



OPEN ACCESS

EDITED BY
Meri Raggi,
University of Bologna, Italy

REVIEWED BY
Zoe Angela Meletis,
University of Northern British Columbia
Canada, Canada
Mahsa Adib,
Michigan State University, United States

*CORRESPONDENCE
Laura A. Warner
✉ lsanagorski@ufl.edu

RECEIVED 26 August 2025
REVISED 29 October 2025
ACCEPTED 04 November 2025
PUBLISHED 26 November 2025

CITATION
Warner LA, Gusto C, Pasula S, Daniels J,
Mattox A, Honeycutt S, Telg R and Lindsey A
(2025) Disentangling public perceptions to
pave the way for pollinator-friendly roadsides.
Front. Conserv. Sci. 6:1693314.
doi: 10.3389/fcsc.2025.1693314

COPYRIGHT
© 2025 Warner, Gusto, Pasula, Daniels, Mattox,
Honeycutt, Telg and Lindsey. This is an open-
access article distributed under the terms of
the [Creative Commons Attribution License
\(CC BY\)](https://creativecommons.org/licenses/by/4.0/). The use, distribution or reproduction
in other forums is permitted, provided the
original author(s) and the copyright owner(s)
are credited and that the original publication
in this journal is cited, in accordance with
accepted academic practice. No use,
distribution or reproduction is permitted
which does not comply with these terms.

Disentangling public perceptions to pave the way for pollinator-friendly roadsides

Laura A. Warner^{1,2*}, Cody Gusto¹, Sravani Pasula¹,
Jaret Daniels^{3,4}, Anissa Mattox⁵, Sydney Honeycutt⁵,
Ricky Telg^{1,5} and Angie Lindsey^{5,6}

¹Department of Agricultural Education and Communication, University of Florida, Gainesville, FL, United States, ²Center for Land Use Efficiency, University of Florida, Gainesville, FL, United States, ³McGuire Center for Lepidoptera and Biodiversity, Florida Museum of Natural History, University of Florida, Gainesville, FL, United States, ⁴Department of Entomology and Nematology, University of Florida, Gainesville, FL, United States, ⁵UF/IFAS Center for Public Issues Education in Agriculture and Natural Resources, Gainesville, FL, United States, ⁶Department of Family, Youth, and Community Sciences, University of Florida, Gainesville, FL, United States

Introduction: Rapid urbanization and land use changes have resulted in extensive road coverage, making roadsides increasingly important as critical landscapes that can support biodiversity. Pollinator-friendly roadsides offer ecological benefits, but public support is essential for their successful implementation. Despite this, adequate audience analyses to inform impactful public initiatives benefiting pollinators have not been conducted. This research study aimed to document public knowledge, perceptions, concerns, and information-seeking preferences regarding pollinator-friendly roadsides to guide future communication campaigns.

Methods: We conducted an initial, descriptive audience analysis using quota sampling to survey 1,011 Floridians. The survey measured four key areas: (1) knowledge, (2) perceptions, (3) concerns, and (4) preferred communication channels related to pollinator-friendly roadsides. Descriptive statistics were used to quantify the findings.

Results: Respondents demonstrated relatively high perceived and actual knowledge of pollinator-friendly roadsides. Perceptions varied, with both positive and negative views of pollinator-friendly roadsides expressed. Ecological and environmental benefits were ranked as the most important characteristics, while safety concerns and increased expenses emerged as the most significant barriers. Preferred communication strategies included immersive experiences such as demonstration gardens at rest stops and road signage. Social media, particularly YouTube, was identified as the favored digital platform for learning about pollinator-friendly roadsides.

Discussion: Findings suggest that educational communications should emphasize ecological benefits while addressing safety and cost concerns and correcting misperceptions. Immersive roadside experiences combined with digital content can enhance public engagement. Future research should include message testing and apply behavioral theory to identify strategies for increasing public support for pollinator-friendly roadsides. Significant opportunities remain to conduct message testing and behavioral theory-based research to uncover ways to increase public support for pollinator-friendly roadsides.

KEYWORDS

pollinator-friendly roadsides, urban biodiversity, public perceptions, audience analysis, conservation communication, environmental attitudes, roadside habitat management, information-seeking preferences

1 Introduction

Roads, the planet's "largest human artifact" (Forman et al., 2003, p. xiii), impact 20% of United States (U.S.) land area (Brady and Richardson, 2017) with public roads totaling nearly 6.8 million km (4.2 million miles) in 2022 (United States Department of Transportation, 2022). Urbanization has resulted in substantial land use changes, including road expansion, with negative impacts on pollinators through direct mortality, barriers to movement, habitat loss and fragmentation, and introduction of pollutants (Coffin, 2007; Dietzel et al., 2024; Glista et al., 2009; Grilo et al., 2021; Liang et al., 2023; Van Der Ree et al., 2011). Given their scope and scale, roads are increasingly recognized by researchers, conservation advocacy organizations, landowner audiences, and state Departments of Transportation (DOTs) engaged in efforts to restore pollinator populations and habitat (Braman and Griffin, 2022; Cariveau et al., 2019; Cass et al., 2022).

Amidst continued global pollinator decline, growing evidence suggests "pollinator-friendly roadsides" can be managed in urban and peri-urban areas to support pollinators by linking otherwise fragmented habitats and providing the ecological resources various species need (Hopwood et al., 2015a; Janousek et al., 2023; Wenzel et al., 2020). The restoration of native herbaceous flowering plants and other types of habitat-providing vegetation in roadsides increases pollen, nectar sources, and potential nesting sites for pollinators which increases the abundance and richness of many pollinator species (e.g., bees) when compared to roadsides dominated by low diversity vegetation (Hopwood, 2008; Majewska and Altizer, 2019; Senapathi et al., 2021).

Despite the benefits, various groups, including U.S. drivers, may lack buy-in for pollinator-friendly roadside management practices (Hopwood et al., 2015a). This study, therefore, was conducted to document public perceptions about pollinator-friendly roadsides and identify ways to increase support for this type of management. Below, we briefly introduce emergent literature on public perceptions of pollinator-friendly roadside management practices, along with related public campaigns.

Challenges to implementing pollinator-friendly roadside practices include difficulties with sourcing native plant material, adjacent landowners' concerns about potential property damage, limited resources, perceived safety risks related to fire or vehicular collisions with wildlife, and potential negative public reactions (Hopwood et al., 2016; Lucey and Barton, 2011a; Nemec et al., 2021, 2022; Van Dyke et al., 2021; Wu et al., 2024). Public perceptions also play a significant role in the success or failure of pollinator-friendly roadside programs (Hopwood et al., 2016): state DOTs have either scaled back alternative roadside management methods or fully reverted to traditional management regimens after receiving public complaints (Lucey and Barton, 2011a; Nemec et al., 2022), which underscores the importance of public buy-in for these initiatives to succeed. Therefore, an increased understanding of the public's awareness, knowledge, and perceptions of pollinator-friendly roadsides is vital.

Lack of knowledge is often blamed for the public complaints state DOTs receive due to pollinator-friendly roadside

enhancements or practices (Lucey and Barton, 2011a; 2011b). Both Ligtermoet et al. (2022) and Warner et al. (2025b) reported low knowledge pertaining to roadside vegetation and pollinator-friendly roadsides, respectively. Generally, public knowledge assessments of sustainable roadside management practices are sparse, but there are reported links between the public's knowledge of specific elements (e.g., roadside trees) and ecological management and the degree to which they hold favorable or unfavorable attitudes towards these practices and elements (DiFalco et al., 2022; Hale, 2019; Lucey and Barton, 2011a; 2011b). Public awareness and knowledge of the ecological and economic value of supporting pollinators have increased variably by topic and audience. For example, U.S. consumers had low awareness of neonicotinoid insecticides (a class of insecticide known for its adverse effects on pollinators) and their impact(s) on pollinators (Rihn and Khachatryan, 2016) and retail consumers widely selected desired plant traits in accordance with existing knowledge across topics (e.g., environmental stewardship) (Khachatryan and Rihn, 2018).

