Routledge
Taylor & Francis Group

Journal of Environmental Planning and Management

ISSN: (Print) (Online) Journal homepage: https://www.tandfonline.com/loi/cjep20

Reconciling road verge management with grassland conservation is met with positive attitudes among stakeholders, but faces implementation barriers related to resources and valuation

Jussi Lampinen & Niina Anttila

To cite this article: Jussi Lampinen & Niina Anttila (2020): Reconciling road verge management with grassland conservation is met with positive attitudes among stakeholders, but faces implementation barriers related to resources and valuation, Journal of Environmental Planning and Management, DOI: 10.1080/09640568.2020.1785405

To link to this article: https://doi.org/10.1080/09640568.2020.1785405

Journal of Environmental Planning and Management, 2020
https://doi.org/10.1080/09640568.2020.1785405

Routledge
Taylor & Francis Group

Reconciling road verge management with grassland conservation is met with positive attitudes among stakeholders, but faces implementation barriers related to resources and valuation

Jussi Lampinen[a]* and Niina Anttila[b]

[a]*Department of Biology, University of Turku, Turku, Finland;* [b]*Southwest Finland Centre for Economic Development, Transport and the Environment, Turku, Finland*

(*Received 22 January 2020; revised 5 June 2020; final version received 15 June 2020*)

Road verges could provide habitats for threatened grassland species, but current verge management is suboptimal for achieving this. Altering verge management to favor grassland species is possible but depends on stakeholder attitudes and valuation. We describe the attitudes of 373 Finnish road verge stakeholders toward grassland-friendly verge management and investigate the drivers underlying these attitudes. We also assess the perceived feasibility of different grassland-friendly management alterations and identify barriers facing their implementation. Gathered with online questionnaires, the data for the study comprises open-ended and Likert scale questions and was analyzed with multivariate methods and linear mixed models. According to the results, valued verge attributes, such as perceived species-richness and safety, and personal familiarity with biodiversity and semi-natural grasslands structure stakeholder attitudes toward grassland-friendly management. Specific management alterations, such as readjusted mowing schedules, are viewed with varying positivity, but insufficient resources and compromised traffic safety are perceived to hinder their implementation.

KEYWORDS: Road verge; semi-natural grassland; attitude survey; nature valuation; implementation barrier

1. Introduction

Anthropogenic environments may provide alternative habitats for species whose original habitats have either disappeared or become rare (Lundholm and Richardson 2010; Gardiner *et al*. 2018). An example of such are species adapted to semi-natural grasslands in Europe. Created by centuries of traditional animal husbandry, semi-natural grasslands are habitats of conservation concern that depend on regular moderate disturbance, such as mowing and grazing, and host a large number of declining specialist species (Vainio *et al*. 2001; Eriksson, Cousins, and Bruun 2002). Since the 19th century, reductions in semi-natural grassland area and connectivity have caused grassland species populations to decline and even suffer local extinctions (Fischer and Stöcklin 1996; Helm *et al.* 2006; Cousins *et al*. 2015). Several studies have suggested that road verges could, with suitable management, mitigate this development by providing grassland species with alternative habitats (Huhta and Rautio 2007; Jantunen *et al*. 2006; Auestad, Rydgren, and Austad 2011; Skórka *et al*.

*Corresponding author. Email: jilamp@utu.fi

2013; Auffret and Lindgren 2020). This is because road verges are regularly mown, structurally connected to one another and the remaining semi-natural grasslands (Tikka *et al*. 2000; Noordijk *et al*. 2009; Auffret and Cousins 2013) and, with an estimated road length of over 4.8 million kilometers in the European Union (European Union Road Federation 2017), cover an immense area compared to the remaining semi-natural grasslands.

While the regular management of road verges inadvertently renders them potentially suitable habitats for grassland species, the primary aim of current road verge construction and management is to create a traffic environment that is both safe for traffic and easy to manage. The verges are regularly mown (in northern Europe often once or more per season), as tall-growing vegetation in the verges may obstruct visibility, especially along bends and at intersections (Finnish Transport Agency 2014). Upon construction, the majority of verges are covered with either local or imported soil and seeded with cultivars of few rapidly growing graminoids (such as *Festuca rubra, Poa pratensis,* or the non-natives *Lolium perenne* and *Festuca trachyphylla*) (Finnish Transport Agency 2014). While several native grassland species occur in road verges, especially in those characterized by old age and sandy, nutrient-poor soils (Jantunen *et al*. 2006), current verge management is suboptimal for grassland species compared to the traditional management of semi-natural grasslands (Tikka *et al*. 2000). For example, early summer mowing and frequent mowing over the course of the growing season hampers the seed production of grassland plants (Jantunen *et al*. 2007) and reduces the species-richness of grassland butterflies (Valtonen, Saarinen, and Jantunen 2006). The mown biomass is seldom removed from roadsides (Finnish Transport Agency 2014), which prevents the depletion of soil nutrients that is typical of semi-natural grasslands (Schaffers, Vesseur, and Sýkora 1998) and may harm grassland seedling recruitment (Walker *et al*. 2004; Loydi *et al*. 2013). Landscaping the verges with fertile soil and sowing them with competitive grasses, in turn, prevents the colonization of grassland plants from the surrounding landscape (Sykora, Kalwij, and Keizer 2002; Auestad, Rydgren, and Austad 2016).

Accordingly, alterations to current verge management and construction practices are often suggested in order to increase the suitability of road verges as grassland habitats. The most common suggestions for grassland-friendly management include altering the frequency and timing of mowing (Valtonen, Saarinen, and Jantunen 2006; Jantunen *et al*. 2007; Noordijk *et al*. 2009) and removing the mown biomass (Parr and Way 1988; Noordijk *et al*. 2009; Jakobsson *et al*. 2018), to better mimic the management of semi-natural grasslands (e.g. Tikka *et al*. 2000; Sykora, Kalwij, and Keizer 2002). The first is beneficial for grassland plant reproduction and increases the species-richness of grassland butterflies (Valtonen, Saarinen, and Jantunen 2006; Jantunen *et al*. 2007), while the latter is linked to increased overall species-richness on road verges (Parr and Way 1988; Jakobsson *et al*. 2018). Further alterations to verge management suggested to favor grassland species include removing the nutrient-rich topsoil (Sykora, Kalwij, and Keizer 2002; Jantunen *et al*. 2006), reducing the amount of fertilizer applied (Tikka *et al*. 2000), communicating the value of road verges as grassland habitats to verge stakeholders (Sykora, Kalwij, and Keizer 2002) and including native grassland species in the seed mixtures used to landscape verges (Akbar, Hale, and Headley 2003; Rydgren *et al*. 2010, Auestad, Rydgren, and Austad 2016).

However, to understand the possibilities and limits to implementing any of the grassland-friendly management alterations described above, one must understand the drivers behind current verge management. These include phenomena operating at the institutional and regional scale, but also at the scale of individual road verge stakeholders (Cook, Hall, and Larson 2012; Lucey and Barton 2011; Akbar, Hale, and

Headley 2003; O'Sullivan *et al*. 2017).The former include, but are not limited to, the amount of resources available for management planning or execution, and legislative constraints and public attitudes concerning how road verges should be managed (Lucey and Barton 2011; O'Sullivan *et al*. 2017). On the scale of individual stakeholders, these phenomena include personal familiarity with the conservation value of road verges (Lucey and Barton 2011), personal attitudes toward particular types of verge management (Cook, Hall, and Larson 2012; O'Sullivan *et al*. 2017) and, most importantly, the ways in which different types of verge vegetation are valued (Ives and Kendal 2014; Garrido, Elbakidze, and Angelstam 2017).

The importance of familiarity, attitudes and valuation for the implementation of grassland-friendly management alterations lies in theories explaining human behavior. Both the integrated behavioral model (Montaño and Kasprzyk 2015) and the cognitive hierarchy theory (Fulton *et al.* 1996; Ives and Kendal 2014) suggest that behavior is explained by, among other things, attitudes, norms and knowledge concerning that behavior (Montaño and Kasprzyk 2015). Attitudes and norms, in turn, are shaped by beliefs and values (Homer and Kahle 1988; Fulton *et al.* 1996; Ives and Kendal 2014). While the definition of "values" varies greatly among disciplines, both in the degree of abstraction and context dependence, on a very general level the concept reflects that which is important to people (Anderson *et al*. 2018; Rawluk *et al*. 2019). In this study, we utilize the concept of *valued attributes*, that is, properties associated with the object of valuation (road verges in this case) perceived as important to individual stakeholders (Kendal *et al*. 2015; Rawluk *et al*. 2019).

As hierarchical cognitions, valued attributes precede attitudes, but are preceded themselves by more abstract core values (Anderson *et al*. 2018). Although the values originally referred to in the context of cognitive hierarchy theory correspond to these abstract core values (Homer and Kahle 1988; Fulton *et al.* 1996; Rawluk *et al*. 2019), research has shown that the more tangible valued attributes are also useful in predicting attitudes (Manning, Valliere, and Minteer 1999; Seymour *et al*. 2010). In habitat and vegetation management, attributes such as beauty (Gobster *et al.* 2007), wildness or naturalness (Fischer *et al.* 2020), cleanliness and evidence of deliberate caretaking (*cues to care*) (Nassauer 1995), are all suggested to correlate with attitudes toward particular management practices. On road verges, especially attributes such as traffic safety and neatness are suggested to drive attitudes toward different types of verge management (Akbar, Hale, and Headley 2003; Weber, Kowarik, and Säumel 2014; Hoyle *et al*. 2017).

