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Species-Specific Wildlife Encounter Expectations and Restorative Potential in Swedish Local Nature

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Abstract

Nearby natural settings are often used for psychological recovery, yet their restorative value may change when specific animals are expected along paths, woodland edges, or rural walking routes. This paper examines species-specific changes in perceived restorative potential for roe deer, squirrel, wild boar, and wolf in Swedish local natural settings. The material includes 223 adults from Jönköping, Falun, and Östersund, with residence, gender, age, outdoor experience, domination orientation, and mutualism orientation included as respondent characteristics. Restorative change was measured as the difference between frequent expected encounter and no expected encounter. Roe deer and squirrel increased restorative potential by 0.94 and 0.96, respectively, while wild boar and wolf reduced it by -0.82 and -0.80. Mutualism orientation contributed most to roe-deer and squirrel responses, gender to wild boar responses, and domination orientation to wolf responses. The findings show that wildlife presence has no single restorative meaning: familiar low-threat animals can strengthen restorative appraisal, whereas conflict-associated animals may reduce relaxed use through vigilance, perceived loss of control, and value-based disagreement.

Keywords: restorative environments; wildlife encounters; local nature; restorative potential; wildlife value orientation; human-wildlife relations; Sweden; environmental psychology

1. Introduction

1.1. Everyday nature and psychological recovery

Contact with natural environments constitutes an important way for residents to recuperate from attention fatigue, emotions, and general urban/rural stress. The two theories that typically underlie this concept include stress recovery theory, which deals with the potential of non-threatening natural environments to restore emotional and physiological balance, and attention restoration theory, according to which fascination, being away, extent, and compatibility enable the recovery of directed attention after prolonged cognitive effort [18, 19, 33]. These approaches have been complemented by public-health and environmental psychology research, which found contact with nature to be associated with improved mental well-being, stress reduction, better social outcomes, and increased possibilities for recuperation in everyday contexts [4, 9, 11, 25].

The restorative power of nearby natural environments is not defined solely by the amount of green space around the place of residence and proximity to one's home. People interact with natural environments along specific routes

through paths, vegetation, visibility, soundscapes, movement, seasonal changes, and perceived safety. Reviews of nature interactions highlight the significance of the type and quality of experience in nature as opposed to its mere existence within the borders of geographical area [12, 21]. Similarly, research into nearby nature highlights the importance of visible and frequently encountered greenery in terms of local opportunities to recuperate and the limited value of exposure to impressive but rare landscapes [2, 6]. Finally, from the perspective of residents moving through greenery after school, work, or household responsibilities, the quality of path may play an equally critical role as formal access to green spaces.

Biodiversity constitutes another dimension of this issue. Species richness, animal encounter, birdsong, and sound variability can make green spaces more lively and fascinating [3, 27, 30, 34]. Biodiversity and health are thus not only ecological issues; they are also personal experiences. People do not encounter biodiversity per se but actual species that can feed along a trail, leave tracks, sing, move suddenly, and appear unexpectedly. The biological diversity underlying fascination and wonder can turn out to be threatening when one is confronted with a larger, ambiguous, or dangerous animal.

A critical shortcoming of many studies dealing with the restorativeness of natural environments is their tendency to regard nature as a consistent positive exposure. This assumption may prove too simplistic for the context in which animal encounters can influence the visitor's experience and sense of compatibility. In this case, a natural environment may become less restorative due to expected encounters that require vigilance, even if the path itself is green, accessible, attractive, and safe. On the other hand, the presence of familiar animals can transform a relatively insignificant trail into an interesting destination full of excitement and safety. Restoration appraisal thus depends on the interplay between the properties of a natural environment and animal encounter meaning.

1.2. Wildlife encounters as restorative conditions

Animal encounters are different from other natural exposures in terms of mobility, responsiveness, and interpretation of one's experiences. Squirrels may invite visitors to experience soft fascination with minimal effort, and roe deer can signal liveliness and ecological continuity when this is an expected feature. However, some other animal species (wild boars and wolves in this case) have a completely different meaning and psychological significance. Regardless of the potential danger associated with these species, their mere presence might change one's perception and draw the visitor's attention to vigilance, precaution, and uncertainty. Studies of perceived threat in forest environments demonstrate that visual access, concealment, and ease of movement are crucial in the process of evaluation [13]. This evaluation process can be supplemented by the psychological component associated with animal expectations.

Perceived threats associated with particular animal species are not uniform across individuals or populations. Research on animal fears demonstrates that factors affecting fear include the degree of perceived control, previous experience, and vulnerability. Studies on attitudes toward large carnivores confirm these findings and show that species type, gender, age, distance to protected areas, and public attitudes contribute to these feelings [8, 17, 20, 28]. These findings are relevant to our study because successful psychological restoration depends not only on actual safety but also on one's expectation regarding a potentially uncomfortable encounter. Such an encounter would prevent the visitor from experiencing effortless attention and emotional deactivation.

Wildlife value orientations are helpful in determining why different people associate particular meanings with specific animals. Domination orientation emphasizes human dominance, control, and utilization of wildlife resources, while mutualism orientation implies a more caring approach, coexistence, and emotional connection with animals [23, 24, 32]. Both orientations are related to the properties of animals. Mutualism is particularly typical for familiar, low-threat species that can easily be integrated into a view of shared human and animal community. In contrast, domination plays an increasingly prominent role when animals are associated with conflicts, cattle damage, fear, or contentious management practices [14, 22]. This distinction is relevant to the issue of restorativeness because a single effect could hide two completely opposite patterns: welcoming animals as a feature of restorative nature and avoiding these creatures as a source of disturbance.

The study of wildlife in Sweden can help to understand the differences in perception between restorative roe deer and squirrels, and less restorative wild boars and wolves. These species are commonly encountered by people

living near green spaces. Roe deer and squirrels are low-threat animals with which most residents are familiar and compatible for outdoor activities. Wild boar and wolf encounters may be associated with precaution, controversy, and fear of potential risks or conflicts. Four species offer the unique opportunity to examine animal-specific effects on restorative perceptions without switching from the restorative setting.

