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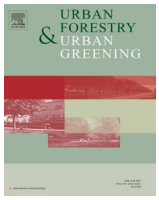

Bug city life: Public acceptance of urban insect-friendly meadows in Germany, Austria, and Switzerland

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ABSTRACT

Reports of continuing declines in some insect populations have raised concerns and calls for action to protect insects. The establishment of insect-friendly meadows in urban areas provides an opportunity to conserve both insect and plant diversity. However, public acceptance can be an obstacle to the implementation of such meadows, for example, due to competing land use interests and the perception that tall meadows are visually unattractive. To address these concerns and align urban green spaces with both public preferences and environmental needs, a systematic understanding of the factors influencing public acceptance of meadows is essential. To this end, a representative online survey was conducted in Germany, Austria, and Switzerland with 899 participants to assess the acceptance of insect-friendly meadows in urban areas. The study shows significant support for insect-friendly meadows across all subgroups and within each country-specific subgroup. The factor that most influences their acceptance is the recognition of the ecological benefits of these meadows. It is therefore highly recommended to prioritize public awareness campaigns that highlight the complex relationship between plant and insect diversity. Such efforts can contribute to a better understanding of the benefits of insect-friendly meadows for biodiversity, thereby increasing public support for these conservation measures. Additionally, considerations related to perceived aesthetics, appreciation of an increase in insect abundance, preference for public funding, and a general sense of safety around these meadows should inform the development and communication strategies for insect-friendly green spaces, as they significantly influence public acceptance. These design and perception aspects of meadows were shown to have a stronger influence on the acceptance of meadows than individual, attitudinal characteristics such as environmental attitudes or attitudes toward insect decline. While this study provides insights into the general public acceptance of insect-friendly meadows, more research is needed to understand the influence of the specific local context on meadow acceptance.

1. Introduction

Insects are important providers of a range of ecosystem services that contribute to the quality of human life (Schowalter et al., 2018). Plant diversity and quantity worldwide depend on the pollination services provided by insects (Ollerton et al., 2011). Additionally, insects serve as pest controllers and decompose excreta and dead biomass (Goulson, 2019). However, insects also have intrinsic value and provide benefits that cannot be economically assessed. For example, insects enhance the beauty of nature (Haslett, 2007; New, 2022), and observing and supporting insects can contribute to human well-being (Wignall et al., 2019).

The interdependencies between vegetation, humans, and insects are bidirectional: Many ecosystems are fragile, and the well-being of humans and insects depends on the well-being of the ecosystem (Schowalter et al., 2018); in turn, the stability of the ecosystem depends on the ecosystem service provided by insects and other contributors (Goulson, 2019; Sánchez-Bayo & Wyckhuys, 2019).

Taking all of this into account, it is alarming that the ongoing "anthrophocene defaunation" (Dirzo et al., 2014), which describes the loss of biodiversity due to anthropocene drivers, is also affecting insects, as shown by numerous reports on different species from different parts

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of the world (Dirzo et al., 2014; Sánchez-Bayo & Wyckhuys, 2019). Despite geographical and taxonomic limitations in the availability of studies, there is sufficient evidence to conclude that conservation measures are needed for insects (Montgomery et al., 2020; Saunders et al., 2020).

Reasons for the decline in insect populations include the effects of climate change and related environmental changes, such as changes in temperature, extreme precipitation, or drought (Sánchez-Bayo & Wyckhuys, 2019), as well as the consequences of direct human impacts, such as stress from pesticides, loss of habitat, a lack of flowering plants, and parasites (Garbuzov & Ratnieks, 2014; Goulson et al., 2015). Urbanization and ground sealing are among the greatest threats to global biodiversity (Seto et al., 2012).

An effective way to conserve insects is to protect their habitats and food sources (Sánchez-Bayo & Wyckhuys, 2019). Well-designed urban green spaces (UGS), such as natural areas, brownfield sites, gardens, and engineered green infrastructure in urban areas, can provide such habitats and habor diverse insect populations (Daniels et al., 2020). While common UGS management practices, such as mowing and pruning, chemical applications, or the introduction of non-native plant species, threaten urban biodiversity (Aronson et al., 2017), reducing UGS maintenance and sustaining native vegetation can transform UGS into biodiverse habitats for insects at relatively low costs (Aronson et al., 2017).

Despite the ecological benefits of such meadows and the general openness of the public to biodiversity (Fischer et al., 2020; Unterweger et al., 2017), insect-friendly meadows are not universally accepted in urban areas (Stoll-Kleemann, 2001). Non-acceptance of such meadows can lead to vandalism and dumping (Turo and Gardiner, 2019), impeding their positive impacts on biodiversity and well-being. This demonstrates that the management of UGS is subject to a complex interplay of social, cultural, environmental, and economic factors (Aronson et al., 2017). A key challenge for the management of UGS is therefore to balance citizens' demands for UGS with the ecological imperatives of maintaining and enhancing biodiversity and with political and economic interests to ensure long-term support for these meadow types (Aronson et al., 2017; Collins et al., 2019; Hoyle et al., 2017). Therefore, this research aims to identify public perceptions of UGS and the factors that contribute to the acceptance of urban insect-friendly meadows. Using a quantitative online survey in Germany, Austria, and the German-speaking part of Switzerland, we derive a statistical model that explains the public acceptance of meadow conversions. The results allow us to provide empirically based recommendations for the implementation of and communication about urban insect-friendly meadows in line with societal requirements.

2. Public acceptance of insect-friendly meadows

The aim of the study is to identify factors relevant to acceptance of meadows. According to Lucke (1995), *acceptance* can be defined as the relationship between the object of acceptance, the subject of acceptance, and the context of acceptance. In line with the study's aim to understand what drives the general attitudes toward urban insect-friendly meadows and to arrive at findings and recommendations that are not only applicable to a specific project context but rather to a much wider audience, the study focuses on the acceptance object and the acceptance subject and how both contribute to overall meadow acceptance. *Acceptance* is thus understood here as acceptance "on the broadest, most general level", as opposed to (local) community acceptance (Wüstenhagen et al., 2007). Thus, the impact of a specific local context on acceptance is not the focus of the empirical study but is regarded in the Discussion. The *object of acceptance* in this study is the meadow, and it is operationalized as aspects related to the meadow itself, such as its appearance and its impact on biodiversity. In this study, we refer to these factors collectively as *meadow-related characteristics*. The *subject of acceptance* is defined as the general public in this study, and it is operationalized by the psychological characteristics of this general public (e.g., awareness of insect decline and environmental attitudes). They are collectively referred to as *individual, attitudinal characteristics*.