Reconciling road verge management with grassland conservation could help prevent the further decline of grassland species populations across Europe. This, however, depends on investigating the attitudes that road verge stakeholders hold toward altering verge management in favor of grassland species, assessing the perceived feasibility of the management alterations suggested in the research literature, and identifying the barriers that face the implementation of these alterations. Finally, understanding how the valuation of different types of verges and familiarity with the potential of road verges to provide habitat for grassland species translate to attitudes toward altered verge management would help understand why implementation barriers to grassland-friendly verge management exist in the first place. In this case study of Finnish road verge management, we delve into these issues by answering the following research questions:

1. Which management alterations do different road verge stakeholders find most feasible for increasing the grassland conservation value of road verges?

2. What are the implementation barriers facing these alterations?
3. How do attitudes toward grassland-friendly verge management vary among stakeholders differing in their valuation of, and familiarity with, verges?

2. Methods

2.1. Stakeholder identification and data collection

We began the study by identifying relevant road verge stakeholders with expert opinion (Reed *et al*. 2009) concerning the administration and management of roads in Finland. We defined stakeholders as the actors responsible for the planning, implementation and execution of road verge construction and management. In Finland, municipal roads are maintained by employees of municipal infrastructure departments, while state-owned roads are maintained by private companies under contracts with regional Centers for Economic Development, Transport and the Environment. Such companies also maintain roads owned by private landowners under contracts with private road cooperatives. As regional administrative bodies implementing regional management schemes, the Centers mentioned above are steered by the national Transport Infrastructure Agency responsible for the maintenance and development of the national transport system. Transport and traffic safety issues, in turn, are the responsibility of the aforementioned Centers, the Finnish Transport and Communications Agency and The Finnish Road Safety Council. While not directly related to road verge management or transport systems, the environmental administration at local, regional and national scales may also be involved in the maintenance and construction of transport systems. For example, regional and national environmental administration is consulted upon managing road verges known to harbor endangered species.

We collected the data for the study with an online questionnaire distributed via email to 2,080 of the stakeholders described above in May-August 2018. Prior to actual data collection, we piloted and readjusted the questionnaire among administrative road verge and environmental stakeholders. To collect data from stakeholders responsible for practical road verge management, we distributed the questionnaire among employees of municipal infrastructure departments and private infrastructure companies ($n = 1{,}070$ distributed questionnaires). To collect data from stakeholders responsible for municipal, regional and national transport and environmental administration, we distributed the questionnaire among employees of the Centers, Agencies and Council described above ($n = 744$ for transport and 266 for environmental administration). To avoid non-response bias, we sent up to four consecutive reminders to potential respondents in all respondent groups until either a tentative minimum (100 responses per group) was reached or the duration of data collection (4 months) came to a close. Altogether, the 2,080 sent questionnaires amounted to 373 responses with an overall response rate of 17.9%. Practical road verge managers comprised 127 responses (11.8% response rate), transport administration 86 responses (11.5% response rate) and environmental administration 160 responses (60.2% response rate).

2.2. Questionnaire structure

The questionnaire began by identifying whether the respondent was currently, or had previously been, employed in tasks related to **a)** practical road verge management, **b)** transport administration or **c)** environmental administration (Appendix A1, Supplementary material). To quantify the respondents' overall attitude toward altering verge management to favor grassland species, we then asked the respondents how **a)**

positive they are toward considering grassland species during road verge mowing and other road management action and **b)** how necessary do they perceive this. The answers were given on Likert scale sliders ranging from 0 (*"Not at all positive/Not at all necessary"*) to 100 (*"Very positive/Extremely necessary"*).

We then asked the respondents to assess the feasibility of seven management alterations aimed at increasing the suitability of road verges as habitat for grassland species. Answers were given on a Likert scale ranging from 1 (*"Entirely unfeasible"*) to 5 (*"Very feasible"*), with the neutral option 3 (*"I don't know"*). Five alterations were identified from research literature and included:

1. **Late mowing, all verges:** Not mowing road verges during the blooming period of grassland plants and timing the mowing on all verges to late summer, or
2. **Late mowing, valuable verges:** Locating road verges with valuable grassland plant occurrences with surveys and timing their mowing to late summer (Tikka *et al*. 2000; Valtonen, Saarinen, and Jantunen 2006; Jantunen *et al*. 2007)
3. **Use of local soil and grassland species seeds in verge landscaping:** Favoring local soils and seeds of native grassland plants during verge construction (Sykora, Kalwij, and Keizer 2002; Rydgren *et al*. 2010; Auestad, Rydgren, and Austad 2016)
4. **Hay removal:** Removing the mown hay and bushes after mowing (Parr and Way 1988; Sykora, Kalwij, and Keizer 2002; Jakobsson *et al*. 2018)
5. **Stakeholder education:** Enhancing stakeholder familiarity on the importance of road verges as habitats for grassland plants and other grassland species (Sykora, Kalwij, and Keizer 2002)

Two of the alterations were formulated during questionnaire planning based on the current restoration and management efforts of semi-natural grasslands in Finland:

1. **Use of volunteers:** Outsourcing the management of verges with valuable grassland plant occurrences to volunteers
2. **Distributing GIS data on valuable verges:** Locating road verges with valuable grassland plant occurrences with surveys and storing them as GIS-data easily distributed among stakeholders

Both of these are established practices in Finnish grassland conservation initiatives: Volunteers are often recruited through local and national conservation NGOs to aid in practical grassland restoration efforts, and the locations of the most valuable remaining semi-natural grasslands have been surveyed in a national inventory and published as open access data (Vainio *et al*. 2001). In addition to these alterations, we also included an open-ended option for including any other grassland-friendly management alterations the respondent could think of.

If the respondent indicated a low or undecided feasibility (Likert scale levels 1-3) of a given alteration, they were presented with a multiple-choice question asking which three implementation barriers out of eight presented they personally perceived as the most important reasons for the low feasibility. We defined implementation barriers as constraints related to resources, legislation, attitudes or knowledge that the respondent explicitly perceives to prevent the adoption of management practices that would favor grassland species. The potential barriers were partly based on literature concerning road verge management and partly formulated during questionnaire planning, and included:

a. *Time*: Stakeholders lack the time for altering verge management (Cook, Hall, and Larson 2012)
b. *Money*: Stakeholders lack financial resources for altering verge management (Akbar, Hale, and Headley 2003; Cook, Hall, and Larson 2012; O'Sullivan *et al*. 2017)
c. *Equipment and employees*: Stakeholders lack other resources for altering verge management (O'Sullivan *et al*. 2017)
d. *Contracts*: The present contracts between managing and administrative stakeholders do not allow alterations to verge management (O'Sullivan *et al*. 2017)
e. *Legislation*: The present verge management adheres to legislation (Lucey and Barton 2011)
f. *Established practices*: Stakeholders are reluctant to change practices considered good (Cook, Hall, and Larson 2012)
g. *Attitudes*: Stakeholders have negative attitudes toward altering verge management (Cook, Hall, and Larson 2012; O'Sullivan *et al*. 2017)
h. *Knowledge*: Stakeholders are not familiar with the role of verges as grassland habitat (Lucey and Barton 2011)
i. *Other*: An open-ended question

Note that barriers f)-g) are both attitudinal barriers (sensu Homer and Kahle 1988; Fulton *et al.* 1996; Ives and Kendal 2014).

To determine whether different stakeholder groups differ in the valued attributes that they associate with different types of verge vegetation, we presented the respondents with two picture collages. One depicted four road verges covered with species-poor vegetation dominated by graminoids (hereafter "Regular verges"), and the other depicted four road verges with species-rich vegetation dominated by herbaceous grassland species (hereafter "Grassland verges") (A1 Figures 1 and 2, Supplementary Material). The respondents were asked to freely describe the perceptions the collages raise with a few words. The questionnaire concluded with questions concerning the respondent's familiarity with four different concepts relevant to the study subject: Three questions concerned familiarity with biodiversity, three with semi-natural grasslands, four with road verge management and nine with the potential of road verges to provide habitat for grassland species. Each question was formulated as a statement based on research literature and present guidelines of verge management and could be answered with a Likert scale slider ranging from 0 ("*I was unfamiliar with this*") to 100 ("*I was already familiar with this*").

2.3. Data analyses

Before the analyses, the answers describing how positive the respondents are toward considering grassland species during road verge mowing and other road management action and how necessary do they perceive this were averaged to form a scale of the respondents' overall attitude toward altering verge management to favor grassland species (hereafter "Attitude towards altered management"). Answers to the questions concerning the respondents' familiarity with concepts of biodiversity, semi-natural grasslands, road verge management and the potential of road verges to provide habitat for grassland species were also averaged to form scales describing the underlying familiarity of the respondent with each concept. The internal consistency of these

scales was assessed by calculating Cronbach's alpha (Cronbach 1951; Taber 2018) for each scale. The alpha varied between 0.66 (familiarity with verge management) and 0.86 (familiarity with the potential of road verges to provide habitat for grassland species) (Appendix A4, Supplementary material).

Open-ended answers concerning management alterations, implementation barriers, and the perceptions reported with the picture collages were manually grouped into distinct hierarchical typologies with inductive qualitative content analysis (Cho and Lee 2014). First the alterations, barriers and perceptions were grouped into preliminary classes of unifying themes, after which the typology of these themes was iterated by re-classifying each answer. The typology of the alterations and barriers was entirely data-driven. As the perceptions raised by the collages were gathered for identifying the valued attributes the stakeholders associate with the verges, their typology was partly based on a preliminary list of valued attributes, such as species-richness, beauty or cues to care, compiled from nature valuation literature (Nassauer 1995; Raymond and Brown 2006; Tyrväinen, Mäkinen, and Schipperijn 2007; Weber, Kowarik, and Säumel 2014; Ives *et al*. 2017). Each attribute was given a positive, neutral or negative connotation, based on the original answer. For example, answers such as *"(…) diverse vegetation, bugs love it"* were classified as positive attributes of the class Species-richness and diversity, while answers such as *"(The vegetation) blocks the visibility"* were classified as negative attributes of the class Traffic safety. Neutral connotations were applied when the positivity/negativity of the answer could not be interpreted. For a full description of the alteration, barrier and valued attribute typologies, see Appendix A3 Tables 1–3 (Supplementary material).