1.3. Study objective and variable structure

This study focuses on the role of wildlife in altering perceived restorative potential depending on an increase in encounter frequency from no presence to frequent visits. Specifically, the analysis will compare four species using several quantitative variables including signed change, standardization, signed logarithmic compression, and moderator value for comparison. The participant characteristics chosen for consideration include residence, gender, age, outdoor experience, domination, and mutualism orientations.

It should be assumed that roe deer and squirrels positively affect restoration potential if their frequency increases because these animals represent familiar low-threat creatures with little to moderate capacity to disturb residents in natural areas. Wild boars and wolves may reduce restorative capacity owing to their associations with danger, conflicts, and precaution. Moderator values will specify the degree to which these effects are driven by residency, gender, age, outdoor experience, domination orientation, and mutualism orientation.



Figure 1. Study setting and sample.

2. Materials and methods

2.1. Participants and local setting

This study draws on participant characteristics, encounter conditions, and species-specific regression data from the analysis of wildlife and restorative potential in natural environments conducted by Johansson, Flykt, Frank, and Hartig [16]. The study sample comprised 223 adults from urban and rural areas in Jönköping, Falun, and Östersund municipalities. The age of participants ranged between 20 and 81 years (mean 53.7 years and standard deviation 16.04). The study sample included 58% women and 42% men. In addition, 41% of participants lived in urban areas, and 59% lived in rural areas.

The distribution of samples was unbalanced but representative of two major types of residential areas. Jönköping provided 26 urban and 40 rural participants, Falun yielded 38 urban and 48 rural participants, and Östersund offered 27 urban and 44 rural participants. Importantly, the sample was highly interested in spending time outdoors in natural areas because almost all respondents were very (46%) or somewhat (51%) interested in visiting natural environments and nearly everyone walked for relaxation or recreation [16]. These factors are important because restoration potential is discussed in terms of people using natural areas on a regular basis.

The four-panel view shown in Figure 1 places this study in a context of common daily walking landscapes. As can be seen, the urban and rural counts provide evidence for the examination of restoration potential among both types of settlements, and the participants' data panel highlights the age composition and distribution of males and females among selected species. This information helps to understand the psychological significance of an expected animal encounter among routine experiences.



Figure 2. Encounter likelihood by species.

2.2. Conditions of Wildlife Encounter

There were four species crossed with three likelihood conditions in the design of the encounter task. Roe deer, squirrel, wild boar, and wolf were used as species. Likelihood conditions corresponded to the absence of expected encounters, occasional encounter occurring once per 100 visits, and frequent encounter occurring 20 times per 100 visits. Comparison between no expectation of encounter and high frequency of the expectation corresponds to the distinction between restoration gain and loss.

Prior familiarity varied dramatically across species. All respondents were familiar with squirrels, 93.3% with roe deer, 27.8% with wild boars, and 22% with wolves. This prior knowledge may provide interpretation of results. Squirrel and roe deer were not perceived positive because they were novel creatures – they were familiar and could make the local environment alive without requiring vigilance. Wild boar and wolves were relatively unfamiliar animals capable of eliciting vigilance.

Photograph configuration in Figure 2 allows separating likelihood conditions for all four species – absence of encounter, rare occurrence, and frequent occurrence of the encounter. Value assessment under such circumstances cannot be considered a rating of positive or negative liking of the species but an evaluation of a setting under a certain likelihood of encounter. Thus, frequent encounter with squirrels and roe deer may increase vitality and compatibility of a route with relaxation experience while frequent encounters with wild boars and wolves decrease it.

2.3. Restorative potential transitions

The primary species-level value is the signed change in restorative potential between frequent expected encounter and no expected encounter. For species s , the transition is expressed as

$$\Delta_s = R_{s,\text{often}} - R_{s,\text{never}}, \quad (1)$$

where $R_{s,\text{often}}$ denotes restorative potential under frequent expected encounter and $R_{s,\text{never}}$ denotes restorative potential under no expected encounter. A positive value indicates that expected encounter increased restorative potential, and a negative value indicates that expected encounter reduced it. The sign is therefore the first substantive result, because it separates animals that support relaxed appraisal from animals that impose a psychological cost.

The second value standardises the signed transition by the corresponding standard deviation:

$$G_s = \frac{\Delta_s}{\sigma_s}. \quad (2)$$

Here σ_s is the standard deviation of the species-specific difference score. The value G_s is used as a consistency-sensitive gradient: it expresses whether the mean transition is large or small relative to response variation. A larger positive value indicates a more consistent restorative gain, while a larger negative value indicates a more consistent restorative loss. A negative mean with high dispersion does not imply weak relevance; it indicates that the loss is unevenly distributed across respondents.

A log-compressed signed value was also retained to compare species without allowing small raw differences to dominate interpretation:

$$P_s = \text{sgn}\Delta_s \log_1 |\Delta_s|. \quad (3)$$

This calculation preserves direction while reducing the influence of raw magnitude. It is useful for ranking the four species because the positive values for roe deer and squirrel are close, as are the negative values for wild boar and wolf. The compressed values allow the analysis to report that the polarity ordering remains stable even when raw difference-score size is moderated.

The final transition value combines direction with adjusted explained variance:

$$S_s = \Delta_s R_{adj,s}^2. \quad (4)$$

The value S_s is not interpreted as a population impact estimate. It indicates how strongly the signed transition aligns with the measured respondent characteristics included in the species-specific model. A larger absolute value means that the gain or loss is more strongly patterned by residence, gender, age, outdoor experience, domination orientation, and mutualism orientation.