This theoretical research framework serves as the basis for our research model (cf. Fig. 2). To further explore which specific factors should be investigated for acceptance of urban insect-friendly meadows, an empirical and a theoretical approach were combined. First, an exploratory empirical prestudy (focus group) was conducted (cf. Fig. 1). By systematically analysing the focus group discussion, recurring themes could be extracted which could serve as possible influential factors for the acceptance of the meadow, such as the *perceived aesthetics* ("It doesn't bloom nicely") or *liking of changes in insect occurrence* ("When you are barbecuing, for example, people might be bothered by the fact that there are more insects on the grass"). As a next step, a literature review was carried out to check the relevance of these topics in the scientific literature on meadow acceptance to date and to identify additional influencing factors. This was necessary because the focus groups provided insightful results for the meadow-related characteristics, but less so for individual, attitudinal characteristics. The following section discusses the results of the literature review on public acceptance of insect-friendly meadows.

2.1. Influence of meadow-related characteristics on acceptance

2.1.1. Perceived ecological benefit, linking of changes in insect abundance, and perceived aesthetics

UGS can enhance people's psychological well-being by eliciting positive feelings and satisfying non-material needs (Chiesura, 2004). This is even more the case when biodiversity is perceived to be high (Fuller et al., 2007). Furthermore, acceptance of meadow transformation is higher when participants have knowledge about biodiversity (Fischer et al., 2020). However, it should be recognized that biodiversity as perceived by laypeople may differ from actual biodiversity, as perceived biodiversity seems to depend mainly on color diversity rather than plant species diversity (Hoyle et al., 2018; Lindemann-Matthies et al., 2010). It is therefore interesting to investigate both the effect of perceived biodiversity and aesthetics on the acceptance of meadows. Furthermore, it has been shown that the presence of valued animal species positively influences the perceived value of UGS (Obrist et al., 2012; Unterweger et al., 2017), even more than the flora (Unterweger et al., 2017). However, no studies were found that investigated the effect of increased insect abundance.

2.1.2. Perceived land use conflicts

Several studies have indicated that design preferences for UGS depend on preferences for the use of UGS (Lampinen et al., 2021). Participants tended to dislike tall-grown meadows when they felt restricted in their desired activities and valued UGS that were free from physical or social barriers (Lampinen et al., 2021; Obrist et al., 2012). However, activities related to nature and socializing were perceived as suitable for tallgrass meadows (Lampinen et al., 2021).

2.1.3. General feeling of safety

In their literature review, Turo and Gardiner (2019) suggested that

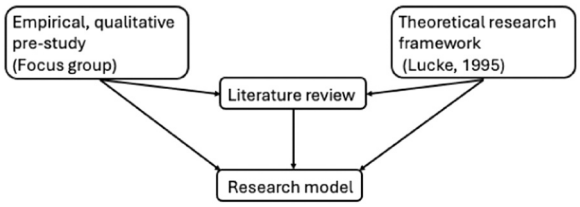

Fig. 1. Research approach combining an empirical prestudy, a theoretical acceptance framework (Lucke, 1995) and a literature review contributing to the design of the research model.

perceptions of safety may influence acceptance of meadows. They point out that the fear of insect bites is a major concern and even outweighs perceived conservation benefits, and that tall and dense vegetation increases both perceived and actual crime rates.

2.1.4. Preference for low costs and public funding

The relationship between perceived costs, funding sources, and acceptance of insect-friendly meadows remains largely unexplored. According to managers of UGS, reduced mowing offers an opportunity to save rather than requiring financial investment (Hoyle et al., 2017). However, implementing insect-friendly meadows may require initial investment. A study of a non-representative sample in Berlin showed a general willingness to pay for UGS (Fruth et al., 2019).

2.1.5. Perceived likelihood of abandonment

Finally, UGS that are not valued or are even actively rejected are at risk of being defiled (Turo & Gardiner, 2019). However, it is known that residents prefer UGS that look tidy and neat (Fischer et al., 2020; Obrist et al., 2012). Therefore, if urban tall-grown meadows are expected to be neglected or bedraggled, this may have a negative influence on their acceptance.

2.2. Influence of individual, attitudinal characteristics on acceptance

Research has extensively explored the correlation between meadow acceptance and various sociodemographic factors, including gender, age, culture, and experience (Gobster et al., 2007; Unterweger et al., 2017; Zobec et al., 2020). It is important to note that socio-demographic variables such as gender are known to be carriers of underlying individual, attitudinal traits. For example, women tend to be more accepting of meadows than men, but they also have a higher sensitivity to biodiversity and natural aesthetics (Unterweger et al., 2017; Zobec et al., 2020). Further investigation into these underlying individual, attitudinal characteristics is necessary, as they have received little attention in the context of pollinator declines (Knapp et al., 2021). The present study will therefore undertake a more detailed examination of the importance of psychological factors such as perception, knowledge, and attitude towards insects and the decline of insects to the acceptance of insect-friendly meadows as a means to conserve pollinators.