We compared the attitudes toward altered management and the perceived feasibility of individual management alterations across different stakeholder groups with pairwise Wilcoxon rank sum tests. To determine whether the valuation of regular verges and grassland verges differs between the stakeholder groups, we compared the main gradients of variation in the valued attributes associated by the stakeholder groups with the two verge types with principal component analyses. We then related the respondents' attitudes toward altered management to the valued attributes they associated with regular verges and grassland verges, and to the four familiarity scales, with linear mixed models. Only valued attributes associated by a minimum of 50 respondents with either type of verge were included in the models to ensure a sufficient quantity of data points. We reduced the number of predictors in the models with backward variable selection based on p-values and corrected the p-values in the final models against false discovery rate (Verhoeven, Simonsen, and McIntyre 2005). Statistical analyses were conducted with R version 3.3.3. and the associated package's stats (R Core Team 2019), vegan (Oksanen *et al*. 2019) and psych (Revelle 2019).

3. Results

3.1. Attitude toward altered management and feasibility of different management alterations

The attitudes toward altered management were most positive among stakeholders in environmental administration, with 95% of respondents in that group reporting to be somewhat or very positive toward altered management and to find it somewhat or extremely necessary. The attitudes were less positive and significantly different among stakeholders in traffic administration and practical verge management, according to

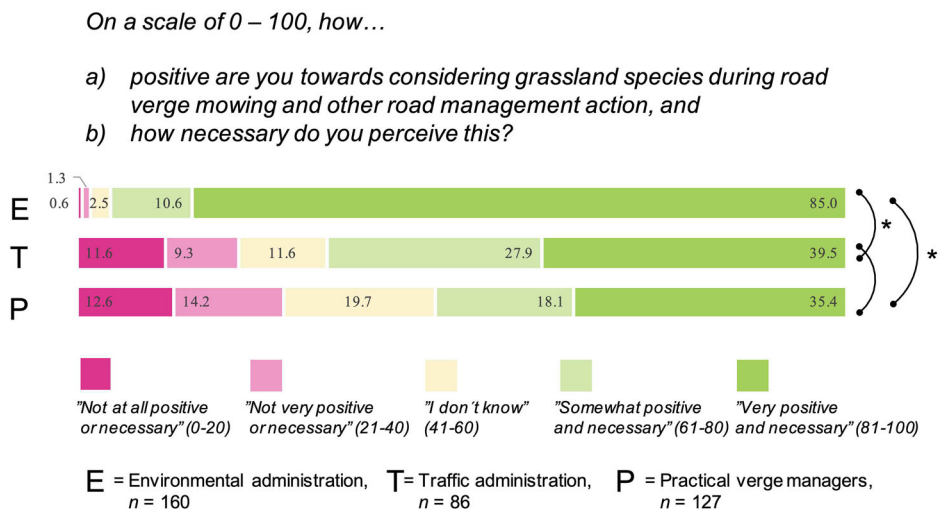

Figure 1. Scale for the overall attitude toward altering verge management to favor grassland species in road verge stakeholders belonging to environmental administration (E), traffic administration (T) and practical road verge managers (P). Arches with asterisks indicate statistically significant pair-wise differences in the average within-group attitude based on pairwise Wilcoxon rank sum tests. Note that the scale was calculated as an average of two separate questions, with answers given on a scale of 0 to 100. For the purpose of this plot the scale based on the answers was grouped to five classes (0-20, 21-40, 41-60, 61-80 and 81-100).

Wilcoxon pairwise rank sum tests. In both groups, however, over 50% of respondents reported positive attitudes toward altered management (Figure 1).

Alterations perceived most feasible across all stakeholder groups were Stakeholder education (alteration 5), Use of local soil and grassland species seeds in verge landscaping (alteration 3) and Distributing GIS data on valuable verges (alteration 7) (Figure 2). For example, over 70% of stakeholders in all groups perceived Stakeholder education as either somewhat or very feasible, and the same applied to Use of local soil and grassland species seeds in verge landscaping in over 80% of stakeholders in all groups. Alterations perceived most unfeasible, in turn, were Hay removal (alteration 4) and Use of volunteers (alteration 6). For example, less than 20% and less than 10% of stakeholders in any group perceived Hay removal and Use of volunteers, respectively, as very feasible.

While the stakeholder groups differed in the average feasibility reported for each alteration, the ranking between the feasibilities reported by each group tended to be similar. In general, stakeholders in environmental administration reported higher feasibilities than those in traffic administration, who in turn reported higher feasibilities than stakeholders in practical verge management. Differences between groups, however, were not always statistically significant. For example, while the feasibility reported by stakeholders in environmental administration differed significantly from the other two groups in all but one alteration, the feasibilities reported by stakeholders in traffic administration and practical verge management differed only in three alterations (5, Stakeholder education, 4, Hay removal and 7, Distributing GIS data on valuable verges).

Additional alterations to verge management for favoring grassland species were mentioned by 170 respondents (45.6%). These could be grouped into a typology of 7 major themes, including specific alterations to verge management (33 alterations),

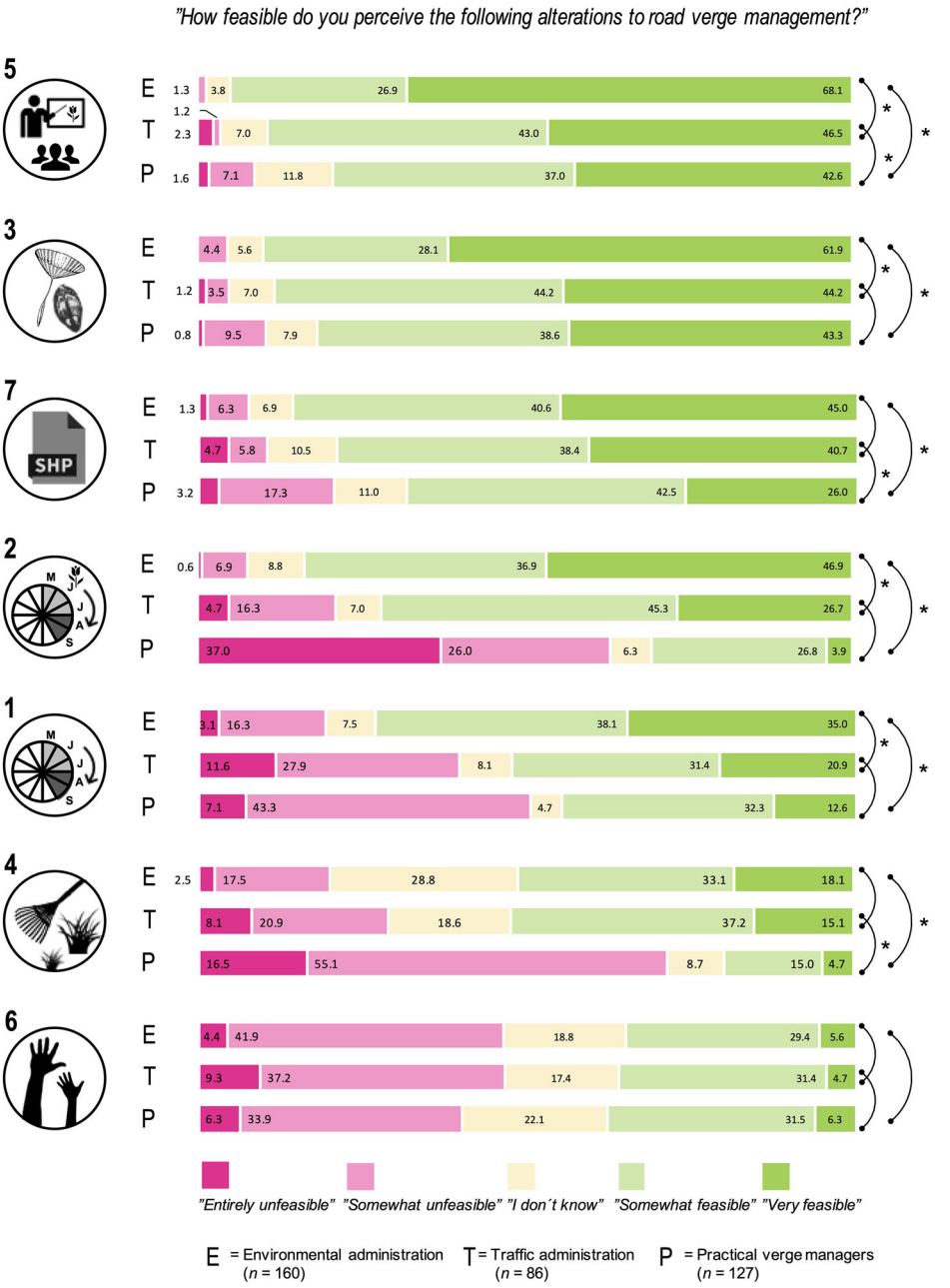

Figure 2. Perceived feasibility of management alterations reported by road verge stakeholders in environmental administration (E), traffic administration (T) and practical road verge management (P), expressed as percentages of total feasibility within each stakeholder group and ranked according to average total feasibility across the stakeholder groups. The alterations are 1 = Late mowing, all verges, 2 = Late mowing, valuable verges, 3 = Use of local soil and grassland species seeds in verge landscaping, 4 = Hay removal, 5 = Stakeholder education, 6 = Use of volunteers in valuable verge management and 7 = Distributing GIS data on valuable verges. Arches with asterisks indicate statistically significant pair-wise differences in the average within-group feasibility based on pairwise Wilcoxon rank sum tests.

specific alterations to road structure (3 alterations), education and attitude engineering (4 alterations), development and projects (10 alterations), governance and costs (4 alterations), data (4 alterations) and non-native species (5 alterations). The most common additional alteration was "Increasing the efforts to eradicate and prevent the further spread of invasive species, mostly *Lupinus polyphyllus*, on road verges" ($n = 47$, 12.6% respondents). This was followed by "Reaching out to stakeholders, decision makers and the general public to increase awareness of the importance of road verges as grassland habitat" ($n = 22$, 5.9% respondents). For a full description of all additional management alterations, see Appendix A3 Table 1 (Supplementary material).