2.4. Moderator contribution values

For each species and moderator k , the contribution share is calculated from the absolute standardised coefficient:

$$D_{sk} = \frac{|\beta_{sk}|}{\sum_{k=1}^K |\beta_{sk}|}. \quad (5)$$

The moderators considered are residency, gender, age, outdoor experience, domination orientation, and mutualism orientation. Absolute values of the moderator effect weights are used as the aim of the moderation analysis is to find out the relative weight of each moderator, without caring about direction. The total weights sum up to one per species, and the maximum of the weights identifies the dominant channel of variation. The result should again be interpreted based on the direction of Δ_s , meaning that the channel is always identified as dominant with respect to either restorative gain or restorative loss.

The computation based on the four animals ensures that each species is taken into account separately. If there was only a single variable representing wildlife, the central psychological difference between the species would be lost. In particular, some of the animals increase expected restorativeness due to their potential, while the other decrease it.

3. Results

3.1. Sample characteristics and species familiarity

The Swedish sample demonstrated great interest in nature together with large individual differences in species familiarity. This sample is important in light of the study design since the respondents were not distant observers rating the restorativeness of unfamiliar landscapes, but used natural settings regularly and experienced most of the species. Encounter values in this case refer to individual assessments of nearby natural environments with different animal expectations.

Table 1 explains how the sample context influences the psychological processes underlying the results. All familiar animals are embedded in the participants' everyday life and experiences, while wild boar and wolves were not that common around the homes of the participants. Although familiarity does not cause the effects observed in the study, it makes their plausibility greater since squirrel and roe deer can be seen as common local nature, while wild boars and wolves require a more careful consideration.

3.2. Restorative changes by species type

For both types of familiar species (roes and squirrels), there were significant positive restorative changes when an encounter is expected. In case of roe deer, the increase in restorative potential is 0.94, and the standard deviation is 0.98. The corresponding values for squirrel are 0.96 and 0.96. In these cases, the expected presence of the familiar species does not only not result in a lack of change. On the contrary, the appraisal of the environment becomes more positive.

Table 1. Participant and species familiarity values.

Descriptor	Value
Participants	223 adults from Jönköping, Falun, and Östersund
Age	20–81 years; mean 53.7 years; SD 16.04
Gender	Women 58%; men 42%
Residence	Urban 41%; rural 59%
Nature interest	97% very or somewhat interested in spending time in natural settings
Nearby nature walking	90% reported walking in nearby natural areas for relaxation or recreation
Species familiarity	Squirrel 100%; roe deer 93.3%; wild boar 27.8%; wolf 22%
Wildlife orientations	Domination M = 2.28, SD = 0.87; mutualism M = 3.70, SD = 0.85; $r = -0.524$

Values describe the participant context and prior familiarity with local wildlife.

Two other types of familiar species have negative impacts on restorative changes. Namely, wild boar reduces restorative potential by -0.82, and its standard deviation is 1.33. The corresponding values for wolves are -0.80 and 1.36, respectively. One can observe that these two negative means differ in their interpretation after considering the social-psychological organisation structure of both animals. Wild boar belongs mainly to the gender category, while wolf mainly to domination orientation.

The most straightforward response to the question of the paper is given in the figure below, namely, the central separation. In particular, one can observe that the two types of familiar species, as well as their impact on restorative changes, are not homogeneous. Roe deer and squirrel fall into the gain cluster of species while wild boar and wolf into the loss cluster. Importantly, the distinction makes it impossible to interpret all results through the lens of either diversity or fear.

Transition values given in Table 2 provide the following insight. Firstly, one can observe the direction of change in the form of raw values. Secondly, the strength of this effect can be seen from standardisation of these values. According to these criteria, squirrel produces the most powerful effect due to its high gain (marginally higher than roe deer) and low dispersion. On the other hand, wild boar demonstrates slightly higher standardised negative gradient but lower segmentation-adjusted value.

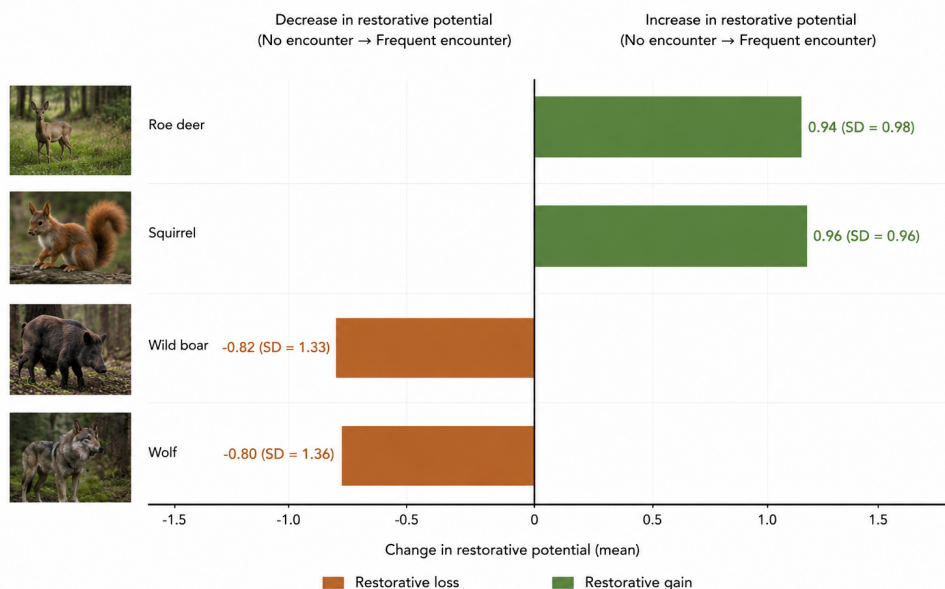


Figure 3. Signed restorative change.

Table 2. Species-specific transition values.