2.2.1. Perceived urgency of insect decline, perceived affectedness by insect decline, self-efficacy beliefs

Within the general framework of behavioral modeling, motivation and attitude toward a behavior are predicted by perceived urgency and self-efficacy beliefs (Ajzen, 1991; Rogers, 1975). Believing that one can achieve the desired change is a necessary condition for motivation (to act accordingly) (Ajzen, 1991; Rogers, 1975). Regarding meadow acceptance, it is thus likely that *self-efficacy beliefs*, i.e. being convinced that actions taken by individuals against insect decline can be effective, influence meadow acceptance. At the same time, it has been shown that the greater (more severe and likely) the perceived threat to the world at large and to oneself, the greater the motivation to take action (Rogers, 1975). Contrary to this, a previous study did not find a significant correlation between self-efficacy beliefs, perceived threat and biodiversity conservation intention (Wenzel et al., 2023). The relationship between these factors thus needs further investigation as it seems plausible that the more insect decline is perceived to be an urgent threat in general and to oneself, the higher the motivation to take action against this decline, i.e. in the form of transformed green spaces.

2.2.2. Knowledge about insect-ecosystem dependency and awareness of insect decline

It can be assumed that the perception of insect decline as a threat presupposes a certain knowledge of the interdependence of the ecosystem on insects and vice versa, as well as awareness for the decline of insects. Indeed, previous studies confirm the importance of awareness of insect decline on general pollinator conservation motivation (Wignall et al. 2019). However, the results on the influence of knowledge about insects on conservation motivation are ambiguous. Unterweger et al. (2017) discovered that individuals with a comprehensive understanding of entomology preferred meadows over lawns. Yet, in another study, the influence of knowledge on pollinator conservation behavior was minimal compared to the significance of perception- and identity-related factors (Knapp et al. 2021).

2.2.3. General environmental attitude, insect-friendliness and -aversion

In addition to the fear of personal harm caused by insect decline, an alternative, less egocentric explanation for insect-protective behavior is that people want to protect insects and the environment for their intrinsic beauty, i.e. for moral reasons. This potential explanation is corroborated by the findings that an appreciation and a sense of responsibility for biodiversity were associated with a higher affinity for nature and more positive attitudes toward insect-friendly meadows (Fischer et al., 2020; Unterweger et al., 2017).

Furthermore, it has been found that insects can evoke positive emotions in individuals (Wignall et al., 2019), and that positive attitudes toward insects increased meadow acceptance (Obrist et al., 2012). However, this effect is limited to certain flagship species. The presence of undesired insects, such as wasps (Sumner et al., 2018), may make insect abundance a factor in rejecting insect-friendly meadows. Therefore, attitudes towards insects, positive as well as negative, should be considered for the explanation of meadow acceptance.

Fig. 2 summarizes the factors that are hypothesized to influence meadow acceptance based on the literature review and empirical study presented previously.

In summary, meadow-related characteristics have received particular attention regarding their influence on meadow acceptance so far, especially aesthetic perception and its interplay with actual and perceived ecological benefits, the likelihood of abandonment, and land use conflicts, while other meadow-related and individual, attitudinal characteristics have also been considered, although less extensively. However, there is a gap in knowledge about the interplay of the individual, attitudinal characteristics and their relative importance for public acceptance compared to meadow-related characteristics. Therefore, this study aims to develop a holistic model to explain the

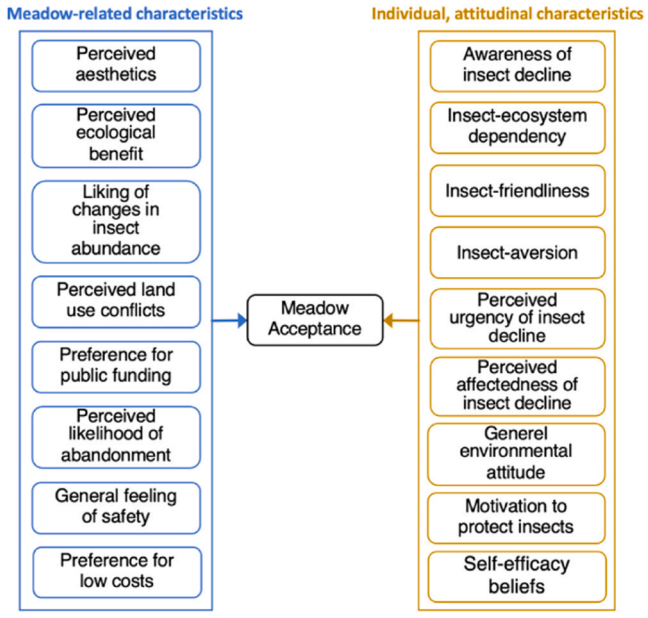

Fig. 2. Research model including both meadow-related and individual, attitudinal characteristics as hypothesized predictors of insect-friendly meadow acceptance.

acceptance of urban meadows that allows for the derivation of socially accepted insect-friendly UGS design and communication recommendations. In addition, the aim is to quantify and understand the interplay between meadow-related and individual, attitudinal characteristics. Therefore, the current study aims to answer the following research questions:

- **RQ1:** To what extent are insect-friendly meadows accepted in public spaces?
- **RQ2:** Which meadow-related and individual, attitudinal characteristics contribute to which extent to the acceptance of insect-friendly meadows?

3. Materials and methods

As described above, a combined empirical and theoretical approach was chosen (Fig. 1) to identify possible relevant factors for meadow acceptance (Fig. 2). Since at the time of the study there was no standardized instrument for measuring meadow acceptance that included all relevant dimensions, several quantitative prestudies were conducted to test the suitability of the newly developed instrument and the particular items used in the questionnaire.

3.1. Sampling procedure

The online survey was conducted in Germany, Austria, and (German-speaking) Switzerland, to test the generalizability of the results beyond a national context. These three German-speaking countries were chosen because it allowed the survey to be repeated in the same language, German, thus avoiding variations in the data due to translation inaccuracies. Also, it allowed for an interpretation of the results against a cultural background with which the authors are most familiar, thus allowing for a more accurate understanding of the results. Participants were recruited between 08.09.2022 and 14.09.2022 through panel sampling by a market research company. To ensure a balanced sample, quotas were set independently for the variables *country of residence*, *gender*, and *education*. In addition, data quality checks were applied. Participants received an incentive from the market research company for their participation. No formal ethical approval was required for the study.[2]

3.2. Outline of the online survey

Prior to the start of the survey, all participants were informed of the privacy standards of the study,[3] its content and its purpose, and that they were free to terminate their participation at any time.