3.2. Most common perceived implementation barriers to management alterations

Implementation barriers mentioned most often across all grassland-friendly management alterations were perceived lack of money ($n = 366$, 98.1% of all respondents), lack of time ($n = 300$, 80.4% of all respondents) and lack of equipment and employees ($n = 258$, 69.2% of all respondents) for altered management. Contractual and legislative constraints were mentioned the least often, only by 88 (23.6%) and 85 (22.8%) respondents, respectively. As the barriers were mentioned only in connection with perceived low feasibility of the alteration in question, the alterations with lowest reported feasibilities were assigned the most implementation barriers, and vice versa. However, as the perceived feasibility among the alterations varied, even the alterations perceived most feasible were assigned implementation barriers by some respondents. For example, lack of time and money were assigned to Stakeholder education by fourteen respondents, respectively. For a full description of all implementation barriers assigned to individual management alterations, see Appendix A2 Table 1 and Appendix A2; Figure 1 (Supplementary material).

Additional implementation barriers to altered management were mentioned by 294 (78.8%) respondents. These could be grouped into a typology of 14 themes, including, for example, compromises to traffic safety, management quality, and to the eradication of non-native species. Additional barriers were assigned especially to Late-summer mowing on all verges (alteration 1) and Use of volunteers (alteration 6). The most common additional barriers assigned to the first of these were "General compromises to traffic safety" (46 respondents) and "Compromises to the eradication of non-native species" (6 respondents). The most common additional barriers assigned to Use of volunteers were "Perceived lack of volunteer workforce" (55 respondents) and the "Perceived lack of management quality and continuity of volunteer work (19). For a description of the additional barriers assigned to management alterations, see Appendix A3 Table 2 (Supplementary material).

3.3. Valued attributes associated with different types of verges

Altogether, 17 valued attributes could be identified with qualitative content analysis in the open-ended answers describing perceptions of regular and grassland verges. The most common attributes associated with grassland verges across all stakeholder groups were positive attributes of beauty ($n = 259$, 69.4% of respondents), species-richness ($n = 101$, 27.1%) and inspiration ($n = 50$, 13.4%) and the negative attribute of neglect ($n = 46$, 12.3%). Valued attributes most commonly associated with regular verges were negative attributes of beauty ($n = 116$, 31.1%), neutral attributes of cues to care

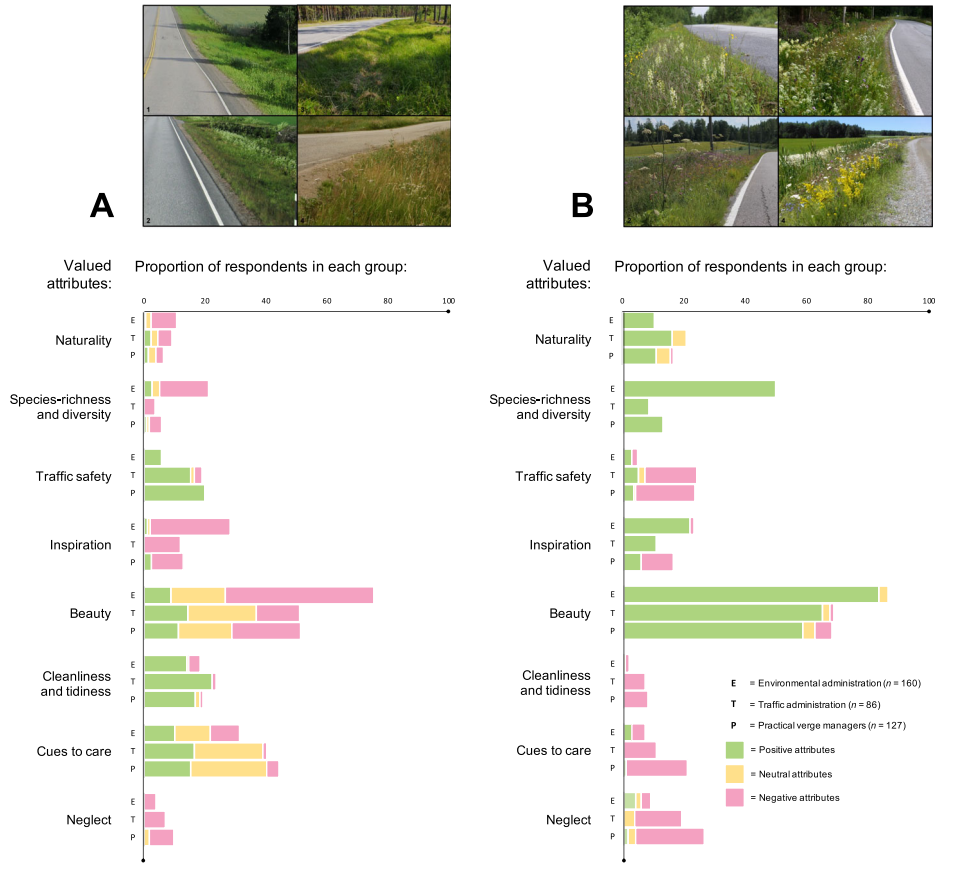

Figure 3. Valued attributes associated with a) regular verges and b) grassland verges by road verge stakeholders in environmental administration (E), traffic administration (T) and practical verge management (P), expressed as proportion of respondents in each group. Only the eight most commonly mentioned attributes are presented (a minimum of 50 respondents associated each presented attribute with either type of verge). Note that the total number of respondents in each stakeholder group varies from 86 (traffic administration) to 127 (practical verge management) and 160 (environmental administration).

($n = 68$, 18.2%) and positive attributes of cleanliness ($n = 62$, 16.6%) and traffic safety ($n = 47$, 12.6% of respondents) (Figure 3). We interpret the attribute of beauty as an aesthetic appreciation, or lack thereof, of the verges (Weber, Kowarik, and Säumel 2014; Säumel, Weber, and Kowarik 2016), species-richness as perceived richness or diversity of any group of species present on the verges, inspiration as perceived possibilities for becoming inspired or uplifted, cues to care as perceived signs of caretaking, neglect as perceived signs of abandonment and lack of care, and cleanliness as an appreciation, or lack thereof, of neatness and tidiness of the verges (Weber, Kowarik, and Säumel 2014; Nassauer 1995). For a full description of the valued attributes associated with the verges, see Appendix A3; Table 3 (Supplementary material).

Principal component analyses showed, that 40-48% of the total variation in the valued attributes each stakeholder group associated with either type of verge could be explained by the first three PCs of each respective analysis. However, the attributes with largest loadings on these PCs differed between the groups (Table 1): Among

Table 1. Three first principal components of the valued attributes associated with regular verges and grassland verges by road verge stakeholders in a) environmental administration, b) traffic administration and c) practical verge management.

Stakeholder group	Axis	Proportion (%) of explained variance	Cumulative proportion (%) of explained variance	Valued attribute with largest loading:
a) Environmental administration				
Regular verges:	PC 1	0.18	0.18	Beauty as a negative attribute (-0.85)
	PC 2	0.12	0.31	Inspiration as a negative attribute (0.89)
	PC 3	0.10	0.41	Species-richness as a negative attribute (0.54)
Grassland verges:	PC 1	0.20	0.20	Species-richness as a positive attribute (-0.94)
	PC 2	0.14	0.34	Inspiration as a positive attribute (0.89)
	PC 3	0.11	0.45	Beauty as positive attribute (0.89)
b) Traffic administration				
Regular verges:	PC 1	0.15	0.15	Cues to care as a neutral attribute (0.52)
	PC 2	0.14	0.29	Beauty as a neutral attribute (0.73)
	PC 3	0.12	0.41	Cleanliness as a positive attribute (-0.80)
Grassland verges:	PC 1	0.21	0.21	Beauty as a positive attribute (0.73)
	PC 2	0.11	0.32	Neglect as a negative attribute (0.58)
	PC 3	0.10	0.42	Traffic safety as a negative attribute (-0.82)
c) Practical verge management				
Regular verges:	PC 1	0.16	0.16	Cues to care as a neutral attribute (0.68)
	PC 2	0.13	0.30	Beauty as a negative attribute (0.79)
	PC 3	0.10	0.40	Beauty as a neutral attribute (0.68)
Grassland verges:	PC 1	0.26	0.26	Beauty as a positive attribute (0.63)
	PC 2	0.11	0.38	Traffic safety as a negative attribute (-0.60)
	PC 3	0.10	0.48	Traffic safety as a negative attribute (-0.67)

environmental administration, the valuation of grassland verges was mainly related to positive attributes of species-richness, beauty and inspiration. Among traffic administration and practical verge management, positive attributes of beauty were also associated with grassland verges, but so were negative attributes of neglect and especially traffic safety. The valuation of regular verges among environmental administration was mainly related to negative attributes of beauty, inspiration and species-richness, while stakeholders in traffic administration and practical verge management associated them mainly with neutral attributes of caretaking, neutral and negative attributes of beauty and positive attributes of cleanliness (Table 1).