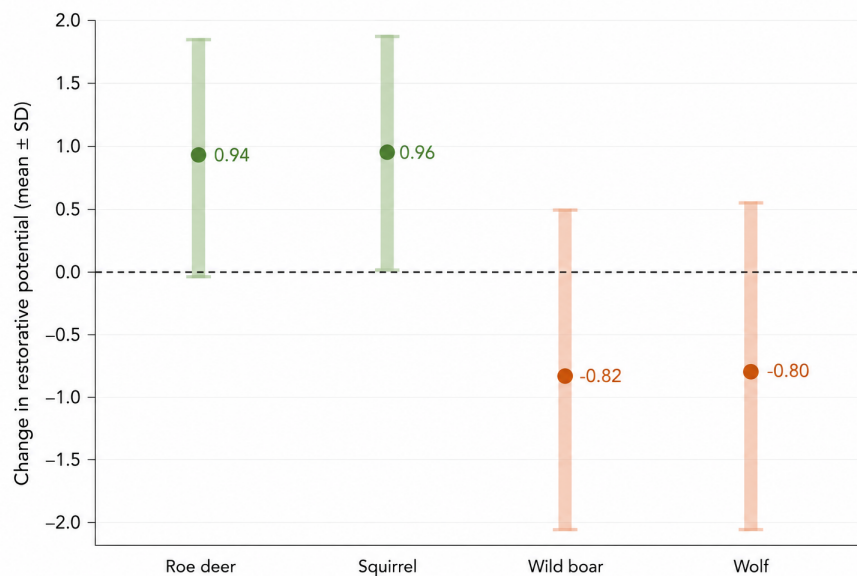
Species	Δ_s	SD	G_s	P_s	R_{adj}^2	S_s
Roe deer	0.94	0.98	0.959	0.663	0.099	0.093
Squirrel	0.96	0.96	1.000	0.673	0.078	0.075
Wild boar	-0.82	1.33	-0.617	-0.599	0.148	-0.121
Wolf	-0.80	1.36	-0.588	-0.588	0.180	-0.144

Δ_s is the mean change from no expected encounter to frequent expected encounter. G_s is the standardised gradient, P_s is the compressed signed value, and S_s combines direction with adjusted explained variance.

3.3. Dispersion and consistency of change

Response dispersion is central to the interpretation because negative wildlife appraisals are not uniform. The positive transitions for roe deer and squirrel are close to one standard-deviation unit, indicating comparatively consistent restorative gain. The negative transitions for wild boar and wolf are smaller in standardised magnitude because their standard deviations are larger. The negative appraisal of conflict-associated species therefore appears more differentiated, not irrelevant.

The mean-and-spread display in Figure 4 demonstrates why the negative species require social interpretation. Wild boar and wolf sit below zero but with broader ranges around the mean. The wider spread suggests that some respondents experienced a much stronger loss of restorative potential than others. For planning, this matters because a moderate average loss may still correspond to substantial avoidance pressure within particular visitor groups.

**Figure 4.** Mean change and spread.

The compressed values maintain the ordering. Squirrel stays the most positively valued at 0.673, only slightly less than roe deer at 0.663. Wild boar continues to be negatively valued at -0.599, as does wolf at -0.588. Thus compression maintains the substantive conclusion. Two species gain together, and two lose together. The key complication with species appraisal is thus not about sign but rather about who or what sorts of characteristics characterise each transition.

3.4. Moderator contribution patterns

Moderator shares are shown for all moderators in Table 3. The fact that six separate moderators account for species appraisal indicates that there is no single general trait of visitors which underpins it. Mutualism orientation contributes 42.2% to the roe-deer moderator pattern and 59.2% to the squirrel moderator pattern. The second most important moderator for roe deer is residence (30.6%), indicating that roe-deer appraisal is more closely linked to settlement context than squirrel appraisal. The third most important moderator for both wild boar (63.5%) and wolf (28.8%) is gender. In the case of wild boar, domination orientation contributes 28.1% of the variance.

The moderator profile plots for all four species (Figure 5) make clear the differences between the species. Mutualism dominates for the two positively valenced species, while gender (63.5%) and domination orientation (28.1%) dominate for wild boar, and domination orientation (37.5%), gender (28.8%), mutualism (14.6%), and age (12.2%) all contribute to the wolf moderator pattern. The implication of this finding is that reducing uncertainty along pathways will be particularly important for wild boar, whereas the wolf moderator pattern suggests that governance issues are involved as well.

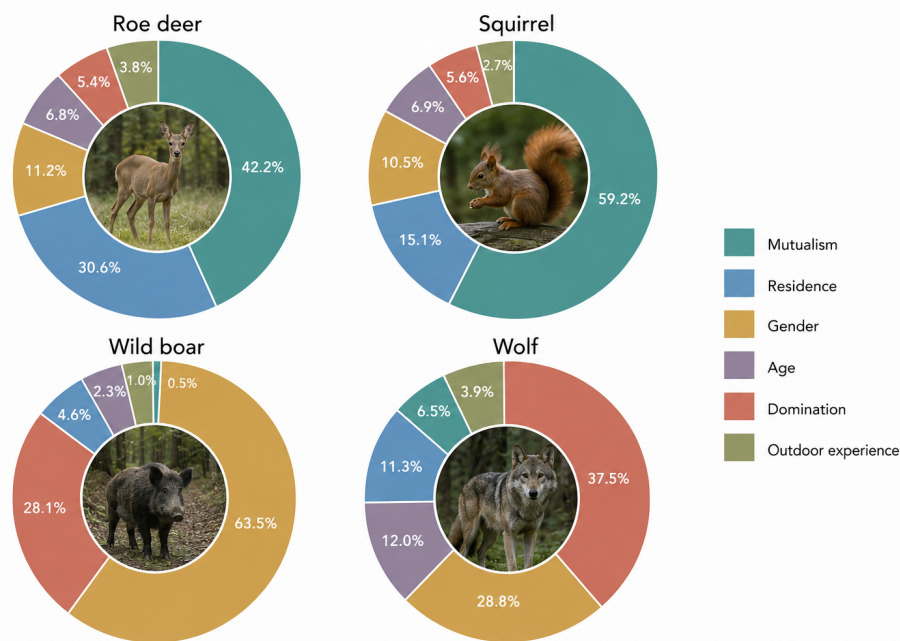


Figure 5. Moderator shares by species.

