. Any element that lacks justification should not be included. To clarify this point, the yellow signage could be integrated into the illustration, indicating its location in the area, and accompanying the bird. This way, the presence of the signage would be mentally associated with the bird. Additionally, since some people are unfamiliar with the exact appearance or location of the bird's nest, illustrations or images representing reality would allow for a better association and understanding, reducing open interpretations regarding these characteristics. This as indicated by Colquhoun (2005) in relation to the importance to connect with relevant or familiar meanings. This would address the fact that people often assume their actions will not cause disturbance when it is not always the case, and therefore it should be clearly conveyed (Aas et al., 2023; Allbrook & Quinn, 2020; Cerri et al., 2019; Gruas et al., 2020; Le Corre et al., 2013; Levêque et al., 2015).
- The third message is related to explaining the actions that cause disturbance and why disturbance occurs. Although the visual aspect already explains the presence of the bird and the request not to enter, understanding why disturbance happens will ultimately close the knowledge gaps and reduce potential frustrations due to a lack of understanding regarding the restriction (Abrams et al., 2020; Winter et al., 2000). Given individuals' limited time reviewing signage, the message should be very brief, clear, and direct. Based on the interviews, it can be deduced that the first paragraph should directly mention what the signage is about, what to do, and the impact caused by the



disturbance. A second paragraph could provide additional information about the bird, offering context and potentially empathizing with the bird's situation.

Regarding the illustration, its realism has already been mentioned as significant for understanding the context. However, it is also essential to carefully choose an illustration that aligns closely with the intended message. In the case of signage 4, although it successfully conveyed a story, participants interpreted that only the dog caused the disturbance. In this regard, using the dog figure was not strategic, as it altered the understanding of the main message and the reasons for the disturbance. Therefore, selecting what to illustrate must be highly aligned with the intended message. For instance, signage 3 effectively communicated the idea of cohabitation in the same space.

The use of color, mentioned earlier, should also be emphasized in terms of the mental associations it creates for people. In signages 3 and 4, the location points were yellow; some interviewees initially thought the color was associated with yellow signage. In signage 1 and 2, with red location points, participants assumed they were related to the restricted area. Thus, the selection of colors is essential for the reasons already mentioned in the literature (Calori & Vanden-Eynden, 2015), but also in avoiding the use of similar colors within the same composition, as it can lead to incorrect associations between the parts.

#### **4.3. Components of the written content on the signage that most effectively communicate the behaviors that cause or reduce disturbance to birds.**

As seen earlier regarding the written content, signages 2 and 4, designed to address the knowledge gap and focus on personal responsibility, were evaluated with an excessively heavy emphasis on this aspect. As a result, they generated other effects on the reader. People perceived the text as restrictive, prohibitive, threatening, and even aggressive. Connecting this with what other participants mentioned regarding such messages tending to limit personal freedom, which is undesirable for individuals, these signs might not effectively communicate the desired behavior, or if communicated, they could trigger a desire to act in opposition. This aligns with the reactance theory, where individuals faced with a threat of loss of behavioral freedom develop an unpleasant motivation to regain their freedom (Steindl et al., 2015).

As analyzed in the descriptive research (Table 2), the reasons why people visit a park are generally associated with positive emotions such as relaxation, contact with nature, enjoyment, observation, appreciation, and physical activity. Considering this, it would make sense to maintain that emotional connection. Eventually, this approach would lead to greater openness to engaging in the desired behaviors (Burns et al., 2021; Gruas et al., 2020). For this purpose, it is suggested to balance the delivery of the message regarding the desired behavior and its impact, without making the person feel guilty or solely responsible for the consequences. Instead, the aim is to make the person empathize with the situation, understand that specific actions can negatively affect the species, and call upon them to collaborate and prevent such situations. This way, the message should be framed as a cooperative and empathetic call, nullifying potential negative reactions or frustration. The use of the word "responsibility," even though some interviews found it captivating, should be used in the context of calling for responsibility without making the person feel responsible for the effects. A clear and concise explanation of what causes disturbance is also important (Gruas et al., 2022; Hughes et al., 2014; Marion & Reid, 2007; Shome & Marx, 2009), as interpretations can be too broad if specific actions generating the impact are not explained. For instance, mentioning that if people or dogs get too close to the bird, it will flee could be a simple solution to communicate that mere presence will have an impact.

Regarding the results of the matrix used (Figure 2), the message was explored with an informative approach and another one focusing on raising awareness about wildlife disturbance. The main conclusion is that balancing both approaches will effectively convey the message. A friendlier and approachable tone, typically associated with more informative messages, while directly communicating the effects of disturbance and the desired behavior without accusing the person, will appeal to their collaboration. Information about the bird is not negative to include however, considering the context of signage as a means of rapid reading, it is essential to prioritize brief and relevant information that connects with the species, but in no more than one sentence.

Providing an alternative to restriction is also a noteworthy element. When people are in a natural space, they are there because they had planned to engage in some recreational activity. Therefore, mere limitation can confuse or lead individuals to choose not to follow the instructions, as their preference for engaging in the activity is higher (Cremer-Schulte et al., 2017). This aligns with the theory of planned behavior,

as individuals perceive their capability to do something, they prioritize that action (Aas et al., 2023; Ajzen, 1991). Different parts of the literature emphasize the importance of delivering prescriptive messages indicating what to do (Abrams et al., 2020; Ballantyne & Hughes, 2003; Hughes et al., 2014; Winter et al., 2000). In addition, providing an alternative solution would facilitate compliance with the message since it offers the possibility of enjoying recreation alongside fulfilling the requirements.

#### 4.4. Updated version of the signage

Considering all the above points, a new signage was developed. Signage 3 was used as the basis because of its better acceptability and positive evaluation. The updated version of the signage can be seen in Figure 8, together with the english translation. A bigger version of the sigage can be found in Appendix D.