General public perceptions of roadside beautification practices have revealed strong preferences for formal and manicured landscapes (Nassauer, 1995; Wu et al., 2024), along with conflicting opinions over less formal plantings which may be perceived as unkempt (Weber et al., 2014). Akbar et al. (2003); Lucey and Barton (2011b), and Manoosingh et al. (2020) all reported diverse and mixed vegetation were desirable. Public criticism of pollinator-friendly roadsides often arises in fall and winter when native plants appear dormant or unhealthy. However, understanding sustainable roadside management and community differences significantly affects whether these attitudes are supportive (DiFalco and Morzillo, 2021; 2022). Strong public support has been reported for management practices that can replace traditional regimens with greater species diversity and positive environmental functions (e.g., water conservation) (Lucey et al., 2010; Manoosingh et al., 2020). These and related findings suggest positively supportive attitudes towards pollinator-friendly or sustainably managed roadsides that provide ecological and environmental benefits.

Regarding economic implications, Manoosingh et al. (2020) and Lucey et al. (2010) both documented preferences for cost-effective strategies that involved less mowing and fewer resources in contrast to traditional roadside management regimens, which were seen as fiscally wasteful. However, Lucey et al. (2010) also reported people would support their state DOT's increased spending on sustainable landscape enhancements to allow for more environmentally conscious roadsides and rights-of-way.

Public campaigns are essential for increasing the prominence of pollinator-friendly roadsides and guiding informed decision-making (Coffman, 2002; Latinopoulos et al., 2018; Reynolds et al., 2020) especially since only one in ten people actively support these initiatives (Warner et al., 2025a). Promising approaches to raise public awareness and bolster support of pollinator-friendly roadsides include: establishing and/or publicizing demonstration pollinator gardens at welcome centers and rest stops; events (e.g., wildflower photo contests); providing access to decision-making

processes; and volunteer/partnership opportunities (e.g., highway sponsorship) (Hopwood, 2023; Hopwood et al., 2016; Kuder, 2019). Roadside or welcome center signage highlighting the importance of pollinator health, the risk of endangered species loss (e.g., the Monarch Migration Trail), or “habitat(s) in progress” have also shown potential (Hopwood, 2023). Recommendations also include visually appealing graphics illustrating pollinator life cycles or wildflower foliage cycles integrated into signage and other materials (Hopwood, 2023). Finally, recommendations have included media-based public service announcements and promotional items (Hopwood et al., 2016; Warner et al., 2025a). Despite the potential value of the above strategies, the efficacy of these methods has not been evaluated, which underscores the need for such research. One exception is a recent study from Warner et al. (2025a), who found social media-style messaging improved Floridians’ attitudes towards supporting pollinator-friendly roadsides.

Campaigns designed to garner public support will be most successful when informed by thoughtful audience analysis to improve the communication of scientific information through messages that are tailored to specific audiences (Ross, 2013; Sanders et al., 2023; Slater, 1996). Therefore, this research was designed as an audience analysis activity to inform future communication campaigns that increase public support for pollinator-friendly roadside management practices. The specific objectives that guided this work were to: 1) Evaluate existing knowledge pertaining to pollinator-friendly roadsides; 2) Assess perceptions associated with pollinator-friendly roadsides; 3) Quantify concerns pertaining to pollinator-friendly roadsides; and 4) Identify information-seeking preferences regarding pollinator-friendly roadsides.

2 Conceptual framework

Audience analysis, the conceptual framework that guided this study, emphasizes understanding the characteristics, knowledge, attitudes, and preferences of a target population to design tailored communication strategies. It provides a systematic approach for predicting audience responses, integrating their needs, and shaping messages that effectively influence behaviors and support desired outcomes (Ali and Narine, 2023; Guan et al., 2022). Researchers agree that strategic promotional campaigns aligned with public interests are critical for pollinator-friendly practices to achieve their objectives. Tailoring messages for specific audiences is essential in communication strategies, but this is only possible once adequate audience analysis has been conducted. Relevant and timely information delivered via preferred modalities plays a vital role in meeting people’s needs and gives them opportunities to adopt novel ideas and behaviors (Kopiyawattage et al., 2018), such as supporting pollinator-friendly roadsides. In the context of pro-environmental behaviors, information gathering and processing may spark action, with people changing their routines and exerting pressure on decision-makers to adopt practices (e.g., managing roadsides for pollinators) (Guan et al., 2022).

The specific audience and context may affect individuals’ information-seeking preferences. For example, in 2016 researchers reported that television was the most commonly used sources of news information among Americans while personal experience was their preferred way of learning about nature (Mitchell et al., 2016; Wilkins et al., 2018). While Owens et al. (2015); Kopiyawattage et al. (2018), and Wilkins et al. (2018) reported live educational events were among the least favored modalities for learning, preferred modalities differ greatly by audience and topic. Icelanders preferred social media for obtaining and disseminating information about health and lifestyle (Pálsdóttir, 2014), while in-ground irrigation users preferred websites for learning about water (Owens et al., 2015) and Ohio urban food producers sought information from the internet (Kopiyawattage et al., 2018). Given the diversity in information-seeking preferences among various audiences and topics, it is critical to conduct audience- and context- specific research before developing a campaign. Messages should incorporate audience information-seeking preferences while addressing their concerns and perceptions and aligning with their current level of knowledge (see Figure 1).

3 Methods

3.1 Study context

Florida, the third most populous state in the U.S. and focus of this study, had 21.5 million people in 2021 (United States Census Bureau, 2021) and is projected to reach 33 million by 2070 (Carr and Zwick, 2016). Urbanization, in this biodiverse state (Stys et al., 2017), has converted large areas of natural lands to other purposes, and by 2070, Florida is projected to house 33 million residents (Carr and Zwick, 2016), making pollination services essential for agriculture, with pollinators contributing over \$50 million per crop annually to the state’s seven most valuable crops (Mallinger et al., 2021). Florida’s 200,000 km (124,000 miles) of public roadways carry 1 billion km (623 million miles) of daily travel (Florida Department of Transportation, 2022). Although no statewide pollinator-friendly roadsides initiative exists, the Florida Wildflower Program, authorized by the Florida Statutes [Sections 20.23(3)(a) and 334.048(3)], prescribes “management practices that sustain planted wildflowers as well as naturally occurring native flora and native plant communities” (Florida Wildflower Foundation, 2024, para. 1) such as reduced mowing of roadways.

3.2 Sampling procedures

This introductory quantitative study was conducted as a preliminary investigation of this topic. The survey was distributed online through Qualtrics, a professional survey consultant company, from December 6, 2023, through January 8, 2024. We used non-probability sampling as random sampling was not feasible (Baker et al., 2013). We employed quota sampling to recruit a pool of respondents that matched state demographics for gender, age,

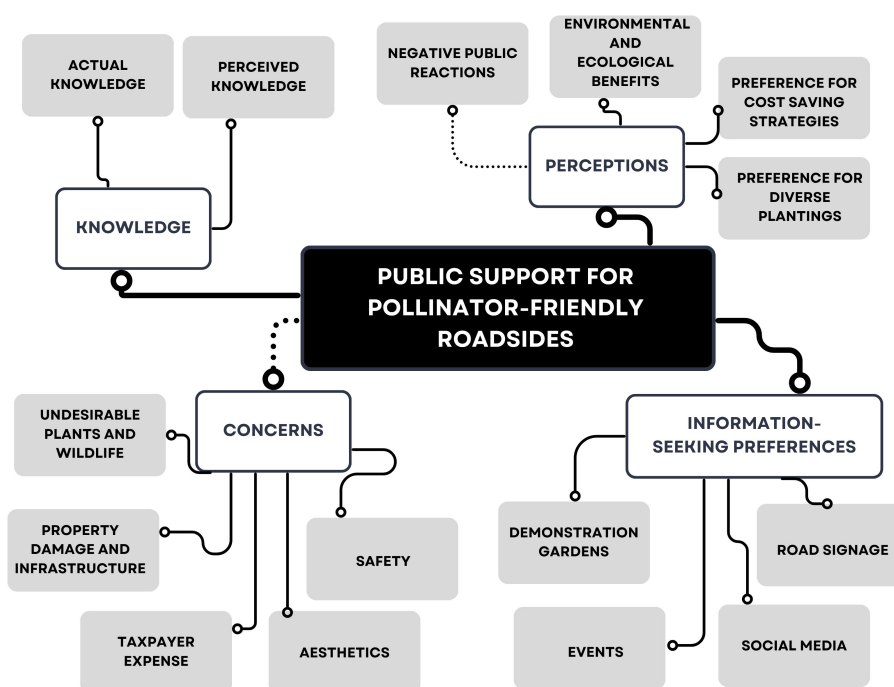


FIGURE 1

Conceptual framework integrating the influence of knowledge, perceptions, concerns, and preferences on public support of pollinator-friendly roadsides.