The numerical shares in Table 3 show that outdoor experience has only a small contribution in all four species models. This is notable because the sample was already active in nature. Regular outdoor activity did not dominate the appraisal of any species once animal meaning and wildlife values were included. The result cautions against assuming that outdoor experience alone neutralises concern about conflict-associated wildlife. Experience with nature may support route familiarity, but it does not necessarily remove the vigilance generated by animals perceived as difficult, contested, or unsafe.

The separated panels in Figure 6 connect the numerical shares to species-specific encounter settings. Roe deer and squirrel show a low-vigilance visual context with strong mutualism contributions. Wild boar and wolf show more cautionary contexts, but their profiles differ. The wild-boar panel highlights gender as the dominant contributor, whereas the wolf panel highlights domination orientation. The visual and numerical evidence together show that restorative loss is not a single fear reaction; it varies according to the animal's social meaning.

Table 3. Moderator contribution shares.

Species	Residence	Gender	Age	Outdoor exp.	Domination	Mutualism	Dominant channel
Roe deer	0.306	0.059	0.077	0.061	0.075	0.422	Mutualism
Squirrel	0.114	0.020	0.165	0.032	0.076	0.592	Mutualism
Wild boar	0.017	0.635	0.027	0.031	0.281	0.009	Gender
Wolf	0.040	0.288	0.122	0.028	0.375	0.146	Domination

Values are $|\beta|/|\beta|$ within each species model. Outdoor exp. denotes outdoor experience during the previous year.

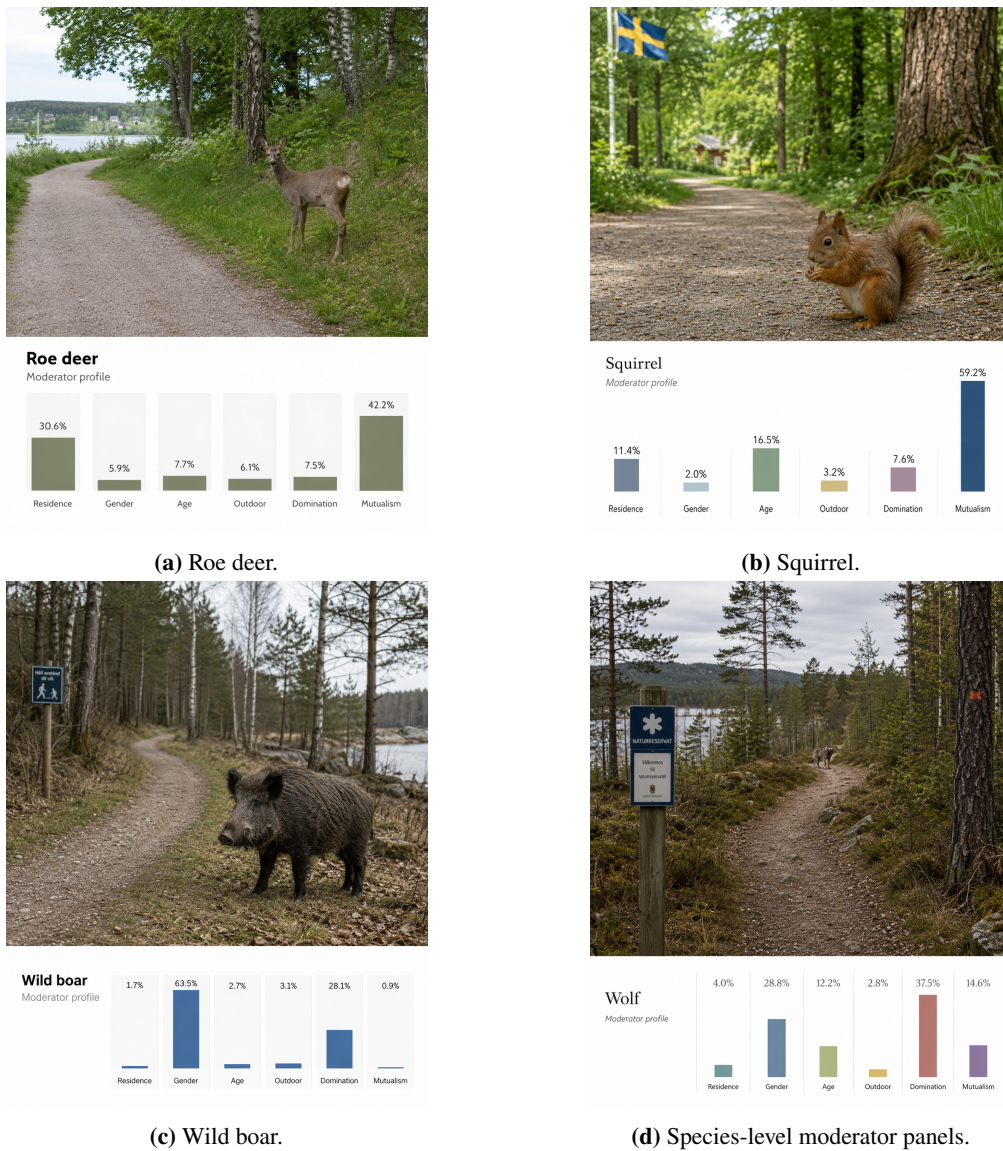


Figure 6. Moderator profiles.

3.5. Signatures of appraisal for local route contexts

The gain of roe deer was moderately positive, and relatively strong, when compared to dispersion. Its transition from restorative to dispersion is larger relative to the other species, and the most prominent moderator channels in the signature were mutualism and especially residence. Thus, presence of roe deer can be interpreted as the marker of natural continuity at a local scale. Roe deer, apparently, introduces lively elements to the path environment, which, however, do not detract from the path being conducive to relaxation.