**Verantwortungsvoll in der Natur unterwegs**

Hier kannst du verweilen, ohne die Vögel zu stören

Betritt bitte nicht den markierten Bereich vom 15.3. - 10.8.

Du bist hier

**Hilf den Flussuferläufer zu schützen!**

Wenn du dieses gelbe Schild siehst, gehe bitte nicht weiter.

Der bedrohte Flussuferläufer lebt auf Kiesbänken. Der scheue Vogel flieht, wenn Du oder Dein Hund ihm zu Nahe kommst. Die Eier in dem unauffälligen Nest kühlen dann schnell aus und damit der Bruterfolg gefährdet.

Von März bis August macht er sich auf die lange Reise aus Afrika, um hier zu brüten und seine Jungen aufzuziehen.

**STOP!**  
Hier brüten bedrohte Vogelarten.  
Betreten der Kiesbänke vom 15.3.-10.8. verboten!

DEIN FREI RAUM. MEIN LEBENS RAUM. Naturpark Ammergauer Alpen

Responsible on the road in nature

Here you can linger without disturbing the birds.

Please do not enter the marked area from 15.3 - 10.8.

Help protect the sandpiper!

When you see this yellow sign, please do not go any further.

The endangered sandpiper lives on gravel bars. The shy bird flees when you or your dog come too close. The eggs in the inconspicuous nest then cool down quickly and thus the breeding success is endangered.

From March to August, it makes the long journey from Africa to breed and raise its young here.

Figure 8: Updated version of the signage

## 5. Conclusions

The signage designed based on descriptive and prescriptive research has led to significant conclusions to address the research questions. From the matrix used to develop the four tested alternatives, it was extracted that the signs that attempted to cover the design gaps were positively perceived compared to the more simplified design. The latter had more limitations in quickly and clearly communicating the message. However, the use of visual communication is highlighted as essential as it is entirely aligned with the purpose of signage. On the other hand, the signs that attempted to cover the message gaps were not as positively perceived, as they generated a negative feeling in people. On the contrary, while being friendlier, the more informative approach was understood as purely educational and lacked a sense of urgency in the message. This implies that the key is to find a balance between both approaches.

Achieving a balanced version of signage that effectively attracts and communicates the message will become an important measure for any park seeking to protect a specific species. As seen during the research, signs are essential in helping protect species in parks and conveying relevant information to people, given their permanent location, ability to deliver a quick message in a short time, free access, and broad reach (Abrams et al., 2020; Ballantyne & Hughes, 2003; Colquhoun, 2005; Martin et al., 2015). However, signs are only part of the campaigns to reduce disturbances to

species and communicate meaningful messages (Abrams et al., 2020; Allbrook & Quinn, 2020; Burns et al., 2021; Colquhoun, 2005; Cremer-Schulte et al., 2017; Gruas et al., 2020; Guo et al., 2015; Juma & Khademi-Vidra, 2022; A. Kidd et al., 2015; Smith-Jackson & Hall, 2002; Tsang et al., 2011).

Using different educational and interpretive components will be more efficient than isolated measures. If all these measures are strategically planned, they will have a much better impact, considering not only a standard graphic alignment to help associate the elements and facilitate people's understanding (Muekthong, 2021) but also consistent planning and management regarding how the different components complement each other. An example of this is the specific case studied in this research concerning the yellow signs in the area where the bird is nesting. In general, interviewees mentioned that while a sign can be obvious, it is difficult to know precisely where the restricted area starts or ends. Having other elements that help with this identification, like the yellow sign, plays a key role. It is important to identify the chain of components that will facilitate communication and implement them accordingly. Moreover, it is crucial to note that the audience facing the signs will be highly diverse, with some individuals not even looking at the signs due to the type of activity they are engaged in (Davis & Thompson, 2011). For this reason, having other measures to raise awareness on the subject is indispensable.

The present study allowed for further recommendations for effective signage design, as the suggestions emanating from previous literature were tested following the approach of mental models in their four stages. In contrast to previous studies, different alternatives were evaluated, facilitating the comparison and validation or dismissal of specific variables. A last version was also developed, incorporating the evaluation results to visualize how a better signage solution could be. However, it is essential to understand that testing processes usually involve more than one iteration (Bitgood, 2000), and testing this last version would be an interesting aspect to implement in future research.

Testing other variables would yield different results and could further improve the understanding of the variables that make signage effective and attractive. Other variables to evaluate could be size, strategic location, and the number of signs distributed in the park (Burns et al., 2021; Martin et al., 2015; Vaughan, 2020). For example, areas near resting zones or meeting areas, where people are likely to stop

and read signs, could be more effective (Colquhoun, 2005; Vaughan, 2020). Testing with real visitors on-site or monitoring how many people are attracted to read signs and the time spent doing so could also provide valuable insights. Moreover, evaluating whether people effectively follow the recommendations after reading the sign and if there are changes in behavior would be a step further. Exploring interactive elements could also be interesting since studies have indicated that interactive experiences effectively communicate messages (Colquhoun, 2005; Davis & Thompson, 2011). Delving deeper into this aspect could assess whether sensory or interactive experiences further increase people's attention, interest, and comprehension of the conveyed message.

The research conducted to shed light on components that facilitate the attraction and positive perception of signs aimed at protecting species in natural parks in Germany, as well as the elements that allow for a better understanding of the message and greater acceptance of the human impact on species. Through the mental model approach, it was possible to contrast the expert vision of what needs to be shared with the information gaps of recreationists based on descriptive research and literature review, elucidating the main recommendations for effective design and text writing based on prescriptive research from existing literature. All these results facilitated the creation of alternative signage that was evaluated and tested through 21 interviews, providing significant results that are expected to strengthen knowledge for the optimization of signage for the protection of endangered species in parks.