At the beginning of the survey, participants were asked to provide demographic information such as age, gender, educational level, residence (urban/rural), nationality (DE/AT/CH), and private or professional involvement with ecological topics. Participants were then asked about their environmental attitudes (Geiger & Holzhauer, 2020).

Next, a description was provided explaining that the study aimed to assess opinions about the conversion of certain parts of lawns in urban parks into insect-friendly wildflower meadows. Two pictures were provided, one of a traditional lawn and one of a wildflower meadow, to illustrate the difference between the two types of green space management (Fig. 3).

In the following section, participants were asked to indicate their agreement with statements about meadow-related characteristics, such as perceived ecological benefits and perceived land use conflicts, which were hypothesized to influence meadow acceptance based on the preliminary study and the literature review (cf. Fig. 2 and Appendix, Table A.3, for specific items).

The next section focused on insects and insect decline (cf. Fig. 2 and Appendix, Table A.4, for specific items), examining perceptions of insects and their interdependency with the ecosystem, and perceptions of insect decline. Questions about actions to protect insects were also asked. Other questions about insects and insect decline followed (e.g., a quiz and questions about willingness to accept restrictions for insect conservation), but these were not part of the analysis and are therefore not described in detail.

All items were measured on a fully verbalized 6-point Likert scale (unless otherwise indicated), ranging from 1 (do not agree at all) to 6 (fully agree). To ensure reliability, only factors with a Cronbach's α value of.7 or higher were considered for further analysis (Blanz, 2015). For factors scoring lower values, factor analysis was performed for all individual, attitudinal characteristics and part-whole correction for all meadow-related characteristics to exclude items until reliability reached the desired level (Field, 2013). Item sources and reliability values for all items included in the analysis can be found in the Appendix (Table A.3 and A.4).

3.3. Participants

After data cleaning, a total of n = 899 data sets remained for analysis, with n = 299 participants from Germany and n = 300 each from Austria and Switzerland. In the total sample, approximately half of the participants were female (n = 450). Participants ranged in age from 18 to 75 years, with a mean age of 44.4 years (SD = 14.8). Regarding educational background, most participants had a secondary school degree (n = 371) or a general university entrance qualification (n = 357).[4] In terms of residency, n = 420 participants lived in urban areas, slightly fewer than those residing in rural areas (n = 477). Regarding ecological involvement, n = 431 participants reported no background in ecological issues, n = 436 participants reported private involvement with ecological

Fig. 3. Illustrationof a traditional lawn (top, ©JanyaSk/Shutterstock.com) and insect-friendly meadow (bottom, ©Jana Jedamski) as used in the survey.

[2] We did not seek an ethics committee approval because our study falls into a category that does not require such approval in Germany. This category includes all non-invasive, non-clinical research on human subjects, where the subjects are informed transparently about the purpose, aim and risks of the studies and where these risks are reasonably low.

[3] Because we do not have consent from the participants to share their data outside of the specific research project they were assessed for, the data cannot be made publicly available. Data can, however, be shared for reviewing purposes should this be required.

[4] For more details and a comparison of the sample to the German population, see Appendix Table A.2

issues, and n = 73 participants reported professional involvement in ecological issues.

3.4. Data analysis

The study aimed to include both meadow-related and individual, attitudinal characteristics in a holistic model with *acceptance of insect-friendly meadows* as the target variable. Therefore, correlations were first performed for all meadow-related and individual, attitudinal characteristics. Only those parameters that significantly correlated with the target variable were included in two separate exploratory backward regression analyses, one focusing on individual, attitudinal and one on meadow-related characteristics. Finally, a first approach to validate the model and to find out about nation-specific influences on the model was carried out. To this end, the meadow-related and individual, attitudinal characteristics that significantly predicted meadow acceptance in the individual models were first combined into an overall model for the entire sample using forced entry regression analysis. The same method was then used to create three models for the three national subsamples.

Statistical assumptions were checked prior to analysis (Bowerman & O'connell, 1990; Stevens, 2002). Cohen's guidelines (Cohen, 1988) were applied to interpret the amount of variance explained in regression and correlation analysis. Because there is a risk of overestimating regression significance with larger sample sizes (Field, 2013), a confidence cutoff of $\alpha \leq .001$ and $\beta(standardized) \geq 0.1$ was defined for all regression analyses. If values for any coefficients were found to be insufficient, they were excluded from the model, and the regression procedure was repeated until all values were within the desired ranges. For the benefit of readability, only the final models are reported in the Results section. A complete overview of all iterations can be found in Table A.6, A.8, A.9, and A.10 in the Appendix.

Tests for group differences were conducted to explore the influence of the national context on the descriptive results. As the assumption of normal distribution and homogeneity of variance was violated, the more robust Welch-ANOVA (instead of standard ANOVA) was applied for statistical analysis of the group differences. To address the issue of Type I errors (false positives) in multiple comparisons, we applied the Bonferroni correction to the ANOVA analysis to adjust the significance levels of individual tests. Pairwise comparisons were performed using the Tukey post-hoc procedure to identify statistically significant group differences.

All statistical analyses were performed using SPSS version 29.0.2.0.

4. Results

Subsequently, the results of the statistical investigation will be presented.

4.1. Analysis of influence of meadow-related characteristics on acceptance

Public acceptance of meadows was high (cf. Fig. 4), reaching a mean value of about 4.9 on the six-point scale. Similarly, *perceived ecological benefit* and a *liking of changes in insect abundance* were positively rated, and *preference for public funding* was also high. The *general feeling of safety* was reported to be positive. On average, participants rated the *perceived aesthetics*, the *perceived likelihood of abandonment* and the *preference for low costs* of the meadows as rather neutral. On average, participants disagreed with statements that dealt with *perceived land use conflicts* that could arise due to the meadow.