ethnicity, and race according to the 2020 U.S. Census (Baker et al., 2013; Lamm and Lamm, 2019). Our target sample size was 1,000 respondents (18 years and older), and email invitations were distributed to 1,643 potential survey participants who participate on the company's panels. The four quotas were programmed in the survey flow and quota-specific demographic information was collected at the beginning of the survey. If an individual opted into the survey but did not match with any unfilled quotas, they were exited from the study. The final sample size was 1,011, giving the study a 61.5% response rate. [University] Institutional Review Board approval (protocol # ET00020637) was secured before data collection began, and the instrument was reviewed by a panel of experts for face and content validity. Respondents were provided with the approved consent information and proceeded with the survey only if they agreed with the information.

3.3 Participant characteristics

Approximately half of respondents were female (see Table 1). Three-quarters reported being white and just over one-quarter identified as Hispanic. The most common household income category was \$25,000–49,999 and high school was the most common education level. Approximately half of respondents reported they lived in an urban or suburban area outside city limits. It was most common for respondents to report driving less than 322 km (200 miles) weekly and about half of respondents' driving was categorized as urban and/or city driving.

3.4 Instrumentation, measures, and interpretation

We used a researcher developed instrument (see Supplementary Table A1 in Supplementary Material) to address the study's objectives. Sections of the survey included perceived knowledge, actual knowledge, concerns related to pollinator-friendly roadsides, information-seeking preferences, and message testing.

3.4.1 Perceived knowledge

This measure was a five-point Likert scale with six individual items (Cronbach's $\alpha = .901$). Two of these collected awareness (e.g., *I am aware of the ecological benefits of pollinator-friendly roadsides*) and four collected knowledge (e.g., *I am knowledgeable of the patterns of migratory pollinators that can inhabit roadsides*). Response options ranged from *strongly disagree* to *strongly agree* and were coded from 1 to 5. Following recommendations from Lindner and Lindner (2024), the interpretation of the means was: *strongly disagree* (1.00 – 1.50), *somewhat disagree* (1.51 – 2.50), *neither agree nor disagree* (2.51 – 3.50), *somewhat agree* (3.51 – 4.50), and *strongly agree* (4.51 – 5.00).

3.4.2 Actual knowledge

Actual knowledge was collected using five true or false questions (e.g., *Roadside vegetation management influences how insect pollinators use roadsides*) where the correct response for all was *true*. A sum of correct responses was created by assigning a point to

TABLE 1 Respondent characteristics in an examination of Florida drivers' perceptions of pollinator-friendly roadsides (n = 1,011).

Characteristic	n	%
Gender ^a		
Male	489	48.4
Female	515	50.9
Other	7	0.7
Age ^a		
18-24	151	14.9
25-34	203	20.1
35-44	192	19.0
45-54	203	20.1
55-64	170	16.8
65+	92	9.1
Ethnicity ^a		
Hispanic/Latino/Chicano	271	26.8
Not Hispanic/Latino/Chicano	740	73.2
Race ^{ab}		
American Indian or Alaska Native	33	3.3
Asian or Pacific Islander	37	3.7
Black or African American	169	16.7
White	745	73.7
Other	72	7.1
Florida residency		
Full time Florida resident	934	92.4
Part-time Florida resident (more than half the year)	48	4.7
Part-time Florida resident (less than half the year)	29	2.9
Gross household income past 12 months		
Less than \$25,000	188	18.6
25,000-49,999	303	30.0
50,000-74,999	230	22.7
75,000-99,999	105	10.4
100,000-149,999	96	9.5
150,000 or more	46	4.5
Prefer not to say	43	4.3
Education		
High school graduate	273	27.0
Some college, no degree	231	22.8
4-year college degree	206	20.4

(Continued)

TABLE 1 Continued

Characteristic	n	%
Education		
2-year college degree	149	14.7
Graduate or professional degree	106	10.5
Less than 12th grade	46	4.5
Residency		
Urban or suburban area outside city limits	504	49.9
Subdivision in a town or city	265	26.2
Rural area, not a farm	116	11.5
Downtown area in a city or town	96	9.5
A farm in a rural area	30	3.0
Occupation		
Retired	254	25.1
Other services (except public administration)	210	20.8
Retail trade	93	9.2
Educational services, and health care and social assistance	82	8.1
Information	57	5.6
Arts, entertainment, and recreation, and accommodation and food services	53	5.2
Manufacturing	52	5.1
Finance and insurance, and real estate and rental and leasing	45	4.5
Professional, scientific, and management, and administrative and waste management services	45	4.5
Agriculture, forestry, fishing and hunting, and wildlife construction	43	4.3
Transportation and warehousing and utilities	36	3.6
Public admin	23	2.3
Wholesale trade	18	1.8
Average miles driven in Florida weekly		
Less than 322 km (200 miles)	669	66.2
Between 322 km and 483 km) (200 and 300 miles)	273	27.0

(Continued)

TABLE 1 Continued

Characteristic	<i>n</i>	%
Average miles driven in Florida weekly		
More than 483 km (300 miles)	69	6.0
Driving habits^c		
Urban and/or city driving	–	52.84 (<i>SD</i> = 27.405)
Interstate and/or major state highway driving	–	27.04 (<i>SD</i> = 20.261)
Rural driving	–	20.12 (<i>SD</i> = 23.657)
Political beliefs		
Moderate	476	47.1
Conservative	188	18.6
Liberal	147	14.5
Very conservative	109	10.8
Very liberal	91	9.0

N = 1011.

^adenotes items used in quota specification.

^btotal exceeds 100% because respondents could select all that applied for this variable.

^ccumulative percentage.

each correct response and adding these points, so an individual could score up to five points.

3.4.3 Perceptions

To assess importance, respondents were instructed to indicate how important each of ten items (e.g., *aesthetics*) were to them (Cronbach's $\alpha = .910$). Response options ranged from *not at all important* to *extremely important* and were coded from 1 to 5. The means for these responses were interpreted as follows: *not at all important* (1.00 – 1.50), *slightly important* (1.51 – 2.50), *moderately important* (2.51 – 3.50), *very important* (3.51 – 4.50), and *extremely important* (4.51 – 5.00) (Lindner and Lindner, 2024).

3.4.4 Concerns

From a list of eight concerns, we asked respondents to indicate whether they were concerned, with two possible responses: *yes* and *no*. Any item to which a respondent indicated they were concerned was followed with a nested question that asked how concerned they were about that item. Response options ranged from *only slightly concerned* to *extremely concerned* and were coded from 1 to 5.

3.4.5 Information-seeking preferences

To gather information-seeking preferences, respondents were asked to indicate the effectiveness they associated with ten different modalities through which they could receive information about pollinator-friendly roadsides (Cronbach's $\alpha = .898$). For the social media item, anyone who indicated social media was *moderately effective*, *very effective*, or *extremely effective* was shown a subsequent question and asked to indicate the perceived effectiveness regarding six specific social media channels

(Cronbach's $\alpha = .841$). Response options ranged from *not at all effective* to *extremely effective* and were coded from 1 to 5. Interpretation of the means was: *not at all effective* (1.00 – 1.50), *somewhat effective* (1.51 – 2.50), *moderately effective* (2.51 – 3.50), *very effective* (3.51 – 4.50), and *extremely effective* (4.51 – 5.00) (Lindner and Lindner, 2024).

3.5 Data cleaning and analysis

Data were imported into SPSS (v. 29.0.1.1), and the file was cleaned to remove any incomplete or spam (e.g., computer generated or fake) responses. Responses were coded as complete only if the participant responded to all items; incomplete responses were not included and the final sample size was 1,011. Following this, reliabilities for the scales were run using Cronbach's α , and all were above .70 as detailed above, which indicates strong reliability and internal consistency (Cronbach, 1951).