## References

- Aas, Ø., Jørgensen, F., Stensland, S., Reiertsen, T., & Dybsand, H. (2023). Your place or mine? Exploring birdwatching tourists' behaviour disturbing birds in a nature reserve. *European Journal of Wildlife Research*, 69(3), 44. <https://doi.org/10.1007/s10344-023-01678-y>
- Abrams, K., Leong, K., Melena, S., & Teel, T. (2020). Encouraging Safe Wildlife Viewing in National Parks: Effects of a Communication Campaign on Visitors' Behavior. *Environmental Communication*, 14(2), 255–270. <https://doi.org/10.1080/17524032.2019.1649291>
- Ajzen, I. (1991). The Theory of Planned Behavior. *Organizational Behavior and Human Decision Processes*, 50(2), 179–211. [https://doi.org/10.1016/0749-5978\(91\)90020-T](https://doi.org/10.1016/0749-5978(91)90020-T)
- Allbrook, D., & Quinn, J. (2020). The effectiveness of regulatory signs in controlling human behaviour and Northern gannet (*Morus bassanus*) disturbance during breeding: An experimental test. *Journal for Nature Conservation*, 58. <https://doi.org/10.1016/j.jnc.2020.125915>
- Ammergauer Alpen GmbH. (2017). *Naturpark Ammergauer Alpen: Pflege- und Entwicklungsplan*. Naturpark Ammergauer Alpen e.V.
- Arnberger, A., Eder, R., Alex, B., Sterl, P., & Burns, R. (2012). Relationships between national-park affinity and attitudes towards protected area management of visitors to the Gesaeuse National Park, Austria. *Forest Policy and Economics*, 19, 48–55. <https://doi.org/10.1016/j.forpol.2011.06.013>
- Ballantyne, R., & Hughes, K. (2003). Measure Twice, Cut Once: Developing a Research-Based Interpretive Signs Checklist. *Australian Journal of Environmental Education*, 19, 15–25. <https://doi.org/10.1017/S0814062600001439>
- Bath, A., & Enck, J. (2003). Wildlife-Human Interactions in National Parks in Canada and the USA. *Social Science Research Review*, 4(1).
- Bayerisches Landesamt für Umwelt. (2023). *Artenhilfsprogramm Kiesbrüter*. [https://www.lfu.bayern.de/natur/artenhilfsprogramme\\_voegel/index.htm](https://www.lfu.bayern.de/natur/artenhilfsprogramme_voegel/index.htm)
- Bitgood, S. (2000). The Role of Attention in Designing Effective Interpretive Labels. *Journal of Interpretation Research*, 5(2), 31–45.

<https://doi.org/10.1177/109258720000500205>

- Boase, N., White, M., Gaze, W., & Redshaw, C. (2017). Evaluating the Mental Models Approach to Developing a Risk Communication: A Scoping Review of the Evidence. *Risk Analysis*, 37(11), 2132–2149.  
<https://doi.org/10.1111/risa.12789>
- Burns, G., Haraldsdóttir, L., & Gunnarsdóttir, G. Þ. (2021). Interpretation in Ásbyrgi: Communicating with National Park Visitors in Iceland. *Sustainability*, 13(22).  
<https://doi.org/10.3390/su132212592>
- Cairngorms National Park. (2009). *Design Guidance for Directional Path Signs* (No. 1).  
<https://doi.org/10.1108/nfs.2011.01741aab.027>
- Calori, C., & Vanden-Eynden, D. (2015). *Signage and Wayfinding Design: A Complete Guide to Creating Environmental Graphic Design Systems* (Second edition). Wiley.
- Carrascosa-López, C., Carvache-Franco, M., Mondéjar-Jiménez, J., & Carvache-Franco, W. (2021). Understanding Motivations and Segmentation in Ecotourism Destinations. Application to Natural Parks in Spanish Mediterranean Area. *Sustainability*, 13(9), 4802.  
<https://doi.org/10.3390/su13094802>
- Cerri, J., Martinelli, E., & Bertolino, S. (2019). Graphical factorial surveys reveal the acceptability of wildlife observation at protected areas. *Journal for Nature Conservation*, 50. <https://doi.org/10.1016/j.jnc.2019.125720>
- Choquette, J., & Hand, A. (2021). Informational Signage Increases Awareness of a Rattlesnake in a Canadian Urban Park System. *Human-Wildlife Interactions*, 15(1), 124–137. <https://doi.org/10.26077/9e24-0dc5>
- City of Surrey. (2021). *Biodiversity Design Guidelines*. Surrey.
- Colquhoun, F. (Ed.). (2005). *Interpretation Handbook and Standard: Distilling the essence*. Department of Conservation.
- Cremer-Schulte, D., Rehnus, M., Duparc, A., Perrin-Malterre, C., & Arneodo, L. (2017). Wildlife disturbance and winter recreational activities in Alpine protected areas: recommendations for successful management. *Eco.Mont - Journal on Protected Mountain Areas Research and Management*, 9(2), 66–73.  
<https://doi.org/10.1553/eco.mont-9-2s66>