The results showed strong positive correlations between meadow *acceptance* and the *perceived ecological benefit* (r =.87), *liking of changes in insect abundance* (r =.82), *perceived aesthetics* (r =.79), *perceived land use conflicts* (r = −.66), a *general feeling of safety* (r =.75), and a *preference for public funding* (r =.68). A moderate correlation was found for the *perceived likelihood of abandonment* (r = −.35). *Preference for low costs* had only a weak but still significant correlation with *acceptance* of insect-friendly meadows (r = −.26). Inter-predictor correlations are documented in the Appendix A.5. Therefore, all variables were included in the regression modeling.

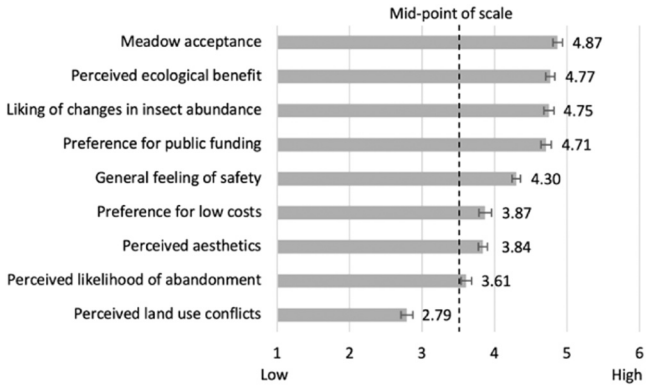

Fig. 4. Means with 95 % confidence intervals for the perception of meadow-related characteristics among the overall sample (n = 899, n = 1 data set missing for *general perception of safety*).

The resulting regression model (Fig. 5) was able to explain 83.8 % (R =.916, SE = 0.40) of the variance in meadow acceptance (F(5, 892) = 930.844, p <.001) and revealed that *perceived ecological benefit* was by far the strongest predictor, contributing approximately twice as much to the acceptance of insect-friendly meadows as *perceived aesthetics*, *liking of changes in insect abundance*, or *preference for public funding*. The *general feeling of safety* was the least explanatory factor. During the backward regression procedure, *perceived land use conflicts*, *perceived likelihood of abandonment*, and *preference for low costs* were excluded from the model because they did not contribute significantly to variance, or their explanatory power was too low for the defined threshold.

4.2. Analysis of influence of individual, attitudinal characteristics on acceptance

Overall, participants showed high awareness of *insects' interdependence with ecosystems*, and reported high *awareness* and *perceived urgency of a decline in insects*, and *perceived personal affectedness* (cf. Fig. 6). Their *general attitude toward the environment* was rather positive and *insect-friendliness* was high, and consequently, *insect-aversion* was low. Participants felt *efficacious* and *motivated to contribute to insect conservation*.

The results showed significant, positive, strong correlations between meadow *acceptance* and awareness of *insects' interdependence with*

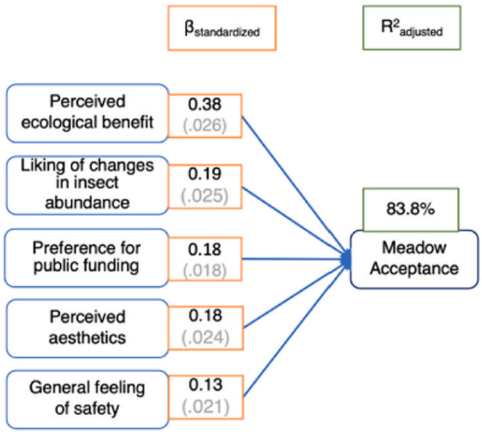

Fig. 5. Meadow-related characteristics predicting insect-friendly meadow acceptance (n = 898, $p \leq .001$) for all displayed predictors. Gray: standardized standard error.

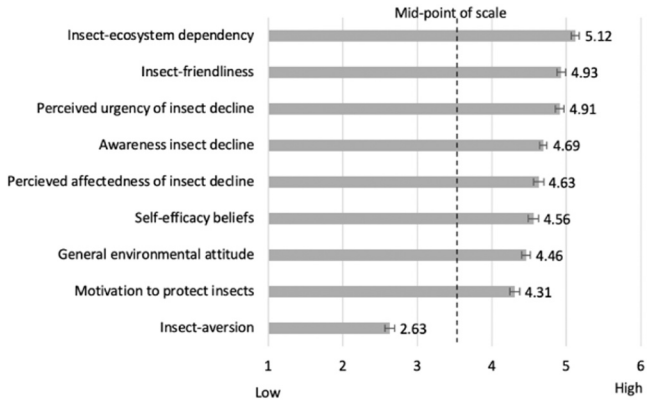

Fig. 6. Means and 95 % confidence intervals of the individual, attitudinal characteristics hypothesized to influence meadow acceptance among the overall sample (n = 899, (n = 899, with missing data for *perceived self-efficacy* and *motivation to protect insects* (n = 2), *perceived urgency of insect decline* (n = 3), *perceived affectedness of insect decline* (n = 10), and *perceived insect-ecosystem dependency* (n = 11)).

ecosystems (r =.65), *awareness of insect decline* (r =.61), *perceived urgency of insect decline* (r =.60), *motivation to protect insects* (r =.59), *insect-friendliness* (r =.60), *self-efficacy beliefs* (r =.50), and *insect-aversion* (r = −.50). A moderate correlation was found for *perceived affectedness of a decline in insects* (r =.48) and the *general environmental attitude* (r =.44). An overview of all inter-predictor correlations is provided in the Appendix A.7. As all variables showed significant correlations with *acceptance*, all were included in the regression model.

The model resulting from the regression analysis is displayed in Fig. 7. The model is able to explain 49.8 % of the total variance in meadow acceptance (R =.707, SE = 0.70, F(4, 881) = 220.628, p <.001). While both, the model including meadow-related characteristics and the one including individual, attitudinal characteristics, exhibit high levels of goodness of fit, the explanatory power of the model that considers individual, attitudinal characteristics is decisively lower than for the model including only meadow-related characteristics, indicating that meadow acceptance may be better predicted by meadow-related characteristics than by individual, attitudinal characteristics.