(a) Roe deer.



(b) Squirrel.



(c) Wild boar.



(d) Wolf.

Figure 7. Species appraisal settings.

Squirrel gained most from restorative transition of any species under consideration. Squirrel had the largest raw gain, largest gradient in the standardised signature, and largest mutualism share in its signature. As the same species was familiar to all respondents, this cannot be a case of novelty effect. Instead, presence of a squirrel seems to contribute to animation through movement and familiarity and small body size, thus creating an attraction without necessity for attentional vigilance. Following attention restoration theory, this means that squirrel presence is compatible with soft fascination.

Wild boar generated the strongest negative transition, in which gender is a prominent channel of effect. High mean loss of restorative experience implies reduced potential for restoration if one expects a frequent contact with wild boar, while large gender share means that such reduced potential for restoration occurs unevenly across respondents. Thus, a path may appear to be green and visually pleasing, but fail to provide potential for restoration if the visitor anticipates difficulty in negotiating with the animal, particularly due to a thick vegetation cover or narrow passageway.

As with wild boar, wolf produced a negative transition. However, in the case of wolves, the primary effect channel was domination orientation. Moreover, adjusted explained variance of a model including wolf presence and segmentation weighting produced the strongest results, implying that respondents' characteristics play important role in their reactions to wolves on a path. Therefore, apart from the safety issue, wolf presence can be viewed as a symbol of control and valuation of animals.

The species settings in Figure 7 illustrate how the same broad environment category can contain different

psychological demands. Open, familiar, and easily interpretable encounters are consistent with restorative gain. Denser path edges and conflict-associated animals are more likely to shift attention toward monitoring. The panels place the numerical results within the kinds of local settings in which encounter expectations are appraised.

The planning interpretation in Table 4 shows why a single wildlife policy message is inadequate for restorative environments. Positive species do not require attention because they are controversial; they require attention because they contribute quietly to the everyday quality of local nature. Negative species do not require attention only because they may pose biological risk; they require attention because expected encounters can make a formally accessible route feel less compatible with recovery. The implication is not wildlife removal. The implication is species-sensitive design and communication that protect both ecological presence and relaxed human use.

Table 4. Planning interpretation of species polarity.

Species	Restorative meaning	Local planning response
Roe deer	Positive change with mutualism and residence contributions.	Preserve visible coexistence along local walking edges without encouraging close contact.
Squirrel	Strongest positive standardised change and strongest mutualism contribution.	Maintain small habitat features that support familiar low-threat wildlife near paths.
Wild boar	Negative change dominated by gender and supported by domination orientation.	Increase route legibility, reduce uncertainty, and communicate practical encounter guidance.
Wolf	Negative change dominated by domination orientation and supported by gender.	Address trust, perceived control, and value disagreement together with encounter information.

Interpretation combines the signed transition, standardised gradient, segmentation-weighted value, and dominant moderator.

The route context in Figure 8 brings the analysis back to ordinary use. The path, vegetation, and signboard represent the scale at which restorative benefits are usually experienced: a resident chooses a local route, assesses comfort, and decides whether the setting allows relaxation. The figure also clarifies the management balance. Local planning should support the restorative contribution of familiar wildlife while reducing avoidable uncertainty around animals that create vigilance or value conflict.

4. Discussion

4.1. Encounter expectations as restorative conditions

The findings suggest that wildlife expectations are restorative conditions rather than neutral background details. Expected frequent encounter with squirrel and roe deer increased restorative potential, while expected frequent encounter with wild boar and wolf decreased restorative potential. Compatibility can therefore be species-sensitive. The same landscape will be more or less compatible with restoration depending on the type of animal presence. Animal presence can mean harmless and animated life – making the environment restorative, or the need for vigilance and preparation – making the landscape incompatible with relaxation.

The finding supports the nature-health paradigm, which stresses the multipathways of nature's beneficial impacts [4, 11, 25]. Restoration can happen via emotional, attentional, social, and embodied processes. Wildlife expectations impact multiple pathways simultaneously. Animals can contribute to environmental interest and fascination. They can also influence the feeling of safety in a place or the confidence of movement through the landscape. Wildlife presence could thus influence cognitive and emotional components of restoration simultaneously.

The present findings add nuance to the debate over biodiversity and health benefits. Biodiversity has been linked to health improvement because rich biodiversity provides multiple sensory experiences and exposures [26, 27]. In that context, the present findings suggest that low-threat animal presence is indeed beneficial for restoration, but that

threat-associated species could be detrimental for restorative potential. High biodiversity does not necessarily equal high restorative value. An ecologically significant species can diminish the perceived restoration opportunity in a popular route.



Figure 8. Restorative route context.

4.2. Familiar animals and soft fascination

Both squirrel and roe deer were associated with positive restorative transitions, and both animals were dominated by soft fascination. Soft fascination is experienced through mild sensory stimuli that capture attention without imposing a need for concentration [18]. Squirrel and roe deer can provide movement, interest, and ecological vitality, without forcing visitors to watch them constantly and pay full attention. That could explain why squirrel and roe deer increased restorative potential instead of providing entertaining diversions.

The mutualism orientation was dominant for both positive species, which means that relational aspects played a significant role in the perception of restoration. The participants who were more mutually oriented towards nature were more likely to appreciate and enjoy wildlife. Mutualistic orientation is relevant in human-wildlife studies where wildlife appreciation, attitudes, and acceptance depend on the relationship between humans and animals [14, 23, 32]. Mutualist orientation could be particularly important for squirrels, which appear less threatening than other mammals.