- Davis, S., & Thompson, J. (2011). Investigating the Impact of Interpretive Signs at Neighborhood Natural Areas. *Journal of Interpretation Research*, 16(2), 55–66. <https://doi.org/10.1177/109258721101600205>
- Donnelly, R., Prots, A., & Donnelly, C. (2021). Better educational signage could reduce disturbance of resting dolphins. *PloS One*, 16(4), e0248732. <https://doi.org/10.1371/journal.pone.0248732>
- Elas, M., Rosendal, E., & Meissner, W. (2023). The Effect of Floods on Nest Survival Probability of Common Sandpiper *Actitis hypoleucos* Breeding in the Riverbed of a Large Lowland European River. *Diversity*, 15(1), 90. <https://doi.org/10.3390/d15010090>
- Garrett, D., & Martin, S. (2002). Comparing the effectiveness of interpretative and sanction messages for influencing wilderness visitors' intended behavior. *International Journal of Wilderness*, 8(2).
- Gibson, D. (2009). *The Wayfinding Handbook: Information design for public places. Design briefs*. Princeton Architectural.
- Goh, E. (2020). Breaking the rules to venture off-trail at national parks: exploring salient beliefs through a planned behaviour approach. *Tourism Recreation Research*, 45(2), 277–283. <https://doi.org/10.1080/02508281.2019.1679526>
- Goh, E. (2023). Walking Off-Trail in National Parks: Monkey See Monkey Do. *Leisure Sciences*, 45(1), 1–23. <https://doi.org/10.1080/01490400.2020.1755750>
- Gruas, L., Perrin-Malterre, C., & Loison, A. (2022). From the Crowded Valleys to the Preserved Summits: Mountain Sports Participants' Attitudes Toward Protected Areas in the Sprawling Urban Areas of the Northern French Alps. *Mountain Research and Development*, 42(3). <https://doi.org/10.1659/MRD-JOURNAL-D-21-00001.1>
- Gruas, L., Perrin-Malterre, C., & Loison, A. (2020). Aware or not aware? A literature review reveals the dearth of evidence on recreationists awareness of wildlife disturbance. *Wildlife Biology*, 2020(4), 1–16. <https://doi.org/10.2981/wlb.00713>
- Gundersen, V., Mehmetoglu, M., Inge Vistad, O., & Andersen, O. (2015). Linking visitor motivation with attitude towards management restrictions on use in a national park. *Journal of Outdoor Recreation and Tourism*, 9, 77–86. <https://doi.org/10.1016/j.jort.2015.04.004>

- Guo, T., Smith, J., Leung, Y.-F., Seekamp, E., & Moore, R. (2015). Determinants of Responsible Hiking Behavior: Results from a Stated Choice Experiment. *Environmental Management*, *56*(3), 765–776.  
<https://doi.org/10.1007/s00267-015-0513-1>
- Hahn, U., & Berkers, P. (2021). Visualizing climate change: an exploratory study of the effectiveness of artistic information visualizations. *World Art*, *11*(1), 95–119.  
<https://doi.org/10.1080/21500894.2020.1769718>
- Haukeland, J., Veisten, K., Grue, B., & Vistad, O. I. (2013). Visitors' acceptance of negative ecological impacts in national parks: comparing the explanatory power of psychographic scales in a Norwegian mountain setting. *Journal of Sustainable Tourism*, *21*(2), 291–313.  
<https://doi.org/10.1080/09669582.2012.692685>
- Hennink, M., & Kaiser, B. (2022). Sample sizes for saturation in qualitative research: A systematic review of empirical tests. *Social Science & Medicine*, *292*.  
<https://doi.org/10.1016/j.socscimed.2021.114523>
- Høyem, J. (2020). Outdoor recreation and environmentally responsible behavior. *Journal of Outdoor Recreation and Tourism*, *31*.  
<https://doi.org/10.1016/j.jort.2020.100317>
- Hughes, K., Ballantyne, R., & Packer, J. (2014). Comparing Chinese and Western Visitors' Responses to Interpretive Signs at Chengdu Research Base of Giant Panda Breeding, China. *Visitor Studies*, *17*(2), 137–158.  
<https://doi.org/10.1080/10645578.2014.945344>
- Immoos, U., & Hunziker, M. (2015). The effect of communicative and on-site measures on the behaviour of winter sports participants within protected mountain areas – results of a field experiment. *Eco.Mont - Journal on Protected Mountain Areas Research and Management*, *7*(1), 17–25. <https://doi.org/10.1553/eco.mont-7-1s17>
- Janeczko, E., Wojtan, R., Korcz, N., & Woźnicka, M. (2021). Interpretative Signs as a Tool Supporting Informal Environmental Education on the Example of Warsaw's Urban Forests. *Forests*, *12*(8). <https://doi.org/10.3390/f12081091>
- Jones, N [Natalie], Ross, H., Lynam, T., Perez, P., & Leitch, A. (2011). Mental Models: An Interdisciplinary Synthesis of Theory and Methods. *Ecology and Society*, *16*(1).

- Jones, N [Nikoleta], Panagiotidou, K., Spilanis, I., Evangelinos, K., & Dimitrakopoulos, P. (2011). Visitors' perceptions on the management of an important nesting site for loggerhead sea turtle (*Caretta caretta* L.): The case of Rethymno coastal area in Greece. *Ocean & Coastal Management*, *54*(8), 577–584. <https://doi.org/10.1016/j.ocecoaman.2011.05.001>
- Jorgensen, J., & Bomberger, M. (2015). Evaluating Recreationists' Awareness and Attitudes Toward Piping Plovers (*Charadrius melodus*) at Lake McConaughy, Nebraska, USA. *Human Dimensions of Wildlife*, *20*(4), 367–380. <https://doi.org/10.1080/10871209.2015.1020579>
- Juma, L. O., & Khademi-Vidra, A. (2022). Nature Interpretation as an Environmental Educational Approach in Visitor Management; The Application Dilemma for Different Target Groups at Masai Mara National Reserve, Kenya. *Sustainability*, *14*(5). <https://doi.org/10.3390/su14052935>
- Jurin, R., Roush, D., & Danter, J. (2010). *Environmental Communication: Skills and Principles for Natural Resource Managers, Scientists, and Engineers* (Second Edition). Springer Netherlands. <https://doi.org/10.1007/978-90-481-3987-3>
- Kidd, A., Monz, C., D'Antonio, A., Manning, R., Reigner, N., Goonan, K., & Jacobi, C. (2015). The effect of minimum impact education on visitor spatial behavior in parks and protected areas: An experimental investigation using GPS-based tracking. *Journal of Environmental Management*, *162*, 53–62. <https://doi.org/10.1016/j.jenvman.2015.07.007>
- Kidd, L., & Dayer, A. (2020). Evidence-based recommendations for strategic communication efforts for shorebird conservation. *Wader Study*, *127*(3), 191–199. <https://doi.org/10.18194/ws.00211>
- Kopp, V., & Coppes, J. (2020). Why do people leave marked trails? Implications for managing outdoor recreationists. *Eco.Mont - Journal on Protected Mountain Areas Research and Management*, *12*(2), 33–40. <https://doi.org/10.1553/eco.mont-12-2s33>
- Larson, C., Reed, S., Merenlender, A., & Crooks, K. (2016). Effects of Recreation on Animals Revealed as Widespread through a Global Systematic Review. *PLoS One*, *11*(12). <https://doi.org/10.1371/journal.pone.0167259>
- Larson, C., Reed, S., Merenlender, A., & Crooks, K. (2019). A meta-analysis of recreation effects on vertebrate species richness and abundance. *Conservation Science and Practice*, *1*(10). <https://doi.org/10.1111/csp2.93>