The model shows that among the individual, attitudinal characteristics, awareness of *insects' interdependence with ecosystems* is by far the strongest predictor of insect-friendly meadow acceptance, followed by the *motivation to protect insects*, the *awareness of insect decline*, and for the *general environmental attitude*. *Insect-friendliness* and *-aversion*, *perceived affectedness by a decline in insects*, *perceived urgency of a decline in insects*, and *self-efficacy beliefs* were excluded due to their low contribution and

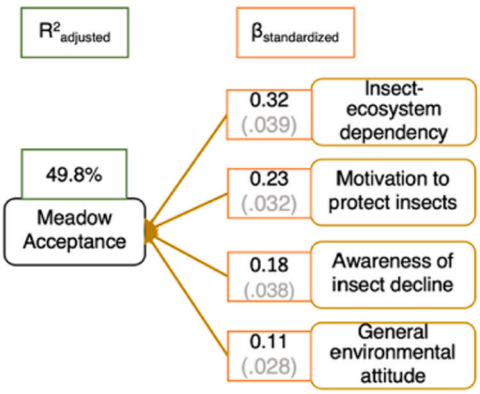

Fig. 7. Individual, attitudinal characteristics predicting insect-friendly meadow acceptance (n = 886, $p \leq .001$ for all coefficients. Gray: standardized standard error.).

low significance in explaining the variance in acceptance of insect-friendly meadows.

4.3. Weighing the influence of meadow-related against individual, attitudinal characteristics

To test the hypothesis that meadow acceptance is better predicted by meadow-related than by individual, attitudinal characteristics, meadow-related and individual, attitudinal characteristics were combined in one model. The regression analysis revealed that the influence of the meadow-related characteristics was indeed much higher than the influence of the individual, attitudinal characteristics, which were all excluded during the modeling process due to small effect sizes or becoming insignificant. Consequently, the overall model corresponds to Fig. 5. Taking all observed factors into account, the *perceived ecological benefit* was the strongest predictor for insect-friendly meadow acceptance.

4.4. National differences in the model

To identify general and specific predictors of acceptance of insect-friendly meadows, nation-specific differences between the model and its predictors were examined. Figs. 8 and 9 depict the means and 95 % confidence intervals for the factors of the final overall regression models for meadow-related and individual, attitudinal characteristics. Potential differences between the subsamples were calculated using Welch-ANOVAs for all factors.[5]

The level of overall *meadow acceptance* did not differ significantly between Germany, Austria, and Switzerland, nor did the subsamples differ significantly in the perception of any meadow-related characteristic. However, a statistically significant difference was observed for the *motivation to protect insects* (F(2, 595.62) = 9.97, p <.001, n = 897): Swiss participants showed significantly lower *motivation to protect insects* than German (-0.32, 99 % CI [-0.56, −0.08], p <.001, SE = 0.08) and Austrian (-0.31, 99 % CI [-0.55, −0.07], p <.001, SE = 0.08) participants. No significant differences were found between the national subsamples for any of the other individual, attitudinal characteristics.

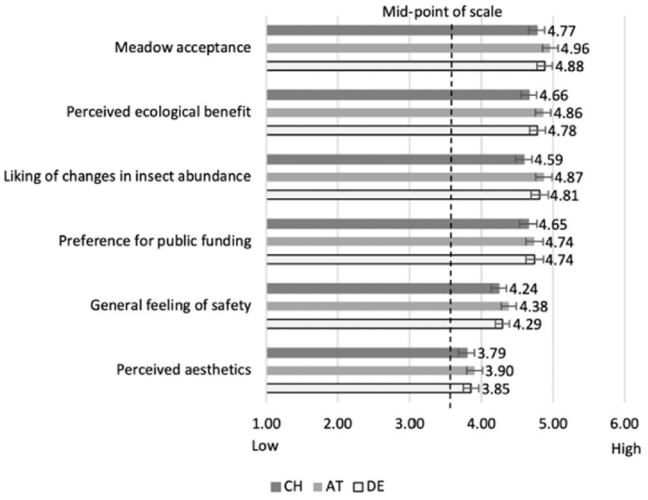

Fig. 8. Comparison of means and 95 % confidence intervals of the perception of meadow-related characteristics in Germany (DE, n = 299), Austria (AT, n = 300), and Switzerland (CH, n = 300).

[5] including any factors that were excluded from the regression models. Therefore, the Bonferroni correction of alpha values resulted in the new alpha threshold of p < 0.003

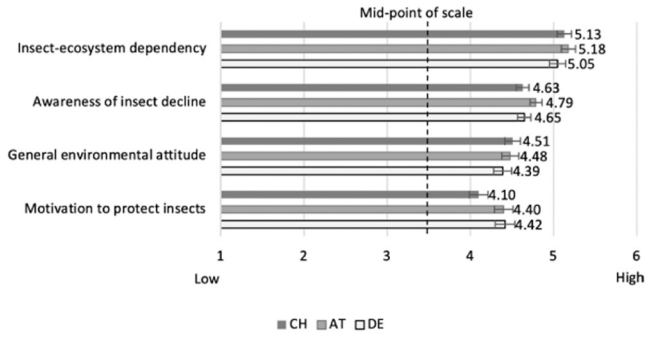

Fig. 9. Comparison of means and 95 % confidence intervals of individual, attitudinal characteristics for the samples from Germany (DE), Austria (AT), and Switzerland (CH). Missing data sets for *insect-ecosystem dependency* (DE: n = 5, AT: n = 4, CH: n = 2) and *motivation to protect insects* (DE: n = 1, CH: n = 1).

Testing the predictor model for *meadow acceptance* in different national contexts revealed which factors remained stable and which were context specific. Table 1 displays the regression results for the overall model and for each subsample. The model was significant for all subsamples and was able to explain a high proportion of the variance in *meadow acceptance* throughout. It was most explanatory for the Swiss context, explaining 85.6 % (R =.926, SE = 0.39) of the variance in *acceptance* (F(4, 295) = 443.685, p <.001, n = 300), 85.6 % (R =.921, SE = 0.37) for Germany (F(5, 293) = 329.55, p <.001, n = 299), and 81.6 % (R =.904, SE = 0.42) for Austria (F(3, 296) = 443.62, p <.001, n = 300).