Roe deer was different from squirrel in terms of moderation. The role of residence was stronger in roe-deer transition, while the role of gender was stronger in squirrel transition. It means that there is an element of place sensitivity for roe-deer presence. The species is common in some residential areas, but uncommon or unusual in others. At the same time, roe-deer can be seen as a marker of natural character, while squirrel is less indicative.

4.3. Conflict-associated species and vigilance

Wild boar and wolf had similar roles in reducing restorative potential, but different moderators for doing so. Wild boar was gender-patterned. It indicates that the negative effects of wild boar relate to perceptions about safety, risk, and movement. Being encountered with the species means being vulnerable in a way that requires caution and alertness. Wild boar are dangerous animals and their presence is often associated with the need for protection and caution [1, 7, 13]. Gender was an important factor in those appraisals.

Wolf was different in terms of dominant moderator. The animal presence transition for wolves was dominated by domination orientation. This finding highlights the complexity of the problem of wolf-human coexistence beyond pure fear and perceived danger. Wolf attitudes depend on many aspects including residence, place, experience,

support of wolf conservation policies, rural-urban differences, and hunting preferences [8, 20]. Wolf presence was associated with complex values beyond mere survival.

Research on large carnivores and human attitudes shows that fear of encounter, cognitive evaluation of danger, past experiences, and attitudes influence fear reactions and support for wildlife management programs [15, 17, 28]. The current results confirm those trends with a different emphasis on the restorative-environment framework. The issue is not only fear and attitudes but also the capacity to relax in a specific habitat. Encounter with wolves is problematic because of the associated loss of the psychological function of local nature.

4.4. Route-level implications for restorative access

The practical takeaway depends on the species. Squirrel and roe deer are expected to improve restorative quality, while wild boar and wolf negatively affect the process of relaxation. The objective for squirrel and roe deer is to maintain them as part of natural habitats in a way that allows non-intrusive observation. Small animals can help restore a sense of safety, liveliness, and healthy distraction in everyday surroundings.

Wild boar and wolf present a different case, since they cannot be easily removed or avoided. However, route planning for restoration should be based on minimizing the expected encounters as much as possible. The problem is not eliminating the species from the natural habitat. The problem is the loss of restorative quality, which might result in avoiding the route or choosing another path to recover. Avoiding the route means losing the opportunity for restoration.

For example, boar can be managed by increasing visual accessibility and reducing food attractors around recreation routes. Providing clear information on boar encounter frequency, timing, and behaviour could help visitors feel more confident. Information will play a lesser role in managing wolf presence because the main problem relates to human-wolf relations. Communication strategies for wolves would emphasize value orientations, legitimacy of policy, and safety.

The present results are relevant for public-health programs because such initiatives assume that green spaces are accessible for recovery. People living close to nature are likely to be able to use it regularly, but the accessibility can change with wildlife expectations. Routes for restoration cannot provide relaxation if they are perceived as dangerous places requiring caution and alertness. Thus, route planning should focus on expected animal encounter.

4.5. Strengths, limitations, and future research

All individual values are summarized per each species. Thus, the conclusions can reflect species-specific trends but lack individual covariation. Non-linear changes related to occasional vs. frequent encounter or latent sub-groups are not captured by the species statistics. It means that the calculations are species-oriented and represent the generalization of results but cannot include individual-level modeling.

The photographs provided examples of real-life environments with wildlife. However, inference is based on transition and variance values. The use of photographs allows demonstrating visually what is meant by particular values.

Future studies could combine expectations with empirical experience by recording actual moments of restoration. Ecological momentary assessment might show whether wildlife presence actually affects the restoration experience. Geographic tracking could help estimate the extent to which negative wildlife appraisals change route use and length. Longitudinal research could assess the stability of reactions based on value orientations. Species sensitivity calculations could also be used with other types of fauna, such as birds, reptiles, large herbivores, or domesticated animals.

5. Conclusion

The findings revealed that expected encounter of wildlife species alters restorative potential. Frequent encounter with squirrel and roe deer increased restorative potential, with the largest gain observed for squirrel and mutualist

dominance. On the other hand, wild boar and wolf decreased the potential for restoration. While both species were associated with negative transitions, the dominant respondent orientation varied between genders for boar and value orientations for wolves.

The conclusion is based on species conditions that make the encounter restorative or disruptive. Low-threat species provide safe interest that contributes to relaxation. High-threat animals require vigilance, alertness, and preparation, thus, make relaxation impossible. Restoration requires safe and familiar presence of wildlife, which means maintaining familiar animals and minimizing negative expectations.