Descriptive statistics were used to fulfill the research objectives and were conducted within SPSS. Perceived knowledge, importance of pollinator-friendly roadsides characteristics, level of concern, perceptions, information-seeking preferences, and social media preferences were all either Likert or semantic differential five-point scales and were thus ordinal data. These data were summarized by calculating means and standard deviations. Quartiles (i.e., 25th, 50th, and 75th percentiles) were calculated to demonstrate the distribution of the data. Actual knowledge (true/false) and presence of concern (yes/no) were bimodal, nominal data and were summarized by calculating the number and percentage of respondents indicating true or yes, respectively. A perceived knowledge mean was quantified by calculating the mean and standard deviation of the six perceived knowledge items and an actual knowledge sum was calculated by adding all true responses.

4 Results

4.1 Objective 1. evaluate existing knowledge pertaining to pollinator-friendly roadsides

The perceived knowledge grand mean was 3.07 (*SD* = 1.046) which corresponds to *neither agree nor disagree* with the items, on average. Means for individual items (see Table 2) fell within this range and revealed higher awareness of ecological and socio-economic benefits of pollinator-friendly roadsides. The lowest knowledge was reported for how roadside management decisions are made pertaining to staffing and funding.

Actual knowledge responses revealed respondents were fairly knowledgeable (see Table 3). Sums of correct answers ranged from 0 (no answers or missing all data) to 5, and 53.0% of respondents (*n* = 536) achieved a perfect score while 28.3% (*n* = 286) achieved four out of five responses correct. A smaller proportion of respondents scored three (13.6%, *n* = 138), two (4.0%, *n* = 40), one (0.7%, *n* = 7), and zero (0.4%, *n* = 4) correct, respectively. On the individual items,

TABLE 2 Perceived knowledge reported by respondents in an examination of Florida drivers' perceptions of pollinator-friendly roadsides ($n = 1,011$).

Response item	<i>M</i>	<i>SD</i>	Percentiles		
			25	50	75
I am aware of the ecological benefits of pollinator-friendly roadsides. ^a	3.42	1.28	3.00	4.00	4.00
I am aware of the socio-economic benefits of pollinator-friendly roadsides. ^a	3.29	1.27	2.00	3.00	4.00
I am knowledgeable of the patterns of migratory pollinators that can inhabit roadsides. ^b	3.06	1.28	2.00	3.00	4.00
I am knowledgeable of how roadside management decisions are made, in regards to driver/passenger safety. ^b	3.00	1.32	2.00	3.00	4.00
I am knowledgeable of how roadside management decisions are made, in regards to funding. ^b	2.86	1.28	2.00	3.00	4.00
I am knowledgeable of how roadside management decisions are made, in regards to staffing. ^b	2.76	1.28	2.00	3.00	4.00
Overall mean ^c	3.07	1.05	2.33	3.00	3.83

The most common response for these items was: ^a*somewhat agree*. ^b*neither agree nor disagree*. ^ccomposite value of all individual items. Responses included: *strongly disagree* (1), *somewhat disagree* (2), *neither agree nor disagree* (3), *somewhat agree* (4), *strongly agree* (5).

respondents were most likely to correctly indicate *true* to “Pollinator-friendly roadsides provide food (e.g. nectar, pollen, and caterpillar host plants) and other resources (nesting habitat, shelter) for insect pollinators.”

4.2 Objective 2. assess perceptions associated with pollinator-friendly roadsides

Eight of the items associated with aspects of pollinator-friendly roadsides fell within the *very important* range, with ecological and environmental benefits ranked as the most important (see Table 4). Two items: location and benefits to my well-being, were designated as moderately important, while aesthetics was the least important.

TABLE 3 Actual knowledge demonstrated by respondents in an examination of Florida drivers' perceptions of pollinator-friendly roadsides ($n = 1,011$).

Knowledge item	Correct responses	
	<i>n</i>	%
Pollinator-friendly roadsides provide food (e.g. nectar, pollen, and caterpillar host plants) and other resources (nesting habitat, shelter) for insect pollinators. ($n = 1010$)	929	91.9
Pollinator-friendly roadsides help increase the diversity and stability of the insect pollinator community. ($n = 1002$)	897	89.5
Pollinator-friendly roadsides can increase the pollination services and natural control of “pest” insects on adjacent landscapes, such as crop fields and wild lands. ($n = 1008$)	874	86.7
Roadside vegetation management influences how insect pollinators use roadsides. ($n = 1007$)	827	82.1
Roadsides with abundant native grasses and wildflowers, managed by judicious mowing and other management tools, provide the best insect pollinator habitat. ($n = 1004$)	798	79.5

Correct response was *true* for all items.

4.3 Objective 3. quantify concerns pertaining to pollinator-friendly roadsides

More than half of respondents were concerned with pollinator-friendly roadsides increasing vehicle collisions with wildlife and affecting taxpayer expenses (see Table 5). The greatest level of concern, on average, was associated with increasing vehicle collisions with wildlife and affecting driver/passenger safety.

4.4 Objective 4. identify information-seeking preferences regarding pollinator-friendly roadsides

The most effective communication method, on average, was demonstration gardens at welcome centers and/or rest stops, with *very effective* status (see Table 6). Among those who indicated social media was *moderately effective*, *very effective*, or *extremely effective*, YouTube and Facebook were the most preferred platforms. YouTube, Facebook, Instagram, and TikTok social media platforms were considered *very effective* while X and Snapchat were deemed *moderately effective*.

5 Discussion

There is a significant lack of information on the public's knowledge and perceptions regarding pollinator-friendly roadsides and roadside management. Without such information, communication campaigns are unlikely to succeed. The lack of existing research also prevents direct comparison of our findings with those of other studies. Returning to the study purpose of informing successful future communication strategies to increase support for pollinator-friendly roadsides, this work sought to evaluate existing knowledge, assess perceptions, quantify concerns, and identify information-seeking preferences pertaining to this topic. While our findings are drawn from respondents in Florida, they may be worthy of consideration on a broader scale.

TABLE 4 Importance of pollinator-friendly roadsides characteristics reported by respondents in an examination of Florida drivers' perceptions of pollinator-friendly roadsides ($n = 1,011$).

Response item	<i>M</i>	<i>SD</i>	Percentiles		
			25	50	75
Ecological benefits (providing habitats for pollinators and wildlife) ^a	3.99	1.06	3.00	4.00	5.00
Environmental benefits (improve air quality, storm water runoff prevention, carbon sequestration) ^a	3.98	1.06	3.00	4.00	5.00
Agricultural benefits (supportive of pollination, pest control) ^a	3.89	1.07	3.00	4.00	5.00
Sustainability (effort required) ^b	3.83	1.05	3.00	4.00	5.00
The extent of native vegetation used ^b	3.74	1.06	3.00	4.00	5.00
Ease of controlling plants used ^b	3.69	1.03	3.00	4.00	4.00
Ease of establishment and maintenance cost ^b	3.63	1.04	3.00	4.00	4.00
Location ^b	3.59	1.09	3.00	4.00	4.00
Benefits to my well-being (stress reduction, rejuvenating) ^b	3.42	1.19	3.00	4.00	4.00
Aesthetics (color, patter/design, combination of plants) ^c	3.10	1.18	3.00	4.00	4.00

Most common responses for these items: ^aextremely important. ^bvery important. ^cmoderately important. Responses included: not at all important (1), slightly important (2), moderately important (3), very important (4), extremely important (5)

Evidenced by objective and subjective measures, our respondents generally have strong knowledge surrounding environmental and ecological aspects of pollinator-friendly roadsides, but less knowledge about related management approaches. In other words, they understand the benefits but see the decision-making leading to this type of roadside management as a mystery. Respondents in the present study report similar levels of perceived knowledge compared to Floridians' knowledge levels reported by Warner et al. (2025a). However, our respondents demonstrated relatively high actual knowledge compared to prior literature that often assumes low public awareness (Lucy and

Barton, 2011a, 2011b), which challenges assumptions about knowledge gaps as the primary barrier. Considering the linkage between knowledge level and public support in similar (Lucy and Barton, 2011a; 2011b) and related (e.g., trees and vegetation management) (DiFalco et al., 2022; Hale, 2019) contexts, the high perceived and actual knowledge we document suggests good likelihood for supportive attitudes towards pollinator-friendly roadsides.