- Le Corre, N., Peuziat, I., Brigand, L., Gélinaud, G., & Meur-Férec, C. (2013). Wintering waterbirds and recreationists in natural areas: A sociological approach to the awareness of bird disturbance. *Environmental Management*, 52(4), 780–791. <https://doi.org/10.1007/s00267-013-0118-5>
- Levêque, J., Marzano, M., Broome, A., Connolly, T., & Dandy, N. (2015). Forest visitor perceptions of recreational impacts on amphibian wildlife. *European Journal of Wildlife Research*, 61(4), 505–515. <https://doi.org/10.1007/s10344-015-0920-x>
- Marasinghe, S., Perera, P., Simpson, G. D., & Newsome, D. (2021). Nature-based tourism development in coastal wetlands of Sri Lanka: An Importance–Performance analysis at Maduganga Mangrove Estuary. *Journal of Outdoor Recreation and Tourism*, 33, 100345. <https://doi.org/10.1016/j.jort.2020.100345>
- Marion, J. (March 2019). *Impacts to Wildlife: Managing Visitors and Resources to Protect Wildlife*. Interagency Visitor Use Management Council.
- Marion, J., Leung, Y.-F., Eagleston, H., & Burroughs, K. (2016). A Review and Synthesis of Recreation Ecology Research Findings on Visitor Impacts to Wilderness and Protected Natural Areas. *Journal of Forestry*, 114(3), 352–362. <https://doi.org/10.5849/jof.15-498>
- Marion, J., & Reid, S. (2007). Minimising Visitor Impacts to Protected Areas: The Efficacy of Low Impact Education Programmes. *Journal of Sustainable Tourism*, 15(1), 5–27. <https://doi.org/10.2167/jost593.0>
- Martin, C., Momtaz, S., Jordan, A., & Moltschaniwskyj, N. (2015). An assessment of the effectiveness of in-situ signage in multiple-use marine protected areas in providing information to different recreational users. *Marine Policy*, 56, 78–85. <https://doi.org/10.1016/j.marpol.2015.03.002>
- Marzano, M., & Dandy, N. (2012). Recreationist behaviour in forests and the disturbance of wildlife. *Biodiversity and Conservation*, 21(11), 2967–2986. <https://doi.org/10.1007/s10531-012-0350-y>
- Muekthong, T. (2021). Study of signage design and information content for The Namtok Sai Khao National Park. *IOP Conference Series: Earth and Environmental Science*, 881(1). <https://doi.org/10.1088/1755-1315/881/1/012006>
- Mutiara, M., Rachmawati, E., & Sunkar, A. (2021). Effectivity assessment of interpretive signs for biodiversity conservation. *IOP Conference Series: Earth*

and *Environmental Science*, 739(1). <https://doi.org/10.1088/1755-1315/739/1/012066>

- National Park Service. (2009). *Wayside Exhibits: A Guide to Developing Outdoor Interpretive Exhibits*. U.S. Department of the Interior.
- Price, A., Monahan, J., & Bergren, R. (2018). Can interpretive graphics influence visitor behavior in an exhibit space? *Journal of Interpretation Research*, 23(1), 47–56. <https://doi.org/10.1177/109258721802300104>
- Province of Nova Scotia. (2008). *Outdoor Interpretive Signage*.
- Radford, A., Kim, J. W., Xu, T., Brockman, G., McLeavey, C., & Sutskever, I. (2022). *Robust Speech Recognition via Large-Scale Weak Supervision*. arXiv. <https://doi.org/10.48550/arXiv.2212.04356>
- Richardson, M., Hamlin, I., Elliott, L., & White, M. (2022). Country-level factors in a failing relationship with nature: Nature connectedness as a key metric for a sustainable future. *Ambio*, 51(11), 2201–2213. <https://doi.org/10.1007/s13280-022-01744-w>
- Rosa, C., & Collado, S. (2019). Experiences in Nature and Environmental Attitudes and Behaviors: Setting the Ground for Future Research. *Frontiers in Psychology*, 10, 763. <https://doi.org/10.3389/fpsyg.2019.00763>
- Shome, D., & Marx, S. (2009). *The Psychology of Climate Change Communication: A Guide for Scientists, Journalists, Educators, Political Aides and Interested Public*. New York. Center for Research on Environmental Decisions.
- Smith-Jackson, T., & Hall, T. (2002). Information Order and Sign Design: A Schema-Bases Approach. *Environment and Behavior*, 34(4), 479–492. <https://doi.org/10.1177/00116502034004004>
- Steindl, C., Jonas, E., Sittenthaler, S., Traut-Mattausch, E., & Greenberg, J. (2015). Understanding Psychological Reactance: New Developments and Findings. *Zeitschrift Fur Psychologie*, 223(4), 205–214. <https://doi.org/10.1027/2151-2604/a000222>
- Sterl, P., Brandenburg, C [C.], & Arnberger, A. (2008). Visitors' awareness and assessment of recreational disturbance of wildlife in the Donau-Auen National Park. *Journal for Nature Conservation*, 16(3), 135–145. <https://doi.org/10.1016/j.jnc.2008.06.001>
- Taczanowska, K., González, L.-M., García-Massó, X., Zięba, A., Brandenburg, C [Christiane], Muhar, A., Pellicer-Chenoll, M., & Toca-Herrera, J.-L. (2019).