3.4. Linear mixed models for the attitude toward altered management

Linear mixed models identified ten statistically significant positive and seven negative predictors for attitude toward grassland-friendly management. Among valued attributes associated with the verges, positive predictors were positive attributes of naturalness, species-richness and beauty associated with grassland verges, positive and negative attributes of inspiration associated with regular verges, and neutral and negative attributes of beauty associated with regular verges. Negative predictors for the attitude were neutral and negative attributes of neglect associated with grassland verges, negative attributes of traffic safety, beauty and cleanliness associated with grassland verges and neutral attribute of cleanliness associated with regular verges (Table 2a and b). As for the familiarity scales, familiarity with biodiversity, semi-natural grasslands and the potential of road verges as grassland habitat were all significant positive predictors for attitude toward altered management, while familiarity with verge management was a negative predictor for it (Table 2c).

4. Discussion

4.1. Road verge stakeholders regard altered verge management with positive attitudes, but certain alterations are perceived more feasible than others

We found, that there is mixed support among Finnish road verge stakeholders for altering verge management to favor grassland species. Despite differing attitudes toward altered management between administrative and managing stakeholders, over half of the respondents in all groups were either somewhat or very positive toward altering verge management to favor grassland species. This follows the results of Akbar, Hale, and Headley (2003), Weber, Kowarik, and Säumel (2014) and Fischer *et al*. (2018), who all found that a large share of the general public views less managed and biodiverse roadsides positively. Together, the results of these studies indicate that neither stakeholder nor public attitudes altogether constrain alterations to verge management for increased benefit to grassland conservation and imply that other barriers are the reason for not implementing altered verge management.

Three specific management alterations were perceived as especially feasible for implementation, namely stakeholder education on the value of road verges as grassland habitat, using local soils and grassland seeds in verge landscaping, and locating valuable verges and distributing their locations as GIS data among stakeholders. The high feasibility of the first alteration is especially encouraging, as increased awareness of the benefits of managing road verges as grassland habitats has been linked with positive perceptions of grassland vegetation on road verges (Lucey and Barton 2011).

Table 2. Linear mixed models between the attitude toward implementing management alterations that would favor grassland species and a) valued attributes associated with regular verges, b) valued attributes associated with grassland verges, and c) familiarity scales of biodiversity, semi-natural grasslands, road verge management and the potential of road verges as grassland habitats. Adjusted p-values were corrected against the false discovery rate (Verhoeven, Simonsen, and McIntyre 2005).

A) Response: Attitude toward altered management	**Predictors:** Valued attributes associated with regular verges	Estimate	Std. error	*t*-value	**Adjusted *p*-value**
	Intercept	65.22	7.76	8.41	0.02
Positive attributes:	**Inspiration**	22.59	10.98	2.06	**0.07**
	Beauty	−4.67	4.22	−1.11	0.38
	Cleanliness, tidiness	3.10	3.31	0.94	0.44
Neutral attributes:	Inspiration	7.08	23.49	0.30	0.76
	Beauty	10.97	3.45	3.18	**0.01**
	Cleanliness, tidiness	−37.89	14.06	−2.70	**0.02**
Negative attributes:	**Inspiration**	13.26	3.31	4.01	**< 0.001**
	Beauty	13.30	3.08	4.32	**< 0.001**
	Cleanliness, tidiness	2.76	8.53	0.32	0.76
	Random effect: Factor describing the respondents' group	**Variance**	**Std. dev**		
	Stakeholder group	166.5	12.9		
Marginal R^2: 0.11					
AIC: 3378.8					

B) Response: Attitude toward altered management	**Predictors:** Valued attributes associated with grassland verges	**Estimate**	**Std. error**	**t-value**	**Adjusted p-value**
	Intercept	65.00	6.22	10.45	0.01
Positive attributes:	**Naturalness**	9.79	3.45	2.84	**0.01**
	Species-richness	8.14	2.69	3.03	**0.01**
	Traffic safety	11.74	6.17	1.91	0.09
	Beauty	13.72	2.78	4.95	**< 0.001**
	Neglect	2.68	8.10	0.33	0.79
Neutral attributes:	Naturalness	9.41	6.97	1.35	0.26
	Traffic safety	1.83	12.25	0.15	0.88
	Beauty	8.41	6.49	1.30	0.26
	Cleanliness, tidiness	−23.32	22.16	-.,05	0.36
	Neglect	−19.11	7.13	−2.68	**0.02**

(*Continued*)

Table 2. (*Continued*).

B) Response: Attitude toward altered management	**Predictors:** Valued attributes associated with grassland verges	**Estimate**	**Std. error**	**t-value**	**Adjusted p-value**
Negative attributes:	Naturalness	−9.06	21.49	−0.42	0.77
	Traffic safety	−9.30	3.68	−2.53	**0.02**
	Beauty	−27.31	8.38	−3.26	**0.01**
	Cleanliness, tidiness	−13.37	5.85	−2.29	**0.04**
	Neglect	−16.55	3.61	−4.59	**< 0.001**
	Random effect: Factor describing the respondents' group	**Variance**	**Std. dev**		
	Stakeholder group	93.89	9.69		
Marginal R^2: 0.31 **AIC:** 3256.539					
C) Response: Attitude toward altered management	**Fixed effects:** Indices describing stakeholder familiarity	**Estimate**	**Std. error**	***t*-value**	**Adjusted *p*-value**
	Intercept	23.71	7.70	3.08	0.00
	Familiarity with verge management	−0.40	0.07	−5.68	**< 0.001**
	Familiarity with biodiversity	0.50	0.10	5.07	**< 0.001**
	Familiarity with grasslands	0.25	0.08	3.05	**0.00**
	Familiarity with grassland habitat potential of road verges	0.26	0.11	2.48	**0.01**
	Random effect: Factor describing the respondents' group	**Variance**	**Std. dev**		
	Stakeholder group	73.23	8.56		
Marginal R^2: 0.22 **AIC:** 3407.52					

Similar results have also been found between increased awareness and the perception of grassland vegetation in other anthropogenic habitats (Southon *et al*. 2017). This indicates that education could help alleviate the negative attitudes toward altered management that remain among certain stakeholders. Education can also help disseminate evidence-based knowledge on how, where and when road verge management should be altered to favor grassland species, thus increasing the likelihood of successful outcomes in such attempts (Sutherland *et al*. 2004).

Using local soils and seeds of native grassland species in verge landscaping, the alteration perceived as second most feasible, has been shown to be successful for establishing grassland vegetation on road verges: Verges landscaped with native grassland seeds may develop in time into communities with high similarity to actual semi-natural grasslands (Auestad, Rydgren, and Austad 2016). If seeds of local provenance are not available, hay transferred from nearby grasslands may also be used as material for establishing grassland vegetation in the verges (Rydgren *et al*. 2010). The strength of the third most feasible alteration (distributing GIS-data concerning the locations of valuable verges among stakeholders) relies on the fact that only the localities of valuable grassland vegetation that stakeholders are aware of can be considered in verge management planning. In Finland, data on the locations of road verges important for biodiversity currently exists only for a limited part of the country (Myllymäki, Nupponen, and Nieminen 2019). Locating similar verges in a larger region would, however, require increased survey resources and systematic field inventories utilizing, for example, pre-existing data for red-listed species occurrences (Helldin, Wissman, and Lennartsson 2015).

Compared to the alterations above, late summer mowing on all or the most valuable verges, removing the mown biomass, and utilizing volunteer workforce in managing the most valuable verges were all perceived less feasible methods for implementation. The most common implementation barriers perceived to face these alterations were lack of time, money, equipment and employees, the possible compromises to traffic safety and, concerning the volunteer workforce, lack of volunteers. The prevalence of especially the first three barriers, all related to stakeholder resources, suggests that substantial increases to stakeholder resources are required for any of these alterations to take place on a large scale. Resource-related barriers were also assigned to the alterations perceived on average to be the most feasible, although the questionnaire structure rendered the number of respondents indicating any given barrier to these alterations as small.

Despite their documented benefits to grassland species on road verges (Valtonen, Saarinen, and Jantunen 2006; Jantunen *et al*. 2007; Jakobsson *et al*. 2018), implementing late summer mowing would mean that a larger share of verges are mown within a shorter period of time, and removing the mown biomass would require additional equipment. Solving the low feasibility of these alterations could be attempted with regional development projects with external funding that would pilot late summer mowing and biomass removal and assess the actual costs and benefits it entails to stakeholders and traffic safety. Hay removal could be further motivated by the fact that biomass collected from road verges may be suitable for energy production (Voinov *et al*. 2015). On a large scale, however, it is likely that both of these alterations could be applied only to verges where tall verge vegetation or the mown biomass would not obstruct visibility. As for volunteer workforce, outsourcing the management of the most valuable verges for volunteers could spare stakeholder resources in the short term, but requires ensuring the long-

term commitment of the volunteers (Conrad and Hilchey 2011) and educating them both on safe practices when working in the road environment and on the specific methods of management that favor grassland species.