Turning from knowledge to perceptions, respondents indicated the most important characteristics of pollinator-friendly roadsides to them are ecological and environmental, which aligns with Lucy

TABLE 5 Concerns associated with pollinator-friendly roadsides in an examination of Florida drivers' perceptions of pollinator-friendly roadsides ($n = 1,011$).

Response item	<i>n</i> ^a	%	<i>M</i>	<i>SD</i>	Percentiles		
					25	50	75
I am concerned about pollinator-friendly roadsides increasing vehicle collisions with wildlife. ^b	558	55.2	3.92	1.08	3.00	4.00	5.00
I am concerned about pollinator-friendly roadsides affecting taxpayer expenses. ^b	515	50.9	3.76	1.09	3.00	4.00	5.00
I am concerned about pollinator-friendly roadsides bringing undesirable wildlife to roadsides. ^c	490	48.5	3.81	1.04	3.00	4.00	5.00
I am concerned about pollinator-friendly roadsides affecting driver/passenger safety. ^c	466	46.1	3.86	.95	3.00	4.00	5.00
I am concerned about pollinator-friendly roadsides having seasons of overgrowth and unsightly plants along roadsides. ^c	465	46.0	3.65	1.08	3.00	4.00	5.00
I am concerned about pollinator-friendly roadsides growing undesirable plants. ^d	456	45.1	3.63	1.10	3.00	4.00	5.00
I am concerned about pollinator-friendly roadsides increasing damage incidents to property (land, vehicles, etc.) ^c	445	44.0	3.85	.94	3.00	4.00	5.00
I am concerned about pollinator-friendly roadsides impacting above and below ground power lines. ^d	445	44.0	3.78	1.00	3.00	4.00	5.00

Five-point semantic differential anchors were: *only slightly concerned* (1) and *extremely concerned* (5). ^aThe number presented here represents those who indicated they were concerned with this item and were subsequently provided a scale upon which to rate the level of their concern. The most common response for these items was: ^b5, ^c4, ^d3.

TABLE 6 Effectiveness of communication methods associated with pollinator-friendly roadsides reported by respondents in an examination of Florida drivers' perceptions of pollinator-friendly roadsides ($n = 1,011$).

Communication method	<i>M</i>	<i>SD</i>	Percentiles		
			25	50	75
Demonstration gardens at welcome centers and/or rest stops	3.59	1.16	3.00	4.00	5.00
Road signs	3.48	1.10	3.00	4.00	4.00
Social media posts ^a	3.45	1.22	3.00	4.00	4.00
YouTube	3.83	1.11	3.00	4.00	5.00
Facebook	3.70	1.12	3.00	4.00	5.00
Instagram	3.64	1.10	3.00	4.00	5.00
TikTok	3.54	1.30	3.00	4.00	5.00
X (formerly known as Twitter)	3.34	1.29	2.00	3.00	4.00
Snapchat	2.94	1.34	2.00	3.00	4.00
Brochures at welcome centers and/or rest stops	3.33	1.20	3.00	3.00	4.00
Billboards	3.21	1.18	2.00	3.00	4.00
Local county-wide meetings	3.16	1.20	2.00	3.00	4.00
County IFAS Extension agent presentations	3.10	1.22	2.00	3.00	4.00
Mailed flyers	2.98	1.30	2.00	3.00	4.00
Radio announcements	2.97	1.20	2.00	3.00	4.00
E-newsletter	2.95	1.28	2.00	3.00	4.00

^arespondents who indicated social media was *moderately effective*, *very effective*, or *extremely effective* ($n = 793$) were shown the subsequent six-item question regarding specific social media.

et al. (2010) and Manoosingh et al. (2020) who found similar elements as the most important characteristics. It is interesting that aesthetics is the least important element, which aligns with Manoosingh et al. (2020). However, our finding diverges from Wu et al.'s (2024) reported high rating for aesthetics in swales and Ligtermoet et al.'s (2022) reported importance of aesthetics in streetscapes, suggesting the existence of critical context-specific differences among stormwater infrastructure, roadside greening, and pollinator-friendly planting preferences. Our finding suggests drivers may be willing to tolerate less aesthetically pleasing or off-season appearances as a tradeoff for the characteristics they find most important. This finding may also be influenced by Florida's year-round growing season, which minimizes the visual disruption typically caused by dormant periods. Unlike regions with harsher winters, much of Florida maintains a consistently verdant landscape, reducing the likelihood of stark or unsightly seasonal transitions and preserving aesthetic continuity throughout the year.

In terms of their concerns, respondents in the present study indicated they were concerned about pollinator-friendly roadsides increasing the likelihood of vehicle collisions with wildlife, like other research (Nemec et al., 2022, 2021; Van Dyke et al., 2021), and were more concerned about this than any other possible issue. This convergence suggests that perceived safety risks are a reoccurring barrier across audiences. Perhaps due to perceived threats of collision, respondents were nearly as concerned about driver/passenger safety and undesirable wildlife being attracted to roadsides.

While previous studies (Lucey et al., 2010; Manoosingh et al., 2020) found traditional maintenance practices were not seen as being cost effective, respondents in the present study as well as in Ligtermoet et al. (2022) diverged by being highly concerned about potential taxpayer expenses associated with roadside plantings rather than viewing them as cost-saving measures. This finding could be explained by a lack of accessible cost data. It is also possible that Floridians, accustomed to year-round vegetation growth, perceive continuous roadside maintenance as a standard necessity without distinguishing between conventional single-species management practices that demand frequent mowing and more ecologically strategic, pollinator-friendly approaches.

In sharing their information-seeking preferences, respondents indicated an interest in educational communication playing a role in the travel experience, with the most effective communication method being demonstration gardens along roadways (e.g., at a rest stop or welcome center), although brochures in these locations were seen as less effective. The preference for demonstration gardens could relate to their integration of experiential learning opportunities and their linkage between humans and nature (Gomez and Derr, 2021). Others have reported interpretive and hands-on programs being effective for pollinator education in general (Bueddefeld et al., 2022; Griffin and Braman, 2021). Although other modalities are potentially interactive (e.g., educational presentations), demonstration gardens comprised the only modality linking people directly to nature. Road signs were the

second most effective communication method, but billboards were seen as being less effective, implying “micro” educational snippets along the journey could be used to connect drivers and passengers to the landscape. Social media also received high ratings, with YouTube being the most preferred channel. As a video-based social media channel, the preference for YouTube suggests immersive video content being a promising option. Considered together, our respondents’ interests in demonstration gardens and YouTube suggests a novel approach to experiential learning in roadside conservation, which suggest technology and physical spaces can jointly foster pro-environmental behaviors.

5.1 Recommendations

Given the value of integrating audience analysis results into communications, individuals tasked with promoting pollinator-friendly roadsides to garner public support, such as Department of Transportation decision-makers, extension educators, and environmental communication professionals, should consider application of the information shared here. Informed by these findings, public communications should highlight the elements drivers value (e.g., environmental and ecological contributions of pollinator-friendly roadsides).

In addition to highlighting valued elements, we also recommend public communications address existing concerns (e.g., perceived safety issues and cost implications). Research has demonstrated a lack of relationship between this type of roadside management approach (e.g., reduced mowing) and wildlife vehicular collisions (e.g., with deer) (Florida Wildflower Foundation, 2024; Hopwood et al., 2015a). There is also documentation that this type of management is linked to cost savings (Hopwood et al., 2015a; 2015b) and highway beautification in general can provide substantial economic benefit including jobs (Khachatryan et al., 2014). This dissonance likely exists due to limited public knowledge about these spaces (Lucey and Barton, 2011a; 2011b), which leads to unfamiliarity. Without clear messaging about ecological benefits, cost savings, and safety data, it is likely the public fills gaps with speculation. These discrepancies between perceived and actual relationships between pollinator-friendly roadsides, wildlife vehicle collisions, and costs demonstrate a dissonance between driver concerns and real threats, presenting an opportunity to correct misperceptions.