- Nature-based Tourism or Mass Tourism in Nature? Segmentation of Mountain Protected Area Visitors Using Self-Organizing Maps (SOM). *Sustainability*, 11(5). <https://doi.org/10.3390/su11051314>
- Taylor, A., & Knight, R. (2003). Wildlife responses to recreation and associated visitor perceptions. *Ecological Applications*, 13(4), 951–963. [https://doi.org/10.1890/1051-0761\(2003\)13\[951:WRTRAA\]2.0.CO;2](https://doi.org/10.1890/1051-0761(2003)13[951:WRTRAA]2.0.CO;2)
- Tilden, F. (1957). *Interpreting our Heritage: Principles and Practices for Visitor Services in Parks, Museums and Historic Places*. University of North Carolina Press.
- Tsang, N., Yeung, S., & Cheung, C. (2011). A Critical Investigation of the Use and Effectiveness of Interpretive Services. *Asia Pacific Journal of Tourism Research*, 16(2), 123–137. <https://doi.org/10.1080/10941665.2011.556336>
- U.S. Fish & Wildlife Service. (2019). *Signage Policy and Guidance US*. U.S. Fish & Wildlife Service.
- Vaughan, J. (2020). *Marking History: Guidelines, Best Practices, and Templates for Interpretive Signage in Anne Arundel Country*.
- Winter, P., Sagarin, B., Rhoads, K., Barrett, D., & Cialdini, R. (2000). Choosing to encourage or discourage: Perceived effectiveness of prescriptive versus proscriptive messages. *Environmental Management*, 26(6), 589–594. <https://doi.org/10.1007/s002670010117>
- Wong-Parodi, G., & Bruine de Bruin, W. (2017). Informing Public Perceptions About Climate Change: A 'Mental Models' Approach. *Science and Engineering Ethics*, 23(5), 1369–1386. <https://doi.org/10.1007/s11948-016-9816-8>

## Appendices

### Appendix A: Questionnaire for interview questions - Evaluative research on signage

Structure (moments of the interview)	Question
<b>Ten second's test</b> Show 10 seconds the first sign	Do you remember what was the first thing you looked at?
	What other visual elements do you remember?
	Can you tell me what the main message is the signage is trying to convey?
<b>Think out loud</b>	Now I will show you the signage again. I need you to start describing out loud everything you see and think about, in whatever order you wish, and whatever comes to mind.
<b>Questions</b>	Can you tell me again what is the message of the sign?
	What are you expected to do with this signage?
	Is there anything in the signage that you find confusing or unclear?
	What is your favorite part of the sign?
	Are there any parts you do not like or would recommend changing? From the content of the text, the layout, colors, the type of illustration, the map, etc. Even if it's a small detail.
	Is there anything in the signage that reminds you of a previous experience or anecdote you have had?
	Is there any emotion, feeling or reflection that emerges when you see the signage?
<b>Repeat the same process with the second sign.</b> (ten second test + think out loud protocol)	
<b>Comparison</b> Show the 2 signs together and let the person observe, read and analyze them	Now let us compare the two.
	Imagine you are walking in a forest in the alps, and you see the signage. Which of the two signage do you think would catch your attention the most and why?
	And which one do you like the most?
	Looking at all the signage together, what design elements or features do you find particularly appealing?

	<p>And what parts are not attractive?</p> <p>In which one do you think it is easier to understand the message we are trying to deliver? You can tell me parts, like this text + this illustration + this map.</p>
<b>Suggestions</b>	<p>Understanding that I want to measure attraction and comprehension, and that it is expected that the signage will make people stop going to places that can create damage to the bird. Is there anything you would like to complement or suggest? Or maybe you have a proposal for something that could be totally different.</p>
<b>Demographic questions</b>	<p>What is your age?</p> <p>What is your occupation or study field?</p>



## **Appendix B: Informed Consent for Participation in Interview Research**



### **Informed Consent for Participation in Interview Research**

Dear Participant, for my master thesis for the Master's Program Sustainable Resource Management at the Technical University of Munich, I investigate the optimization of interpretive signage for the protection of endangered species in the natural park Ammergauer Alpen in Germany.

To this end, I conduct qualitative interviews with German citizens, considering that the signage to be analyzed is located in a area with limited tourist access, and therefore a target group is sought that is similar to the group found in the research area.

In the context of this thesis, I request your participation in a 45-minute interview. The interview will consist of the presentation of signage designed for the purposes of this thesis, and questions related to the signage observed by the interviewee.

In the following, you are informed of provisions regarding data protection law, and the treatment of your personal data. At the end of this document, you are asked to grant your permission to process your interview data as described. Please read the following information carefully. If you have any questions, please feel free to contact me about them at any time.

Once you have read the document and agree to participation, please sign the declaration of consent, and send it back to me, e.g., as a scan or a photo. Regardless of your signature, you are always free to withdraw your consent to be interviewed.

Thank you for your trust and your participation.

Valentina Arros

### **What happens to your data?**

#### **1. Processing, Use, and Storage of your data**

The interviews will be recorded via the video conferencing software Zoom for online interviews, and with a cell phone recorder for in-person interviews. The interviews will be transcribed. Following the guidelines of good academic practice, the recordings and transcripts will be archived for ten years.