Although not included in the questionnaire, partial or mosaic-mowing could provide a more feasible alternative, as both are suggested to provide equal benefit to grassland insects and plants on road verges as late summer mowing, while not compromising traffic safety to a similar extent (Valtonen, Saarinen, and Jantunen 2006; Noordijk *et al*. 2009; Auestad *et al*. 2010). For example, mowing only the part of the verge closest to the road early in the summer and the part farther away later in the summer would maintain undisturbed vegetation on the verge for a longer period than mowing the entire verge at once (Noordijk *et al*. 2009; Auestad *et al*. 2010). The feasibility of partial mowing, however, depends on the physical features of the verges, such as verge width.

In addition to the pre-selected management alterations, 12.6% of the respondents perceived eradicating and preventing the further spread of non-native species, especially *Lupinus polyphyllus*, as an important additional measure for favoring grassland species on road verges. Originally imported as an ornamental from North America, *L. polyphyllus* has escaped from cultivation in many European countries and is able to outcompete plant species native to Europe in various habitats (Ramula and Pihlaja 2012). On road verges, invasion by *L. polyphyllus* is associated with decreases in plant species-richness and butterfly abundance (Valtonen, Jantunen, and Saarinen 2006). Mowing invaded verges and removing the mown biomass have been suggested as suitable eradication methods for the species (Valtonen, Jantunen, and Saarinen 2006), which is encouraging, as the same methods could also favor grassland plants (Jakobsson *et al*. 2018).

4.2. Valuation of road verges differs between stakeholder groups and covaries with attitudes toward altered verge management

Stakeholder values, whether abstract core values (Homer and Kahle 1988; Fulton *et al.* 1996) or more tangible valued attributes (Manning, Valliere, and Minteer 1999; Seymour *et al*. 2010), are important in nature management, as they may explain variation in attitudes toward particular conservation actions (Ives and Kendal 2014). We found that the perceived beauty or ugliness, neatness or untidiness and care or neglect of road verges broadly structure the valuation of the verges among road verge stakeholders. This follows the previous observations that the aesthetics, perceived order and cues to care evident in nature influence whether landscapes, and especially designed or artificial habitats, are perceived as desirable or not (Nassauer 1995; Gobster *et al* 2007). In addition to the valued attributes above, especially traffic safety and management costs are associated with the valuation of road verges and their management (Akbar, Hale, and Headley 2003; Weber, Kowarik, and Säumel 2014), a result also confirmed by this study.

While stakeholders in environmental administration perceived grassland verges as species-rich and inspiring, other stakeholder groups perceived them as neglected and unsafe for traffic. Respondents in all groups, however, also perceived grassland verges as beautiful. Regular verges were perceived as ugly, species-poor and uninspiring by environmental administration, and as cared for and clean by other stakeholder groups. These results highlight how personal contexts influence the way individuals value nature (Zheng, Zhang, and Chen 2011; Brun *et al.* 2018). Similar results have been

found by e.g. Özgüner, Kendle, and Bisgrove (2007), who showed that support for naturalistic, ecologically sensitive design in urban greenspaces is higher among conservation trusts than local authorities responsible for greenspace management. Awareness of the ecological benefits of grasslands has also been shown to increase the positive attitudes toward increasing the grassland cover in urban greenspaces (Southon *et al*. 2017). Among stakeholders related to road verge management, such awareness is most likely highest among stakeholders in environmental administration due to their experience in environmental conservation. The awareness of safety issues related to tall-growing vegetation in the verges, on the other hand, is most likely highest among stakeholders in traffic administration and verge management. The result that grassland verges were perceived as beautiful across stakeholder groups may, in turn, relate to the observation that species-richness and floral diversity are in themselves often considered beautiful (Junge *et al*. 2009; Lindemann-Matthies, Junge, and Matthies 2010).

We also showed that different valued attributes associated with verges translated into different attitudes toward altered management. Stakeholders who perceived grassland verges as natural, species-rich or beautiful and regular verges as ugly or uninspiring were more positive toward altering verge management in favor of grassland species. The opposite was true for stakeholders who perceived grassland verges as unsafe for traffic, ugly, untidy or neglected. These results follow those of Weber, Kowarik, and Säumel (2014), who found that attributes such as aesthetics, cleanliness and order, safety and costs influence the preference for either wild or planted road verge vegetation. Besides road verges, valued attributes have been shown to influence the perception and preferred management type of suburban yards (Larson *et al*. 2010), urban parks (Özgüner, Kendle, and Bisgrove 2007) and wastelands (Brun *et al.* 2018). For example, economic costs and public demand for neatness have been shown to be important constraints for introducing grassland vegetation into urban parks (Hoyle *et al*. 2017).

Understanding how different valued attributes associated with road verges lead to positive or negative attitudes toward grassland-friendly management is important for identifying the ways with which the ecological requirements of grassland species could be reconciled with the non-ecological motivations for managing road verges. For example, the negative attributes of traffic safety and neglect associated with grassland verges indicate that the perceived compromises to traffic safety associated with grassland vegetation have to be solved and signs of care retained in verges managed for grassland conservation for such verges to be perceived as acceptable among stakeholders. On the other hand, positive attributes of beauty, species-richness, inspiration and naturalness associated with grassland verges indicate that as long as such conflicts between the valued attributes are resolved, there is support for grassland-friendly verge management among the stakeholders.

4.3. Familiarity with the role of road verges as potential grassland habitats increases positive attitudes toward altering verge management

We also found that stakeholders familiar with biodiversity, semi-natural grasslands and the potential of road verges to provide alternative habitats for grassland species are positive toward implementing management that would favor grassland species. In turn, stakeholders familiar with practical verge management are less positive toward implementing such management. These results could easily be interpreted to indicate that simply educating stakeholders on the conservation potential of road verges could help

alter the present verge management regimes. However, familiarity with or knowledge concerning a given problem is but one step toward behavior that would solve it (Steg and Vlek 2009), as behavior is the product of many other phenomena, such as social norms, operating both within and outside an individual (Schultz 2011; Montaño and Kasprzyk 2015). Still, these results are encouraging, as positive attitudes toward altered management are nonetheless an important prerequisite for considering grassland species during verge management in the first place. The results also echo those obtained from other anthropogenic habitats: the more familiar urban residents across Europe are with biodiversity, the more positive they are toward managing urban greenspaces in a biodiversity-friendly manner (Fischer *et al.* 2020). Educating stakeholders on the grassland conservation value of road verges could thus be one of many steps toward reconciling road verge management with grassland conservation, especially as it was reported as highly feasible by the stakeholders themselves, as described earlier.

5. Conclusions and implications for practice

If we are to increase the suitability of road verges as grassland habitat, the following actions need to be in place. First, awareness of the potential of road verges as habitats for grassland species should be increased among stakeholders in traffic administration and practical verge management. This could increase positive attitudes toward altered management and positive perceptions of grassland vegetation on road verges (cf. Zheng, Zhang, and Chen 2011; Southon *et al*. 2017). Increasing stakeholder awareness of road verges as grassland habitat could be helped by, for example, distributing GIS location data for verges currently rich in grassland species among stakeholders. Second, newly built road verges should be landscaped with local soils and seeds of native grassland species as this would, in time, increase the cover of grassland-like vegetation on the verges (Auestad, Rydgren, and Austad 2016). Third, large-scale alterations to mowing schedules or removing the mown biomass from mown verges appear to be beyond current verge management resources, both monetary and non-monetary. Recognizing the need for increased resources could relieve the conflict between what ecological studies call for (Tikka *et al*. 2000; Jakobsson *et al*. 2018) and the reality of practical verge management.

Finally, the fact that road verges may be viewed through several equally justifiable values besides grassland conservation, such as traffic safety, neatness and cues to care, must not be forgotten in attempts to implement grassland-friendly management practices. Partial mowing (i.e. mowing a part of the verge in early summer and the rest in late summer) could provide a solution that is both beneficial for grassland species (Noordijk *et al*. 2009) and retains a safe, neat traffic environment with a cared for appearance. Before it can be recommended on a large scale, more studies are needed concerning the long-term ecological effects, the realized changes to perceived traffic safety, and thus the feasibility of partial mowing of the verges, especially regarding verges varying in their spatial features and landscape context.

Acknowledgements

This study would not have been possible without a research grant from the Kone Foundation to the first author. The authors express their thanks to all of the respondents who took the effort of participating in the study, and to M. Hyvärinen for kindly commenting on the manuscript.

Disclosure statement

No potential conflict of interest was reported by the author(s).

Supplemental data

Supplemental data for this article can be accessed here.

References

Akbar, K. F., W. H. G. Hale, and A. D. Headley. 2003. "Assessment of Scenic Beauty of the Roadside Vegetation in Northern England." *Landscape and Urban Planning* 63 (3): 139–144. doi:10.1016/S0169-2046(02)00185-8.

Anderson, N., R. M. Ford, L. T. Bennett, C. Nitschke, and K. J. H. Williams. 2018. "Core Values Underpin the Attributes of Forests That Matter to People." *Forestry: An International Journal of Forest Research* 91 (5): 629–640. doi:10.1093/forestry/cpy022.

Auestad, I., K. Rydgren, E. Jongejans, and H. de Kroon. 2010. "Pimpinella Saxifraga is Maintained in Roadverges by Mosaic Management." *Biological Conservation* 143 (4): 899–907. doi:10.1016/j.biocon.2009.12.037.

Auestad, I., K. Rydgren, and I. Austad. 2011. "Road Verges: Potential Refuges for Declining Grassland Species Despite Remnant Vegetation Dynamics." *Annales Botanici Fennici* 48 (4): 289–303. doi:10.5735/085.048.0401.

Auestad, I., K. Rydgren, and I. Austad. 2016. "Near-Natural Methods Promote Restoration of Species-Rich Grassland Vegetation: Revisiting a Road Verge Trial after 9 Years." *Restoration Ecology* 24 (3): 381–389. doi:10.1111/rec.12319.