With the appropriate messaging content identified in terms of important elements and concerns, drivers’ preferences for content delivery should be incorporated into the preferred modalities. We recommend the development of communications close to the location and timing of pollinator-friendly roadside implementation and/or maintenance projects, with micro signage used in the immediate path of the journey and demonstration gardens with interpretive signage along the route. Using these communications to inform drivers of the type of plants they have seen along with their associated benefits, and inserting additional education, may be valuable. Videos that replicate the drive through exposure to pollinator-friendly roadsides should be considered as a “digital twin” to these recommended experience-focused communications. Our recommendations for immersive

education may be especially effective when considered together with Wu et al.’s (2024) report that actual exposure to biodiverse swales reduced people’s previous concerns with them.

While this research was conducted to inform communication strategies, the findings do also offer implications for policy and implementation. We recommend policies be developed to offer public-facing information of safety and costs associated with pollinator-friendly roadsides to demonstrate these practices do not increase wildlife collisions and can reduce maintenance costs. Cost-benefit analyses should be developed along with new transportation projects. We echo Ligtermoet et al.’s (2022) call for stakeholder engagement and suggest the development of participatory frameworks, such as pollinator-friendly roadside sponsorship programs, to involve community on a deeper level.

5.2 Limitations and potential for future research

Limitations of this research are consistent with that of other purposive online survey studies. First, the online survey format limited participation to individuals with access to a computer or similar device as well as internet, resulting in possible coverage error (Baker et al., 2010), especially in rural areas where internet access may be less available. Generalizability is limited by the use of purposive rather than probability sampling; however, our alignment with a quota sample mirroring the population reduced this limitation (Lamm and Lamm, 2019). The use of self-reported measures rather than observation is also a limitation, but the anonymity and non-personal nature of the topic reduced the possibility that respondents were swayed to respond in a specific manner (Larson, 2019). Finally, the geographic scope of our research was limited to Florida, and the findings may be region-specific due to several contextual factors including the state’s year-round growing season, absence of a state income tax, and competing economic priorities such as hurricane recovery and infrastructure resilience.

To build on this initial audience analysis activity, future research should integrate behavioral theory to further disentangle drivers of support for pollinator-friendly roadsides (Balmford et al., 2021). Future research should develop more nuanced measures of knowledge. To build on this descriptive study, future research could integrate more complex multivariate analyses, identify predictive relationships, and compare results among various subgroups that comprise the population of Florida drivers. Message testing research should be conducted, and it would be advantageous to explore driver responses to message frames that emphasize the important elements of pollinator-friendly roadsides while addressing the concerns documented here.

6 Conclusions

This research offers a timely and nuanced understanding of public perceptions and preferences surrounding pollinator-friendly roadsides. The findings reveal clear support for biodiversity-focused management approaches in contrast to intensively mown, turfgrass dominated

roadsides, which seems to be rooted in broader environmental values. These values may be further activated by immersive communications, especially if concerns over perceived safety issues and expenses are thoughtfully addressed. Ultimately, this work provides actionable insights for future educational campaigns aimed at cultivating public support of pollinator-friendly roadsides, especially in the context of rapid urbanization and land development.

Data availability statement

The datasets presented in this study can be found in online repositories. The names of the repository/repositories and accession number(s) can be found below: <https://doi.org/10.23668/psycharchives.21379>.

Ethics statement

The studies involving humans were approved by University of Florida Institutional Review Board. The studies were conducted in accordance with the local legislation and institutional requirements. The participants provided their written informed consent to participate in this study.

Author contributions

LW: Investigation, Conceptualization, Methodology, Writing – review & editing, Supervision, Formal Analysis, Writing – original draft, Funding acquisition, Data curation, Project administration. CG: Writing – review & editing, Conceptualization, Writing – original draft. SP: Conceptualization, Writing – original draft, Writing – review & editing. JD: Writing – original draft, Funding acquisition, Project administration, Writing – review & editing, Conceptualization, Methodology. AM: Data curation, Writing – review & editing, Conceptualization, Methodology, Formal Analysis, Validation. SH: Writing – review & editing, Methodology, Conceptualization. RT: Conceptualization, Writing – review & editing, Methodology. AL: Writing – review & editing, Conceptualization, Methodology.

References

- Akbar, K. F., Hale, W. H., and Headley, A. D. (2003). Assessment of scenic beauty of the roadside vegetation in northern England. *Landscape Urban Plann.* 63, 139–144. doi: 10.1016/S0169-2046(02)00185-8
- Ali, A. D., and Narine, L. K. (2023). Educational Interests and information-seeking behaviors of Utah residents. *J. Hum. Sci. Extension* 11, 8. doi: 10.55533/2325-5226.1386
- Baker, R., Blumberg, S. J., Brick, J. M., Couper, M. P., Courtright, M., Dennis, J. M., et al. (2010). AAPOR report on online panels. *Public Opin. Q.* 74, 711–781. doi: 10.1093/poq/nfq048
- Baker, R., Brick, J. M., Bates, N. A., Battaglia, M., Couper, M. P., Dever, J. A., et al. (2013). *Report of the AAPOR task force on non-probability sampling*. Available online at: www.aapor.org/AAPORKentico/AAPOR_Main/media/MainSiteFiles/NPS_TF_Report_Final_7_revised_FNL_6_22_13.pdf (Accessed July 3, 2023).
- Balmford, A., Bradbury, R. B., Bauer, J. M., Broad, S., Burgess, G., Burgman, M., et al. (2021). Making more effective use of human behavioural science in conservation interventions. *Biol. Conserv.* 261, 109256. doi: 10.1016/j.biocon.2021.109256
- Brady, S. P., and Richardson, J. L. (2017). Road ecology: shifting gears toward evolutionary perspectives. *Front. Ecol. Environ.* 15, 91–98. doi: 10.1002/fee.1458
- Braman, S. K., and Griffin, B. (2022). Opportunities for and impediments to pollinator conservation in urban settings: A review. *J. Integrated Pest Manage* 13, 6. doi: 10.1093/jipm/pmac004
- Bueddefeld, J., Ostrem, J., Murphy, M., Halpenny, E., and Orr, B. (2022). Petting bees or building bee boxes? Strategies for transformative learning. *Environ. Educ. Res.* 28, 560–580. doi: 10.1080/13504622.2022.2045905

Funding

The author(s) declare financial support was received for the research and/or publication of this article. Funding for this research was provided by the Disney Conservation Fund.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Generative AI statement

The author(s) declare that no Generative AI was used in the creation of this manuscript.

Any alternative text (alt text) provided alongside figures in this article has been generated by Frontiers with the support of artificial intelligence and reasonable efforts have been made to ensure accuracy, including review by the authors wherever possible. If you identify any issues, please contact us.

Publisher's note

All claims expressed in this article are solely those of the authors and do not necessarily represent those of their affiliated organizations, or those of the publisher, the editors and the reviewers. Any product that may be evaluated in this article, or claim that may be made by its manufacturer, is not guaranteed or endorsed by the publisher.