The analysis and evaluation of data will be conducted by myself, Valentina Arros. And only the author will have access to this information. Personal contact data will be stored separately from the recordings/transcripts and are only accessible to the author. The thesis will not include any personal information. Your personal contact data is deleted after thesis submission, unless you expressly consent to the option of being contacted in the future. You can withdraw such consent at any time.

## **2. Your Rights**

You can make use of the following rights at any time:

*Right to Information:* At all times, you have the right to receive information about all the data saved that involves information about your person. This right to information pertains to your personal data and to information individually listed in article 15 GDPR (General Data Protection Regulation).

*Right to Correction:* At all times, you have the right to demand immediate correction and/or completion of incorrect/incomplete personal data (article 16 GDPR).

*Right to Deletion:* You have the right to demand immediate deletion of data involving your person if one of the reasons individually listed in article 17 GDPR applies, e.g., if the data is no longer needed to pursue the goals consented to.

*Right to Restrict Processing:* You have the right to restrict the processing of your personal data if one of the conditions listed in article 18 GDPR applies. For example, processing of your personal data can be restricted, if you doubt the correctness of the data pertaining to your person. In this case, the use of concerned data can be restricted during a period of review.

*Right to Withdraw Consent:* At all times and without having to give reasons, you have the right to withdraw your consent to be interviewed, or to change/refuse the terms of the Declaration of Consent. If your data has already been collected prior to your withdrawal, they may still be used as research data in anonymized form. There will be no deletion of anonymized data.

*Right to Bring a Complaint to a Regulatory Body:* You have the right to bring a complaint to a regulatory body if you believe that the processing of your personal data is in violation of the General Data Protection Regulation (article 77 GDPR).

If you have any further questions about the assessment and processing of interview data, you can always approach the author: Valentina Arros, [valentina.arros@tum.de](mailto:valentina.arros@tum.de)

**3. Consent**

I agree to being interviewed in the context of the aforementioned Master’s thesis. I have received the information, have read them, and understood them. I confirm that I was given the opportunity to ask questions.

I confirm that I agree with the recording of the interview, and with the processing and storage of this data under the terms described above. I am aware that I can always withdraw my consent. I am aware that interview data can only be reused in strictly anonymized form and that the anonymized transcript of the interview will be included in the thesis.

I am aware that my participation in the interview is voluntary, and I can always withdraw my participation at any time, without having to provide reasons, and without having to fear negative consequences for me. I agree to participate in the research project.

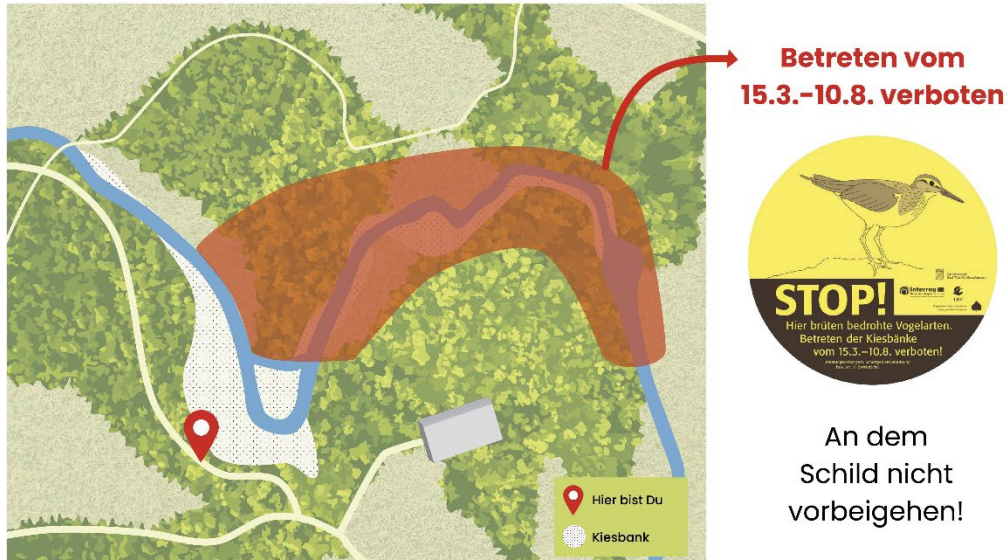
-----  
First name, Last Name

-----  
Signature

-----  
Place, Date

## Appendix C: Signage designed based on the descriptive and prescriptive research

### Signage 1:



## VERANTWORTUNGSVOLL IN DER NATUR UNTERWEGS

### Hilf den Flussuferläufer zu schützen!

Auf den Kiesbänken lebt der Aussterben bedrohte Flussuferläufer. Von April bis August kommt er aus Afrika, um seine Jungen auf den spärlich bewachsenen Kiesbänken auszubrüten und aufzuziehen.

Wenn sie gestört werden, verlassen sie ihre Nester und verlieren Ihren Nachwuchs.

Hilf uns, ihr Zuhause zu schützen und sie nicht zu stören.





## Signage 2:

**Betreten vom  
15.3.-10.8. verboten**



An dem  
Schild nicht  
vorbeigehen!



© Bayerische Vermessungsverwaltung

## DU BIST VERANTWORTLICH FÜR DIE ZUKUNFT DES FLUSSUFERLÄUFERS

**Deine Anwesenheit kann den Unterschied zwischen dem Überleben und dem lokalen Aussterben dieser Vögel ausmachen.**

Wenn du sie störst, verlassen sie ihre Nester und die Jungen sterben. Wenn du sie respektierst, schützt du ihr Zuhause und hilfst ihrem Überleben.

Sei bereit, hier Deinen Freiraum einzuschränken, um den Lebensraum des Flussuferläufers zu schützen.



## Signage 3:

### VERANTWORTUNGSVOLL IN DER NATUR UNTERWEGS



Hier kannst du auf der Kiesbank lagern und den Wildfluss genießen, ohne die Vögel zu stören.