Auffret, A. G., and E. Lindgren. 2020. "Roadside Diversity in Relation to Age and Surrounding Source Habitat: Evidence for Long Time Lags in Valuable Green Infrastructure." *Ecological Solutions and Evidence* 1 (1): e12005. doi:10.1002/2688-8319.12005.

Auffret, A. G., and S. A. O. Cousins. 2013. "Grassland Connectivity by Motor Vehicles and Grazing Livestock." *Ecography* 36 (10): 1150–1157. doi:10.1111/j.1600-0587.2013.00185.x.

Brun, M., F. Di Pietro, and S. Bonthoux. 2018. "Residents' Perception and Valuations of Urban Wastelands are Influenced by Vegetation Structure." *Urban Forestry and Urban Greening* 29: 393–403. doi:10.1016/j.ufug.2017.01.005.

Cho, J. Y., and E. H. Lee. 2014. "Reducing Confusion About Grounded Theory and Qualitative Content Analysis: Similarities and Differences." *The Qualitative Report* 19: 1–20.

Conrad, C. C., and K. G. Hilchey. 2011. "A Review of Citizen Science and Community-Based Environmental Monitoring: Issues and Opportunities." *Environmental Monitoring and Assessment* 176 (1–4): 273–291. doi:10.1007/s10661-010-1582-5.

Cook, E. M., S. J. Hall, and K. L. Larson. 2012. "Residential Landscapes as Social-Ecological Systems: A Synthesis of Multi-Scalar Interactions Between People and Their Home Environment." *Urban Ecosystems* 15 (1): 19–52. doi:10.1007/s11252-011-0197-0.

Cronbach, L. J. 1951. "Coefficient Alpha and the Internal Structure of Tests." *Psychometrika* 16 (3): 297–334. doi:10.1007/BF02310555.

Cousins, S. A. O., A. Auffret, J. Lindgren, and L. Tränk. 2015. "Regional-Scale Land-Cover Change During the 20th Century and Its Consequences for Biodiversity." *AMBIO* 44 (S1): 17–27. doi:10.1007/s13280-014-0585-9.

Eriksson, O., S. A. O. Cousins, and H. H. Bruun. 2002. "Land-Use History and Fragmentation of Traditionally Managed Grasslands in Scandinavia." *Journal of Vegetation Science* 13 (5): 743–748. doi:10.1111/j.1654-1103.2002.tb02102.x.

European Union Road Federation. 2017. *Road Statistics Yearbook 2017*. http://www.erf.be/wp-content/uploads/2018/01/Road_statistics_2017.pdf

Finnish Transport Agency. 2014. "Viherrakentaminen ja-hoito tieympäristössä [The Building and Management of Greenspaces in Road Environments]." *Liikenneviraston Ohjeita* 18/2014. In Finnish.

Fischer, L. K., J. Honold, R. Cvejic, T. Delshammar, S. Hilbert, R. Lafortezza, M. Nastran, et al. 2018. "Beyond Green: Broad Support for Biodiversity in Multicultural European Cities." *Global Environmental Change* 49: 35–45. doi:10.1016/j.gloenvcha.2018.02.001.

Fischer, L. K., L. Neuenkamp, J. Lampinen, M. Tuomi, J. G. Alday, A. Bucharova, L. Cancellieri, et al. 2020. "Public Attitudes Towards Biodiversity-Friendly Greenspace Management in Europe." *Conservation Letters* 2020: e12718. doi:10.1111/conl.12718.

Fischer, M., and J. Stöcklin. 1996. "Local Extinctions of Plants in Remnants of Extensively Used Calcareous Grasslands 1950-1985." *Conservation Biology* 11: 727–737. doi:10.1046/j.1523-1739.1997.96082.x.

Fulton, D. C., M. J. Manfredo, and J. Lipscomb. 1996. "Wildlife Value Orientation: A Conceptual and Measurement Approach." *Human Dimensions of Wildlife* 1: 24–47. doi:10.1080/10871209609359060.

Gardiner, M. M., C. B. Riley, R. Bommarco, and E. Öckinger. 2018. "Rights-of-Way: A Potential Conservation Resource." *Frontiers in Ecology and the Environment* 16 (3): 149–158. doi:10.1002/fee.1778.

Garrido, P., M. Elbakidze, and P. Angelstam. 2017. "Stakeholders' Perceptions on Ecosystem Services in Östergötland's (Sweden) Threatened Oak Wood-Pasture Landscapes." *Landscape and Urban Planning* 158: 96–104. doi:10.1016/j.landurbplan.2016.08.018.

Gobster, P. H., J. I. Nassauer, T.C. Daniel, and G. Fry. 2007. "The Shared Landscape: What Does Aesthetics Have to Do with Ecology?" *Landscape Ecology* 22: 959–979. doi:10.1007/s10980-007-9110-x.

Helldin, J. O., J. Wissman, and T. Lennartsson. 2015. "Abundance of Red-Listed Species in Infrastructure Habitats: 'Responsibility Species' as a Priority-Setting Tool for Transportation Agencies' Conservation Action." *Nature Conservation* 11: 143–158. doi:10.3897/natureconservation.11.4433.

Helm, A., I. Hanski, and M. Pärtel. 2006. "Slow Response of Plant Species Richness to Habitat Loss and Fragmentation." *Ecology Letters* 9: 72–77. doi:10.1111/j.1461-0248.2005.00841.x.

Homer, P. M., and L. R. Kahle. 1988. "A Structural Equation Test of the Value-Attitude-Behavior Hierarchy." *Journal of Personality and Social Psychology* 54: 638–646. doi:10.1037/0022-3514.54.4.638.

Hoyle, H., A. Jorgensen, P. Warren, N. Dunnett, and K. Evans. 2017. "'Not in Their Front Yard': The Opportunities and Challenges of Introducing Perennial Urban Meadows: A Local Authority Stakeholder Perspective." *Urban Forestry & Urban Greening* 25: 139–149. doi:10.1016/j.ufug.2017.05.009.

Huhta, A., and P. Rautio. 2007. "A Case with Blue Gentian Blues: Roadside-Cutters Creating Neo Grasslands as Refugia for Endangered Gentianella campestris." *Nordic Journal of Botany* 25: 372–379. doi:10.1111/j.0107-055X.2008.00131.x.

Ives, C. D., and D. Kendal. 2014. "The Role of Social Values in the Management of Ecological Systems." *Journal of Environmental Management* 144: 67–72. doi:10.1016/j.jenvman.2014.05.013.

Ives, C. D., C. Oke, A. Hehir, A. Gordon, Y. Wang, and S. A. Bekessy. 2017. "Capturing Residents' Values for Urban Green Space: Mapping, Analysis and Guidance for Practice." *Landscape and Urban Planning* 161: 32–43. doi:10.1016/j.landurbplan.2016.12.010.

Jakobsson, S., C. Bernes, J. M. Bullock, K. Verheyen, and R. Lindborg. 2018. "How Does Roadside Vegetation Management Affect the Diversity of Plants and Invertebrates? A Systematic Review." *Environmental Evidence* 7 (1): 17. doi:10.1186/s13750-018-0129-z.

Jantunen, J., K. Saarinen, A. Valtonen, and S. Saarnio. 2006. "Grassland Vegetation Along Roads Differing in Size and Traffic Density." *Annales Botanici Fennici* 43: 107–117.

Jantunen, J., K. Saarinen, A. Valtonen, and S. Saarnio. 2007. "Flowering and Seed Production Success Along Roads with Different Mowing Regimes." *Applied Vegetation Science* 10 (2): 285–292. doi:10.1111/j.1654-109X.2007.tb00528.x.

Junge, X., K. A. Jacot, A. Bosshard, and P. Lindemann-Matthies. 2009. "Swiss People's Attitudes Towards Field Margins for Biodiversity Conservation." *Journal for Nature Conservation* 17 (3): 150–159. doi:10.1016/j.jnc.2008.12.004.

Kendal, D., R. M. Ford, A. M. Anderson, and A. Farrar. 2015. "The VALS: A New Tool to Measure People's General Valued Attributes of Landscapes." *Journal of Environmental Management* 163: 224–233. doi:10.1016/j.jenvman.2015.08.017.

Larson, K. L., E. Cook, C. Strawhacker, and S. J. Hall. 2010. "The Influence of Diverse Values, Ecological Structure and Geographic Context on Residents' Multifaceted Landscaping Decisions." *Human Ecology* 38 (6): 747–761. doi:10.1007/s10745-010-9359-6.

Lindemann-Matthies, P., X. Junge, and D. Matthies. 2010. "The Influence of Plant Diversity on People's Perception and Aesthetic Appreciation of Grassland Vegetation." *Biological Conservation* 143 (1): 195–202. doi:10.1016/j.biocon.2009.10.003.

Loydi, A., R. L. Eckstein, A. Otte, and T. W. Donath. 2013. "Effects of Litter on Seedling Establishment in Natural and Semi-Natural Grasslands: A Meta-Analysis." *Journal of Ecology* 101 (2): 454–464. doi:10.1111/1365-2745.12033.

Lucey, A., and S. Barton. 2011. "Influencing Public Perception of Sustainable Roadside Vegetation Management Strategies." *Journal of Environmental Horticulture* 29: 119–124.

Lundholm, J. T., and P. J. Richardson. 2010. "Habitat Analogues for Reconciliation Ecology in Urban and Industrial Environments." *Journal of Applied Ecology* 47 (5): 966–975. doi:10.1111/j.1365-2664.2010.01857.x.