Supplementary material

The Supplementary Material for this article can be found online at: <https://www.frontiersin.org/articles/10.3389/fcsc.2025.1693314/full#supplementary-material>

- Cariveau, A. B., Anderson, E., Baum, K. A., Hopwood, J., Lonsdorf, E., Nootenboom, C., et al. (2019). Rapid assessment of roadsides as potential habitat for monarchs and other pollinators. *Front. Ecol. Evol.* 7. doi: 10.3389/fevo.2019.00386
- Carr, M. H., and Zwick, P. D. (2016). *Florida 2070 technical report: Mapping Florida's future – Alternative patterns of development in 2070 [Technical Report]* (Tallahassee, FL, USA: Florida Department of Agriculture and Consumer Services & 1000 Friends of Florida).
- Cass, R. P., Hodgson, E. W., O'Neal, M. E., Toth, A. L., and Dolezal, A. G. (2022). Attitudes about honey bees and pollinator-friendly practices: A survey of iowan beekeepers, farmers, and landowners. *J. Integrated Pest Manage.* 13, 30. doi: 10.1093/jipm/pmac027
- Coffin, A. W. (2007). From roadkill to road ecology: A review of the ecological effects of roads. *J. Transport Geogr.* 15, 396–406. doi: 10.1016/j.jtrangeo.2006.11.006
- Coffman, J. (2002). Public communication campaign evaluation. *Harvard Family Res. Project*, 1–42. Available online at: <https://www.dors.it/documentazione/testo/200905/Public%20Communication%20Campaign%20Evaluation.pdf> (Accessed April 15, 2024).
- Cronbach, L. J. (1951). Coefficient alpha and the internal structure of texts. *Psychometrika* 16, 297–334. doi: 10.1007/BF02310555
- Dietzel, S., Rojas-Botero, S., Dichtl, A., Kollmann, J., and Fischer, C. (2024). Winners and losers at enhanced urban roadsides: Trait-based structuring of wild bee communities at local and landscape scale. *Biol. Conserv.* 291, 110480. doi: 10.1016/j.biocon.2024.110480
- DiFalco, S., and Morzillo, A. T. (2021). Comparison of attitudes towards roadside vegetation management across an exurban landscape. *Land* 10, 308. doi: 10.3390/land10030308
- DiFalco, S., Morzillo, A. T., and Ghosh, D. (2022). Interpolating resident attitudes toward exurban roadside forest management. *Landscape Ecol.* 38, 4211–4226. doi: 10.1007/s10980-022-01537-2
- Florida Department of Transportation (2022). *Public road mileage and miles traveled*. Available online at: [https://www.fdot.gov/statistics/mileage-rpts/default.shtm/lists/reports-of-highway-mileage-and-travel-\(dvmt\)/public-road-mileage-and-travel-\(dvmt\)-report](https://www.fdot.gov/statistics/mileage-rpts/default.shtm/lists/reports-of-highway-mileage-and-travel-(dvmt)/public-road-mileage-and-travel-(dvmt)-report) (Accessed May 24, 2023).
- Florida Wildflower Foundation (2024). *Florida department of transportation wildflower program, program procedure*. Available online at: <https://www.flawildflowers.org/fdot-wildflower-program-procedure/> (Accessed April 14, 2024).
- Forman, R. T., Sperling, D., Bissonette, J. A., Clevenger, A. P., Cutshall, C. D., Dale, V. H., et al. (2003). *Road ecology*. Sci. solutions, Washington, DC, USA: Island Press 482, xiii–xvi.
- Glista, D. J., DeVault, T. L., and DeWoody, J. A. (2009). A review of mitigation measures for reducing wildlife mortality on roadways. *Landscape Urban Plann.* 91, 1–7. doi: 10.1016/j.landurbplan.2008.11.001
- Gomez, T., and Derr, V. (2021). Landscapes as living laboratories for sustainable campus planning and stewardship: A scoping review of approaches and practices. *Landscape Urban Plann.* 216, 104259. doi: 10.1016/j.landurbplan.2021.104259
- Griffin, B., and Braman, S. K. (2021). School and community garden pollinator census: a pilot project in Georgia. *J. Entomological Sci.* 56, 287–304. doi: 10.18474/JES20-38
- Grilo, C., Borda-de-Água, L., Beja, P., Goolsby, E., Soanes, K., le Roux, A., et al. (2021). Conservation threats from roadkill in the global road network. *Global Ecol. Biogeography* 30, 2200–2210. doi: 10.1111/geb.13375
- Guan, M., Jennings, F. J., Villanueva, I. I., and Jackson, D. B. (2022). Delineating antecedents and outcomes of information seeking upon exposure to an environmental video opposing single-use plastics. *Environ. Communication* 16, 563–575. doi: 10.1080/17524032.2022.2102048
- Hale, D. C. (2019). *Human dimensions of roadside vegetation management across the Connecticut landscape* (Digital Commons). Available online at: https://digitalcommons.lib.uconn.edu/gs_theses/1349/ (Accessed June 10, 2023).
- Hopwood, J. L. (2008). The contribution of roadside grassland restorations to native bee conservation. *Biol. Conserv.* 141, 2632–2640. doi: 10.1016/j.biocon.2008.07.026
- Hopwood, J. (2023). “Chapter 11: communication support,” in *National academies of sciences, engineering, and medicine. 2023. Pollinator habitat conservation along roadways, volume 3: florida* (The National Academies Press, Washington, DC), 239–264. doi: 10.17226/27062
- Hopwood, J., Black, S., and Fleury, S. (2015a). *Pollinators and roadsides: best management practices for managers and decision makers*. (Xerxes Society for Invertebrate Conservation). Available online at: https://www.environment.fhwa.dot.gov/env_topics/ecosystems/Pollinators_Roadsides/BMPs_pollinators_roadsides.aspxch6g3 (Accessed June 12, 2023).
- Hopwood, J., Black, S., and Fleury, S. (2015b). *Roadside Best Management Practices that Benefit Pollinators: Handbook for Supporting Pollinators through Roadside Maintenance and Landscape Design*. (Xerxes Society for Invertebrate Conservation). Available online at: https://www.environment.fhwa.dot.gov/env_topics/ecosystems/Pollinators_Roadsides/BMPs_pollinators_landscapes.aspx (Accessed June 12, 2023).
- Hopwood, J., Black, S., and Fleury, S. (2016). “Chapter 6: overcoming obstacles to implementing pollinator-friendly practices,” in *Pollinators and roadsides: best management practices for managers and decision makers* (Federal Highway Administration, United States). Available online at: https://www.environment.fhwa.dot.gov/env_topics/ecosystems/Pollinators_Roadsides/BMPs_pollinators_roadsides.aspx#ch6 (Accessed April 30, 2024).
- Janousek, W. M., Douglas, M. R., Cannings, S., Clément, M. A., Delphia, C. M., Everett, J. G., et al. (2023). Recent and future declines of a historically widespread pollinator linked to climate, land cover, and pesticides. *Proc. Natl. Acad. Sci.* 120, e2211223120. doi: 10.1073/pnas.2211223120
- Khachatryan, H., Hodges, A. W., Rahmani, M., and Stevens, T. J. (2014). Investigation of economic impacts of Florida's highway beautification program (No. BDV31-977-03) (Florida. Dept. of Transportation). Available online at: <https://rosap.natl.bts.gov/view/dot/27463> (Accessed June 12, 2023).
- Khachatryan, H., and Rihn, A. (2018). Defining US consumers' (mis) perceptions of pollinator friendly labels: an exploratory study. *Int. Food Agribusiness Manage. Rev.* 21, 365–378. Available online at: https://brill.com/view/journals/ifa/21/3/article-p365_5.xml (Accessed June 10, 2023).
- Kopiyawattage, K. P., Warner, L. A., and Roberts, T. G. (2018). Information needs and information-seeking behaviors of urban food producers: Implications for urban Extension programs. *J. Agric. Educ.* 59, 229–242. doi: 10.5032/jae.2018.03229
- Kuder, L. (2019). Evaluating integrated roadside vegetation management (IRVM) techniques to improve pollinator habitat (No. MD-19-SHA/UM/4-38) (University of Maryland). Available online at: <https://rosap.natl.bts.gov/view/dot/43907> (Accessed June 10, 2023).
- Lamm, A. J., and Lamm, K. W. (2019). The use of nonprobability sampling methods in agricultural and extension education research. *J. Int. Agric. Extension Educ.* 26, 52–59. doi: 10.5191/jiaec.2019.26105
- Larson, R. B. (2019). Controlling social desirability bias. *Int. J. Market Res.* 61, 534–547. doi: 10.1177/1470785318805305
- Latinopoulos, D., Mentis, C., and Bithas, K. (2018). The impact of a public information campaign on preferences for marine environmental protection. The case of plastic waste. *Mar. pollut. Bull.* 131, 151–162. doi: 10.1016/j.marpolbul.2018.04.002
- Liang, H., He, Y. D., Theodorou, P., and Yang, C. F. (2023). The effects of urbanization on pollinators and pollination: A meta-analysis. *Ecol. Lett.* 26, 1629–1642. doi: 10.1111/ele.14277
- Ligtermoet, E., Ramalho, C. E., Foellmer, J., and Pauli, N. (2022). Greening urban road verges highlights diverse views of multiple stakeholders on ecosystem service provision, challenges and preferred form. *Urban Forestry Urban Greening* 74, 127625. doi: 10.1016/j.ufug.2022.127625
- Lindner, J. R., and Lindner, N. (2024). Interpreting Likert type, summated, unidimensional, and attitudinal scales: I neither agree nor disagree, Likert or not. *Advancements Agric. Dev.* 5, 152–163. doi: 10.37433/aad.v5i2.351
- Lucey, A., and Barton, S. (2011a). Influencing public perception of sustainable roadside vegetation management strategies. *J. Environ. Horticulture* 29, 119–124. doi: 10.24266/0738-2898-29.3.119
- Lucey, A., and Barton, S. (2011b). Public perception and sustainable management strategies for roadside vegetation. *Transportation Res. Rec.* 2262, 164–170. doi: 10.3141/2262-16
- Lucey, A., Barton, S., and Bruck, J. (2010). *Public perception and attitudes about roadside vegetation: pre-and post-environmental education* (University of Delaware University Transportation Center). Available online at: https://rosap.natl.bts.gov/view/dot/23060/dot_23060_DS1.pdf (Accessed June 18, 2023).
- Majewska, A. A., and Altizer, S. (2019). Exposure to non-native tropical milkweed promotes reproductive development in migratory monarch butterflies. *Insects* 10, 253. doi: 10.3390/insects10080253
- Mallinger, R. E., Ternest, J. J., Weaver, S. A., Weaver, J., and Pryer, S. (2021). Importance of insect pollinators for Florida agriculture: a systematic review of the literature. *Florida Entomologist* 104, 222–229. doi: 10.1653/024.104.0312
- Manoosingh, C., Cubas, F. J., and Purcell, R. C. (2020). Public response to different planting techniques for annual color and enhancement (No. FHWA-GA-21-1731) (Georgia. Department of Transportation. Office of Performance-Based Management & Research). Available online at: <https://rosap.natl.bts.gov/view/dot/58007> (Accessed June 10, 2023).
- Mitchell, A., Gottfried, J., Barthel, M., and Shearer, E. (2016). *The modern news consumer: News attitudes and practices in the digital era*. Available online at: https://www.pewresearch.org/journalism/wp-content/uploads/sites/8/2016/07/PJ_2016.07_07_Modern-News-Consumer_FINAL.pdf (Accessed June 12, 2023).
- Nassauer, J. I. (1995). Messy ecosystems, orderly frames. *Landscape J.* 14, 161–170. doi: 10.3368/lj.14.2.161
- Nemec, K., Stephenson, A., Gonzalez, E. A., and Losch, M. (2021). Local decision-makers' perspectives on roadside revegetation and management in Iowa, USA. *Environ. Manage.* 67, 1060–1074. doi: 10.1007/s00267-021-01448-z
- Nemec, K., Stephenson, A., and Losch, M. (2022). How engineers and roadside vegetation managers maintain roadside vegetation in Iowa, USA. *Environ. Manage.* 70, 593–604. doi: 10.1007/s00267-022-01683-y
- Owens, C., Warner, L. A., Rumble, J., Lamm, A., Martin, E., and Cantrell, R. (2015). Encouraging landscape water-conservation behaviors# 6: information seeking preferences of florida residents who use irrigation in the home landscape: AEC542/WC204, 4/2015. *EDIS* 2015, 5–5. Available online at: <https://journals.flvc.org/edis/article/download/129116/135793> (Accessed April 15, 2024).