In all three countries, *perceived ecological benefit* contributed the most to overall meadow acceptance. In the German and Austrian subsamples, the *liking of changes in insect abundance* was the second most relevant for acceptance, whereas in the Swiss subsample, the *preference for public funding* and the *perceived aesthetics* were stronger predictors. *Preference for public funding* and *perceived aesthetics* were significant predictors only in the German and Swiss models, although their proportion in predicting acceptance differed considerably between the samples, being almost twice as high in the Swiss as in the German sample. A *general feeling of safety* was relevant only in the German and Austrian models.

In summary, the developed model has high explanatory power to predict meadow acceptance, which was most strongly influenced by the perceived ecological benefits of the meadow, both overall and in the individual subsamples. More detailed investigations revealed that other influential factors differ in their relevance and strength in influencing acceptance depending on the particular subsamples.

5. Discussion

To the best of our knowledge, this study is the first to statistically compare factors related to the meadow itself and individual, attitudinal factors side-by-side in terms of their influence on overall meadow acceptance in a holistic model, allowing statements to be made about their relative importance. By conducting an empirical survey with three different national samples, we are able to derive findings that are stable across contexts. The model can inform implementation strategies for meadows in urban areas that align with social requirements. The results provide insights into the general acceptance of meadows and its specific contributing factors. However, the approach has limitations in explaining local attitudes.

5.1. Key results and responses to the research questions

5.1.1. Acceptance of insect-friendly meadows in public spaces

In general, a high level of acceptance of insect-friendly meadows was observed among the sample, and acceptance levels did not differ significantly between the German, Swiss, and Austrian subsamples. This confirms previous results showing a general openness to near-natural design of urban and rural green spaces (Fischer et al., 2020; Southon et al., 2017). These results can be considered an opportunity for the establishment of such meadows in urban areas which can serve conservation purposes and at the same time evoke a positive public response. No less important, the study shows that such meadows are perceived as an ecological benefit to urban areas and the expected increase in insect abundance is welcomed. However, it should be kept in mind that although participants expressed a willingness to accept insect-friendly meadows in general, this does not necessarily mean that they would unanimously support the conversion of lawns into meadows at the local level, especially if they are (too) close to their homes (Hoyle et al., 2017). Nevertheless, the results imply that the general idea of such meadows in urban areas appeals to a wide audience in the countries surveyed.

5.1.2. Relevance of meadow-related or individual, attitudinal characteristics for the acceptance of insect-friendly meadows

The results of the study showed that meadow-related characteristics outweighed individual, attitudinal characteristics in importance for meadow acceptance.

The *perceived ecological benefit* was identified as by far the most important factor for meadow acceptance, strongly correlated with *perceived aesthetics*. This reinforces the results of previous research on the interrelationships between acceptance of meadows, perceived biodiversity value and aesthetics (Hoyle et al., 2018; Lampinen et al., 2021; Lindemann-Matthies et al., 2010).

While the wilderness of biodiversity-rich meadows can evoke positive reactions and even be perceived as aesthetic by some (Lampinen et al., 2021), it can also provoke opposition (Hoyle et al., 2017). It should therefore be ensured that biodiversity-rich meadows appear neat and cared for, for example by implementing “mowing strips” to provide a formal framing for otherwise informal green spaces (Fischer et al., 2020). This could also enhance the general feeling of safety that is attributed to short-cut lawns rather than meadows (Garvin et al., 2012).

Given the interrelationship between perceived biodiversity, perceived aesthetics, and acceptance, it will be important to increase communication efforts, especially at times when their benefits for

Table 1
Regression models for the overall sample (n = 898), and for the national subsamples Germany (DE, n = 299), Austria (AT, n = 300), & Switzerland (CH, n = 299) ($p \leq$ .001 for all coefficients).

Country	$R^2_{adjusted}$	$\beta_{standardized}$ (standardized standard error)				
		Perceived ecological benefit	Liking of changes in insect abundance	Preference for public funding	Perceived aesthetics	General feeling of safety
Overall	.838	0.38	0.19	0.18	0.18	0.13
		(.026)	(.025)	(.018)	(.024)	(.021)
DE	.846	0.39	0.21	0.16	0.13	0.16
		(.048)	(.044)	(.032)	(.039)	(.036)
AT	.816	0.46	0.31			0.22
		(.045)	(.046)			(.036)
CH	.856	0.37	0.14	0.29	0.26	
		(.039)	(.037)	(.029)	(.037)	

biodiversity are not obvious and their perceived aesthetics is rather negative, for example in late summer when they are long and potentially dry (Hoyle et al., 2017). Accepting insect-friendly meadows will also require a change in urban dwellers' expectations about the aesthetics of urban green spaces, which could be supported by providing information about the ecological value of seemingly unaesthetic green spaces (Sikorski et al., 2021).

Indeed, providing information about the increased biodiversity value of meadows compared to short-cut lawns has been shown to effectively promote meadow acceptance (Fischer et al., 2020; Gobster et al., 2007; Southon et al., 2017; Unterweger et al., 2017). One way to further support this relationship is to actively communicate how biodiversity is increasing in those urban green areas that have been transformed into meadows, not only on a general level but also locally, for example by conducting scientific monitoring of plant and insect development on site over time and preparing the results for a non-scientific audience.

Regarding the influence of other factors, it was found that, contrary to our expectations, the *general environmental attitude* and *awareness* and *perceived urgency of insect decline* were outweighed by the meadow-related characteristics in terms of their importance for the acceptance of meadows, minimizing their impact to the extent that they were finally excluded from the explanatory model. The results suggest that insect-friendly meadows are accepted primarily because of their expected general ecological value, and that it is less decisive for their acceptance whether people have an environmentally friendly attitude per se or are aware of environmental issues (such as insect decline). However, it should be noted that the individual, attitudinal characteristics in this study were focused mainly on attitudes toward insects. If the meadows were not perceived as an insect conservation measure but rather as an aesthetic enhancement of urban areas or a general increase in biodiversity, this would explain why the individual, attitudinal characteristics played a lesser role in explaining the acceptance of the meadows. However, further research is needed, as this study did not investigate whether the meadows are perceived as a (suitable) insect conservation strategy.