**Betrete nicht den  
markierten Bereich  
vom 15.3.-10.8.**



#### Hilf den Flussuferläufer zu schützen!

Auf den Kiesbänken lebt der Aussterben bedrohte Flussuferläufer. Von April bis August kommt er aus Afrika, um seine Jungen auf den spärlich bewachsenen Kiesbänken auszubrüten und aufzuziehen.

Wenn sie gestört werden, verlassen sie ihre Nester und verlieren Ihren Nachwuchs.

Hilf uns, ihr Zuhause zu schützen und sie nicht zu stören.





## Signage 4:

### DU BIST VERANTWORTLICH FÜR DIE ZUKUNFT DES FLUSSUFERLÄUFERS



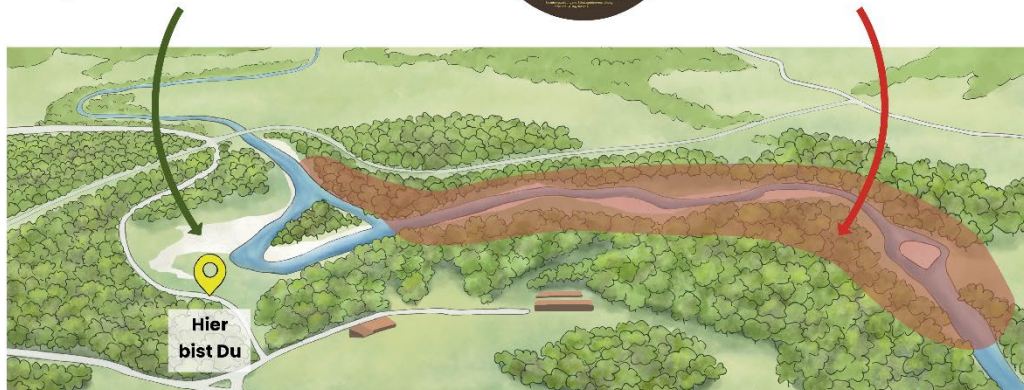
Deine Anwesenheit kann den Unterschied zwischen dem Überleben und dem lokalen Aussterben dieser Vögel ausmachen.

Wenn du sie störst, verlassen sie ihre Nester und die Jungen sterben. Wenn du sie respektierst, schützt du ihr Zuhause und hilfst ihrem Überleben.

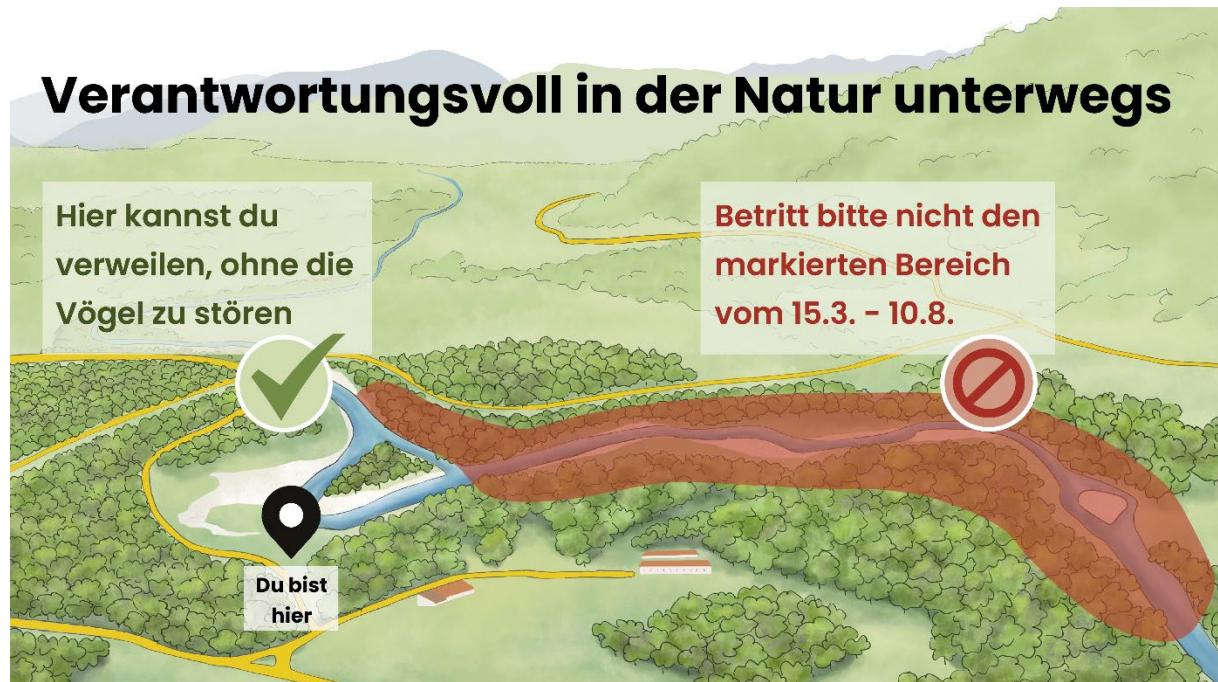
Hier kannst du auf der Kiesbank lagern und den Wildfluss genießen, ohne die Vögel zu stören.



**Betrete nicht den markierten Bereich vom 15.3.-10.8.**



Appendix D: New version of the signage based on the evaluation



**Hilf den Flussuferläufer zu schützen!**

Wenn du dieses gelbe Schild siehst, gehe bitte nicht weiter.

Der bedrohte Flussuferläufer lebt auf Kiesbänken. Der scheue Vogel flieht, wenn Du oder Dein Hund ihm zu Nahe kommst. Die Eier in dem unauffälligen Nest kühlen dann schnell aus und damit der Bruterfolg gefährdet.

Von März bis August macht er sich auf die lange Reise aus Afrika, um hier zu brüten und seine Jungen aufzuziehen.