- Pálsdóttir, Á. (2014). Preferences in the use of social media for seeking and communicating health and lifestyle information. *Inf. Research: Int. Electronic J.* 19, n4. Available online at: <https://eric.ed.gov/?id=EJ1050472> (Accessed June 18, 2023).
- Reynolds, J. P., Stautz, K., Pilling, M., van der Linden, S., and Marteau, T. M. (2020). Communicating the effectiveness and ineffectiveness of government policies and their impact on public support: a systematic review with meta-analysis. *R. Soc. Open Sci.* 7, 190522. doi: 10.1098/rsos.190522
- Rihn, A., and Khachatryan, H. (2016). Does consumer awareness of neonicotinoid insecticides influence their preferences for plants? *HortScience* 51, 388–393. doi: 10.21273/HORTSCI.51.4.388
- Ross, D. G. (2013). Deep audience analysis: A proposed method for analyzing audiences for environment-related communication. *Tech. Communication* 60, 94–117. Available online at: <https://www.ingentaconnect.com/content/stc/tc/2013/00000060/00000002/art00002> (Accessed June 12, 2023).
- Sanders, C., Gibson, K., Byrd, A. R., Markosyan, T., and Lamm, A. J. (2023). Exploring the social media health information seeking patterns of rural residents to provide communication strategies for extension. *J. Appl. Commun.* 107, 1. doi: 10.4148/1051-0834.2499
- Senapathi, D., Fründ, J., Albrecht, M., Garratt, M. P., Kleijn, D., Pickles, B. J., et al. (2021). Wild insect diversity increases inter-annual stability in global crop pollinator communities. *Proc. R. Soc. B* 288, 20210212. doi: 10.1098/rspb.2021.0212
- Slater, M. D. (1996). Theory and method in health audience segmentation. *J. Health Communication* 1, 267–283. doi: 10.1080/108107396128059
- Stys, B., Foster, T., Fuentes, M. M., Glazer, B., Karish, K., Montero, N., et al. (2017). Climate change impacts on Florida's biodiversity and ecology. *Florida's Climate: Changes Variations Impacts*. Washington, DC, USA: Island press doi: 10.17125/fci2017.ch12
- United States Census Bureau (2021). *2020 population and housing state data*. (United States Census Bureau). Available online at: <https://www.census.gov/library/visualizations/interactive/2020-population-and-housing-state-data.html> (Accessed April 15, 2024).
- United States Department of Transportation (2022). *Highway statistics 2022*. Available online at: <https://www.fhwa.dot.gov/policyinformation/statistics/2022/> (Accessed April 30, 2024).
- Van Der Ree, R., Jaeger, J. A., van der Grift, E. A., and Clevenger, A. P. (2011). Effects of roads and traffic on wildlife populations and landscape function: road ecology is moving toward larger scales. *Ecol. Soc.* 16. Available online at: <http://www.ecologyandsociety.org/vol16/iss1/art48/> (Accessed November 14, 2024).
- Van Dyke, C., Wallace, C., and Kreis, D. (2021). Economic and environmental benefits of a reduced roadside mowing program for kentucky highways (*No. KTC-21-07/SPR20-590-1F*) (Lexington, KY, USA: University of Kentucky Transportation Center). doi: 10.13023/KTC.RR.2021.07
- Warner, L. A., Aryal, D., Daniels, J., Diaz, J. M., and Pasula, S. (2025a). Pollinator pathways: Identifying strategies to engage drivers through creative segmentation. *J. Environ. Manage.* 393. doi: 10.1016/j.jenvman.2025.127120
- Warner, L. A., Pasula, S., Daniels, J., Rhoden, J., and Hundemer, S. (2025b). Driving change: Persuading drivers to support pollinator-friendly roadsides through strategic environmental communication. *Biol. Diversity* 2, 119–138. doi: 10.1002/bod2.70010
- Weber, F., Kowarik, I., and Säumel, I. (2014). A walk on the wild side: Perceptions of roadside vegetation beyond trees. *Urban Forestry Urban Greening* 13, 205–212. doi: 10.1016/j.ufug.2013.10.010
- Wenzel, A., Grass, I., Belavadi, V. V., and Tscharnkte, T. (2020). How urbanization is driving pollinator diversity and pollination—A systematic review. *Biol. Conserv.* 241, 108321. doi: 10.1016/j.biocon.2019.108321
- Wilkins, E. J., Miller, H. M., Tilak, E., and Schuster, R. M. (2018). Communicating information on nature-related topics: Preferred information channels and trust in sources. *PloS One* 13, e0209013. doi: 10.1371/journal.pone.0209013
- Wu, H., Hoffman, M. C., Wang, R., Kelley, K. M., and Adib, M. (2024). Revealing public perceptions of biodiverse vs. turf swales: Balancing enhanced ecosystem services with heightened concerns. *Water* 16, 2899. doi: 10.3390/w16202899