Land use conflicts (Obrist et al., 2012; Stoll-Kleemann, 2001) and *cleanness/ likelihood of abandonment* (Fischer et al., 2020; Lampinen et al., 2021; Obrist et al., 2012) have been shown to influence the acceptance of insect-friendly meadows in previous studies. In this study, however, these factors did not have a significant impact when examined in combination with other, more influential factors. This discrepancy could be explained by the fact that in this study the general and abstract acceptance of insect-friendly meadows was measured, so that, e.g., specific land use conflicts were attributed to the meadow to a lesser extent. A local replication of the study could help to analyze the effect of possible land use conflicts on meadow acceptance more reliably.

Finally, while the *preference for low costs* seems to play a subordinate role, the *preferred source of funding* is clearly defined and relevant for acceptance: the meadows should be financed by public funds. Therefore, the communication strategy should disclose the source of funding for the meadow implementation and maintenance.

Regarding the similarities and differences of the explanatory models between the subsamples, it was shown that *perceived ecological benefit* and *liking of changes in insect abundance* influenced acceptance in the overall sample as well as in all subsamples. In contrast, the *perceived aesthetics*, a *preference for public funding*, and a *general feeling of safety*, while affecting *acceptance* in the overall model, differed in their relevance for meadow acceptance in the different subsamples. Welch-ANOVA analyses of possible differences between the subsamples revealed no significant differences that could account for the different models. Thus, we can only hypothesize that the country of origin served as a carrier variable for other underlying psychological, attitudinal, or contextual differences that we did not assess in the study. For example, we did not assess subjective or objective knowledge of biodiversity in general or insect decline in particular, which would be a useful addition to the model.

The variation in the explanatory models across the subsamples indicates that the acceptance of urban meadows is subject to contextual differences, although some patterns emerged that were stable across the subsamples. This calls for a holistic approach to urban meadow acceptance, which should not be limited to communicating biodiversity benefits, but should target a multitude of factors to reach diverse audiences. This means that it is necessary to incorporate non-ecological topics in the communication about urban meadows, such as discussing new aesthetics in the design of urban green spaces.

5.2. Limitations and future research

In our approach, we have focused on acceptance-relevant factors of insect-friendly meadows that are stable across contexts. This inevitably entails a definition of acceptance that is generalized and does not take into account specific local circumstances. It should be considered a first step toward a deeper understanding of the public's response to insect-friendly meadows. Future research should repeat the measurements at specific sites with meadow conversion projects that directly affect participants. This could validate the results in practice and allow for the identification of possible gaps between the general attitude toward insect-friendly meadows and a specific local project, a phenomenon well-known in other domains (Jones & Eiser, 2010). It would also allow to explore the possible variability of the perception of insect-friendly meadows depending on the local context. Furthermore, examining local acceptance on-site and before/after the implementation of insect-friendly meadows would allow for comparative studies, and interventions such as the communication strategies, as proposed here, could be evaluated for their effectiveness.

In addition, In the survey, we used a picture of a meadow with flowers in bloom to ensure that all participants shared the same idea of an insect-friendly meadow. The picture may have influenced the aesthetic perception and the relevance of this factor in the survey because it depicts the meadow in a rather attractive state. Different photographs depicting various states of meadows or field studies in different seasons could reduce this methodological bias.

Since no statistical differences were found between the national subsamples in the predictor variables using Welch-ANOVAs, it could be interesting to conduct analyses on group differences on moderating effects, considering that the composition and strength of the predictor variables still differed between the national contexts. Conducting more qualitative studies to examine the underlying factors contributing to the difference in the nation-specific samples and building structural equation models could be a next step to explore the context of insect-friendly meadow acceptance.

6. Conclusion

The study found a high acceptance of insect-friendly meadows in urban areas in the overall sample and in the subsamples for Germany, Austria, and Switzerland. In addition, potential predictors of acceptance were examined. The findings highlight the particular importance of the perceived ecological benefits and a positive attitude toward an increase in insect abundance for meadow acceptance. Educating citizens about the ecological benefits of urban insect-friendly meadows, such as an increase in local insect abundance, could therefore be a promising approach to further enhance the already positive attitudes toward insect-friendly meadows in urban areas. In this way, also non-experts can understand the use and benefits of seemingly neglected green spaces for urban biodiversity. The perceived aesthetics of such meadows also plays a central role and calls for a general discussion on how to find trade-offs between the requirements for the aesthetic appearance of urban green spaces and new, biodiversity-friendly maintenance practices. It is important to acknowledge that urban green space management, especially changes toward more biodiversity-friendly practices, should therefore not only be seen as an environmental management

task, but must be accompanied by targeted communication strategies to engage citizens in a more biodiverse city. If communicated in an engaging way, urban insect-friendly meadows have great potential to win over not only insects but also urban dwellers.

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CRediT authorship contribution statement

Mona Frank: Writing – review & editing, Writing – original draft, Visualization, Formal analysis, Data curation. **Barbara S. Zaunbrecher:** Writing – review & editing, Writing – original draft, Visualization, Supervision, Project administration, Methodology, Investigation, Funding acquisition, Conceptualization. **Simon Himmel:** Methodology, Investigation, Data curation, Conceptualization. **Martina Ziefle:** Supervision, Resources, Funding acquisition.

Declaration of Generative AI and AI-assisted technologies in the writing process

During the preparation of this work, the authors used ChatGPT August version 3 and DeepL Write β to translate and refine pieces of text from their native language into English. After using these tools, the authors reviewed and edited the content as needed and take full responsibility for the content of the publication.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data Availability

Because we do not have the participants' permission to publish individual data sets, they cannot be included with this research article.

Appendix A. Supporting information

Supplementary data associated with this article can be found in the online version at doi:10.1016/j.ufug.2024.128426.

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