Manning, R., W. Valliere, and B. Minteer. 1999. "Values, Ethics, and Attitudes Toward National Forest Management: An Empirical Study." *Society and Natural Resources* 12: 421–436.

Montaño, D. E. and D. Kasprzyk. 2015. "Theory of Reasoned Action, Theory of Planned Behaviour and the Integrated Behavioural Model." In *Health Behavior and Health Education: Theory, Research, and Practice*, edited by K. Glanz, K. R. Rimer, and K. Viswanath. San Francisco: John Wiley & Sons.

Myllymäki, T., K. Nupponen, and M. Nieminen. 2019. *Roadside Biodiversity Pilot Project in Southwestern Finland*. Publications of the Finnish Transport Infrastructure Agency 1/2019: 1–91. Helsinki: Finnish Transport Infrastructure Agency.

Nassauer, J. I. 1995. "Messy Ecosystems, Orderly Frames." *Landscape Journal* 14 (2): 161–169. doi:10.3368/lj.14.2.161.

Noordijk, J., K. Delille, A. P. Schaffers, and K. V. Sýkora. 2009. "Optimizing Grassland Management for Flower-Visiting Insects in Roadside Verges." *Biological Conservation* 142 (10): 2097–2103. doi:10.1016/j.biocon.2009.04.009.

Oksanen, J., F. G. Blanchet, M. Friendly, R. Kindt, P. Legendre, D. McGlinn, P. R. Minchin, et al. 2019. Vegan: Community Ecology Package. R package version 2.5-6. https://CRAN.R-project.org/package=vegan

O'Sullivan, O. S., A. R. Holt, P. H. Warren, and K. L. Evans. 2017. "Optimising UK Urban Road Verge Contributions to Biodiversity and Ecosystem Services with Cost-Effective Management." *Journal of Environmental Management* 191: 162–171. doi:10.1016/j.jenvman.2016.12.062.

Özgüner, H., A. D. Kendle, and R. J. Bisgrove. 2007. "Attitudes of Landscape Professionals Towards Naturalistic Versus Formal Urban Landscapes in the UK." *Landscape and Urban Planning* 81 (1–2): 34–45. doi:10.1016/j.landurbplan.2006.10.002.

Parr, T. W., and J. M. Way. 1988. "Management of Roadside Vegetation: The Long-Term Effects of Cutting." *The Journal of Applied Ecology* 25 (3): 1073–1087. doi:10.2307/2403767.

Raymond, C., and G. Brown. 2006. "A Method for Assessing Protected Area Allocations Using a Typology of Landscape Values." *Journal of Environmental Planning and Management* 49 (6): 797–812. doi:10.1080/09640560600945331.

R Core Team. 2019. *"R: A Language and Environment for Statistical Computing"*. Vienna, Austria: R Foundation for Statistical Computing.

Ramula, S., and K. Pihlaja. 2012. "Plant Communities and the Reproductive Success of Native Plants after the Invasion of an Ornamental Herb." *Biological Invasions* 14 (10): 2079–2090. doi:10.1007/s10530-012-0215-z.

Rawluk, A., R. Ford, N. Anderson, and K. Williams. 2019. "Exploring Multiple Dimensions of Values and Valuing: A Conceptual Framework for Mapping and Translating Values for Social-Ecological Research and Practice." *Sustainability Science* 14 (5): 1187–1200. doi:10.1007/s11625-018-0639-1.

Reed, M. S., A. Graves, N. Dandy, H. Posthumus, K. Hubacek, J. Morris, C. Prell, C. H. Quinn, and L. C. Stringer. 2009. "Who's in and Why? A Typology of Stakeholder Analysis Methods for Natural Resource Management." *Journal of Environmental Management* 90 (5): 1933–1949. doi:10.1016/j.jenvman.2009.01.001.

Revelle, W. 2019. *Psych: Procedures for Personality and Psychological Research*. Evanston, IL: Northwestern University. https://CRAN.R-project.org/package=psych Version. = 1–912.

Rydgren, K., N. Jørn-Frode, A. Ingvild, A. Inger, and H. Einar. 2010. "Recreating Semi-Natural Grasslands: A Comparison of Four Methods." *Ecological Engineering* 36 (12): 1672–1679. doi:10.1016/j.ecoleng.2010.07.005.

Schaffers, A. P., M. C. Vesseur, and K. V. Sýkora. 1998. "Effects of Delayed Hay Removal on the Nutrient Balance of Roadside Plant Communities." *Journal of Applied Ecology* 35 (3): 349–364. doi:10.1046/j.1365-2664.1998.00316.x.

Schultz, P. W. 2011. "Conservation Means Behavior." *Conservation Biology: The Journal of the Society for Conservation Biology* 25 (6): 1080–1083. doi:10.1111/j.1523-1739.2011.01766.x.

Seymour, E., A. Curtis, D. Pannell, C. Allan, and A. Roberts. 2010. "Understanding the Role of Assigned Values in Natural Resource Management." *Australasian Journal of Environmental Management* 17 (3): 142–153. doi:10.1080/14486563.2010.9725261.

Skórka, P., M. Lenda, D. Moroń, K. Kalarus, and P. Tryjanowski. 2013. "Factors Affecting Road Mortality and the Suitability of Road Verges for Butterflies." *Biological Conservation* 159: 148–157. doi:10.1016/j.biocon.2012.12.028.

Southon, G. E., A. Jorgensen, N. Dunnett, H. Hoyle, and K. L. Evans. 2017. "Biodiverse Perennial Meadows Have Aesthetic Value and Increase Residents' Perception of Site Quality in Urban Green-Space." *Landscape and Urban Planning* 158: 105–118. doi:10.1016/j.landurbplan.2016.08.003.

Steg, L., and C. Vlek. 2009. "Encouraging Pro-Environmental Behaviour: An Integrative Review and Research Agenda." *Journal of Environmental Psychology* 29 (3): 309–317. doi:10.1016/j.jenvp.2008.10.004.

Sutherland, W. J., A. S. Pullin, P. M. Dolman, and T. M. Knight. 2004. "The Need for Evidence-Based Conservation." *Trends in Ecology & Evolution* 19 (6): 305–308. doi:10.1016/j.tree.2004.03.018.

Sýkora, K. V,. J. M. Kalwij, and P. J. Keizer. 2002. "Phytosociological and Floristic Evaluation of a 15-Year Ecological Management of Roadside Verges in The Netherlands." *Preslia* 74: 421–436.

Säumel, I., F. Weber, and I. Kowarik. 2016. "Toward Livable and Healthy Urban Streets: Roadside Vegetation Provides Ecosystem Services Where People Live and Move." *Environmental Science & Policy* 62: 24–33. doi:10.1016/j.envsci.2015.11.012.

Taber, K. S. 2018. "The Use of Cronbach's Alpha When Developing and Reporting Research Instruments in Science Education." *Research in Science Education* 48 (6): 1273–1296. doi:10.1007/s11165-016-9602-2.

Tikka, P. M., P. S. Koski, R. A. Kivelä, and M. T. Kuitunen. 2000. "Can Grassland Plant Communities Be Preserved on Road and Railway Verges?" *Applied Vegetation Science* 3 (1): 25–32. doi:10.2307/1478915.

Tyrväinen, L., K. Mäkinen, and J. Schipperijn. 2007. "Tools for Mapping Social Values of Urban Woodlands and Other Green Areas." *Landscape and Urban Planning* 79 (1): 5–19. doi:10.1016/j.landurbplan.2006.03.003.

Vainio, M., H. Kekäläinen, A. Alanen, and J. Pykälä. 2001. "Traditional Rural Biotopes in Finland: Final Report of the Nationwide Inventory." *The Finnish Environment* 527: 1–163.

Valtonen, A., J. Jantunen, and K. Saarinen. 2006. "Flora and Lepidoptera Fauna Adversely Affected by Invasive *Lupinus Polyphyllus* along Road Verges." *Biological Conservation* 133 (3): 389–396. doi:10.1016/j.biocon.2006.06.015.

Valtonen, A., K. Saarinen, and J. Jantunen. 2006. "Effect of Different Mowing Regimes on Butterflies and Diurnal Moths on Road Verges." *Animal Biodiversity and Conservation* 29: 133–148.

Verhoeven, K. J. F., K. L. Simonsen, and L. M. McIntyre. 2005. "Implementing False Discovery Rate Control: Increasing Your Power." *Oikos* 108 (3): 643–647. doi:10.1111/j.0030-1299.2005.13727.x.

Voinov, A., O. Arodudu, I. van Duren, J. Morales, and L. Qin. 2015. "Estimating the Potential of Roadside Vegetation for Bioenergy Production." *Journal of Cleaner Production* 102: 213–225. doi:10.1016/j.jclepro.2015.04.034.

Walker, K. J., P. A. Stevens, D. P. Stevens, J. O. Mountford, S. J. Manchester, and R. F. Pywell. 2004. "The Restoration and Re-Creation of Species-Rich Lowland Grassland on Land Formerly Managed for Intensive Agriculture in the UK." *Biological Conservation* 119 (1): 1–18. doi:10.1016/j.biocon.2003.10.020.

Weber, F., I. Kowarik, and I. Säumel. 2014. "A Walk on the Wild Side: Perceptions of Roadside Vegetation Beyond Trees." *Urban Forestry & Urban Greening* 13 (2): 205–212. doi:10.1016/j.ufug.2013.10.010.

Zheng, B., Y. Zhang, and J. Chen. 2011. "Preference to Home Landscape: Wildness or Neatness?" *Landscape and Urban Planning* 99 (1): 1–8. doi:10.1016/j.landurbplan.2010.08.006.