References

- [1] Arrindell, W. A. (2000). Phobic dimensions: IV. The structure of animal fears. *Behaviour research and therapy*, 38(5), 509-530.
- [2] Astell-Burt, T., Hartig, T., Putra, I. G. N. E., Walsan, R., Dendup, T., & Feng, X. (2022). Green space and loneliness: A systematic review with theoretical and methodological guidance for future research. *Science of the total environment*, 847, 157521.
- [3] Bell, S. L., Westley, M., Lovell, R., & Wheeler, B. W. (2018). Everyday green space and experienced well-being: the significance of wildlife encounters. *Landscape Research*, 43(1), 8-19.
- [4] Bratman, G. N., Anderson, C. B., Berman, M. G., Cochran, B., De Vries, S., Flanders, J., ... & Daily, G. C. (2019). Nature and mental health: An ecosystem service perspective. *Science advances*, 5(7), eaax0903.
- [5] Brügger, A., Kaiser, F. G., & Roczen, N. (2011). One for all?. *European Psychologist*.
- [6] Cox, D. T., Shanahan, D. F., Hudson, H. L., Plummer, K. E., Siriwardena, G. M., Fuller, R. A., ... & Gaston, K. J. (2017). Doses of neighborhood nature: the benefits for mental health of living with nature. *AIBS Bulletin*, 67(2), 147-155.
- [7] Davey, G. C., McDonald, A. S., Hirisave, U., Prabhu, G. G., Iwawaki, S., Im Jim, C., ... & Reimann, B. C. (1998). A cross-cultural study of animal fears. *Behaviour research and therapy*, 36(7-8), 735-750.
- [8] Ericsson, G., & Heberlein, T. A. (2003). Attitudes of hunters, locals, and the general public in Sweden now that the wolves are back. *Biological conservation*, 111(2), 149-159.
- [9] Frumkin, H., Bratman, G., Breslow, S., Cochran, B., Kahn Jr, P., Lawler, J., ... & Wood, S. (2017). Nature contact and human health. *INTERNATIONAL ADVISORY AND EDITORIAL BOARD*, 1090.
- [10] Hartig, T., Korpela, K., Evans, G. W., & Gärling, T. (1997). A measure of restorative quality in environments. *Scandinavian housing and planning research*, 14(4), 175-194.
- [11] Hartig, T., Mitchell, R., De Vries, S., & Frumkin, H. (2014). Nature and health. *Annual review of public health*, 35, 207-228.
- [12] Hartig, T. (2021). Restoration in nature: Beyond the conventional narrative. In *Nature and psychology: Biological, cognitive, developmental, and social pathways to well-being* (pp. 89-151). Cham: Springer International Publishing.
- [13] Herzog, T. R., & Kutzli, G. E. (2002). Preference and perceived danger in field/forest settings. *Environment and behavior*, 34(6), 819-835.
- [14] Jacobs, M. H., Vaske, J. J., & Sijtsma, M. T. (2014). Predictive potential of wildlife value orientations for acceptability of management interventions. *Journal for Nature Conservation*, 22(4), 377-383.
- [15] Johansson, M., Ferreira, I. A., Støen, O. G., Frank, J., & Flykt, A. (2016). Targeting human fear of large carnivores—Many ideas but few known effects. *Biological Conservation*, 201, 261-269.

- [16] Johansson, M., Flykt, A., Frank, J., & Hartig, T. (2024). Wildlife and the restorative potential of natural settings. *Journal of Environmental Psychology*, 94, 102233.
- [17] Johansson, M., & Karlsson, J. (2011). Subjective experience of fear and the cognitive interpretation of large carnivores. *Human Dimensions of Wildlife*, 16(1), 15-29.
- [18] Kaplan, S. (1995). *Journal of Environmental Psychology*, 15, 169–182.
- [19] Kaplan, R., & Kaplan, S. (1989). *The experience of nature: A psychological perspective*. Cambridge university press.
- [20] Karlsson, J., & Sjöström, M. (2007). Human attitudes towards wolves, a matter of distance. *Biological conservation*, 137(4), 610-616.
- [21] Keniger, L. E., Gaston, K. J., Irvine, K. N., & Fuller, R. A. (2013). What are the benefits of interacting with nature?. *International journal of environmental research and public health*, 10(3), 913-935.
- [22] Landon, A. C., Jacobs, M. H., Miller, C. A., Vaske, J. J., & Williams, B. D. (2020). Cognitive and affective predictors of Illinois residents' perceived risks from gray wolves. *Society & Natural Resources*, 33(5), 574-593.
- [23] Manfredo, M. J. (2008). Who cares about wildlife?. In *Who cares about wildlife? Social science concepts for exploring human-wildlife relationships and conservation issues* (pp. 1-27). New York, NY: Springer US.
- [24] Manfredo, M. J., Teel, T. L., & Henry, K. L. (2009). Linking society and environment: A multilevel model of shifting wildlife value orientations in the western United States. *Social science quarterly*, 90(2), 407-427.
- [25] Markevych, I., Schoierer, J., Hartig, T., Chudnovsky, A., Hystad, P., Dzhambov, A. M., ... & Fuertes, E. (2017). Exploring pathways linking greenspace to health: Theoretical and methodological guidance. *Environmental research*, 158, 301-317.
- [26] Marselle, M. R., Hartig, T., Cox, D. T., De Bell, S., Knapp, S., Lindley, S., ... & Bonn, A. (2021). Pathways linking biodiversity to human health: A conceptual framework. *Environment international*, 150, 106420.
- [27] Ratcliffe, E. (2021). Sound and soundscape in restorative natural environments: A narrative literature review. *Frontiers in psychology*, 12, 570563.
- [28] Røskaft, E., Bjerke, T., Kaltenborn, B., Linnell, J. D., & Andersen, R. (2003). Patterns of self-reported fear towards large carnivores among the Norwegian public. *Evolution and human behavior*, 24(3), 184-198.
- [29] Scannell, L., & Gifford, R. (2010). The relations between natural and civic place attachment and pro-environmental behavior. *Journal of environmental psychology*, 30(3), 289-297.
- [30] Smalley, A. J., White, M. P., Ripley, R., Atack, T. X., Lomas, E., Sharples, M., ... & Depledge, M. H. (2022). Forest 404: Using a BBC drama series to explore the impact of nature's changing soundscapes on human wellbeing and behavior. *Global Environmental Change*, 74, 102497.
- [31] Staats, H., Kieviet, A., & Hartig, T. (2003). Where to recover from attentional fatigue: An expectancy-value analysis of environmental preference. *Journal of environmental psychology*, 23(2), 147-157.
- [32] Teel, T. L., & Manfredo, M. J. (2010). Understanding the diversity of public interests in wildlife conservation. *Conservation biology*, 24(1), 128-139.
- [33] Ulrich, R. S., Simons, R. F., Losito, B. D., Fiorito, E., Miles, M. A., & Zelson, M. (1991). Stress recovery during exposure to natural and urban environments. *Journal of environmental psychology*, 11(3), 201-230.
- [34] White, M. P., Weeks, A., Hooper, T., Bleakley, L., Cracknell, D., Lovell, R., & Jefferson, R. L. (2017). Marine wildlife as an important component of coastal visits: The role of perceived biodiversity and species behaviour. *Marine Policy*, 78, 80-89.