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REVIEW

Community experiences of landscape-based stormwater management practices: A review

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Abstract Urban stormwater management increasingly changes urban landscapes. From rain gardens to stormwater ponds, landscape-based practices are visible and often accessible to community members, whose support and experience of these practices will affect their success. This critical narrative review addresses these Landscape-based Stormwater Management Practices (L-SWMPs). It assesses quantitative and qualitative evidence for the effects of characteristics of individual community members, L-SWMP landscape context, and L-SWMPs themselves on community members' perceptions, attitudes, and societal outcomes. Characteristics of community members are most well-studied. Environmental knowledge and past experiences of community members have strong, consistent effects, while the effects of demographic characteristics are weaker and inconsistent. Landscape characteristics, especially greenspace context and neighborhood landscape norms, consistently influence perceptions of L-SWMPs as amenities. Effects of noticeable L-SWMP characteristics are understudied; we argue that paying greater attention to these characteristics may help practitioners innovate L-SWMPs that benefit communities and receive their support.

Keywords Design · Green infrastructure · Nature-based solution · Public preference · Social dimension · Urban planning

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INTRODUCTION

Background

The purpose of this literature review is to evaluate evidence for factors affecting public perceptions, attitudes, and societal outcomes related to Landscape-Based Stormwater Management Practices (L-SWMPs), a term some landscape architects have used to describe practices that manage stormwater in the landscape (Backhaus and Fryd 2013). We use this term to frame our review because, different from some stormwater management practices, L-SWMPs have a visible landscape component. Thus, they are likely to directly affect community members' experience of urban landscapes. Drawing from among practices known as Best Management Practices (BMPs), Low Impact Design (LID), Green Stormwater Infrastructure (GSI), Water Sensitive Urban Design (WSUD), or Sustainable Urban Drainage Systems (SuDS) (Fletcher et al. 2015; Bartesaghi Koc et al. 2016), we focus on L-SWMPs because their visibility and increasingly pervasive implementation globally in the context of climate change and infrastructure investment (Chang et al. 2018) affects the everyday experiences of urban residents.

L-SWMPs, which may include swales, bioretention gardens, urban wetlands, and stormwater detention ponds, inherently engage public attention because they are visible in the landscape, with implications for the well-being of community members, as well as for public support and cultural sustainability (Nassauer 1997). Some of their landscape characteristics may be immediately noticeable (Nassauer 1992; Gobster et al. 2007), directly affecting the public's assessment of their attractiveness, utility, safety, and appropriateness to context. L-SWMPs perceived as safe and attractive may provide aesthetic, recreational, real

estate, and health benefits to urban residents (Nassauer et al. 2021). Negative public perceptions and attitudes toward L-SWMPs can create barriers to implementation (Brown et al. 2016; Turner et al. 2016; Shandas et al. 2020), undermine social benefits, and prompt people to make "improvements" that alter environmental performance (Nassauer 2004).

Designing and managing L-SWMPs solely for stormwater functional requirements risks failure to obtain public support. Unlike conventional stormwater systems that are largely hidden from public view (Leonard et al. 2019), successful design and management of L-SWMPs require decision-makers to understand how changing landscape to enhance stormwater management functions may affect human experience. This will allow stormwater professionals to develop L-SWMP designs and policies that better align with prevalent public perceptions of desirable landscapes. We review studies on L-SWMP perceptions, attitudes, and societal outcomes to identify human and landscape characteristics influencing human experience of L-SWMPs. Evaluating the evidence about these characteristics in the literature, we present a synthesis to support policy-making, practice, and innovation of L-SWMPs.

Definitions

We define L-SWMPs as urban stormwater management practices with a visible landscape component. We use "the public" to mean community members who are laypeople as distinguished from experts and decision-makers. "Perception" refers to the public's immediate apprehensions of L-SWMPs (Nassauer 1992). To identify human and landscape characteristics influencing perception in this review, we included studies that examined: (1) the public's beliefs about the functions and purposes of an L-SWMP, (2) their judgments of its safety, attractiveness, utility, naturalness, or appropriateness, and (3) their beliefs about its benefits and disadvantages. We use the term "attitudes" to refer to the public's behavioral predispositions (Eagly and Chaiken 2007) and behavioral intentions (Fishbein and Ajzen 1977) toward L-SWMPs. While perceptions play a part in determining attitudes toward L-SWMPs, attitudes are also influenced by other factors such as practical concerns over maintenance responsibility and economic incentives (Venkataramanan et al. 2020). To identify human and landscape characteristics influencing attitudes towards L-SWMPs, we examined studies that investigated stated support for L-SWMPs, hypothetical willingness to adopt or pay, and intent to participate in stewardship activities. Finally, we use "outcomes" to refer to realized societal changes, e.g., actual adoption rates of L-SWMP implementation programs and effects of L-SWMPs on public health or property value.

Research objectives and approach

Our review focuses on characteristics of landscapes and individuals that influence perceptions, attitudes, and societal outcomes of L-SWMPs (see Fig. 1). We ask the following research questions:

(1) What individual, landscape context, and L-SWMP characteristics have been examined in the literature?
(2) How consistent are findings on each characteristic?
(3) What causal relationships can be inferred between these characteristics and perceptions, attitudes, and outcomes?

To answer them, we conducted a "systematic search and review" (c.f. Grant and Booth 2009) that combines a critical review with a systematic search process. The literature relevant to our objectives is diverse in study design and methods, requiring a narrative approach to synthesize findings. To reduce bias, enhance transparency, and enable stakeholder review, we developed systematic procedures to identify relevant studies and extract evidence from this heterogeneous body of literature (Bilotta et al. 2014). To enhance the relevance of our review to practice and policy, we focused on real and measurable characteristics of humans and landscapes. We review three types of characteristics (Fig. 1), with the following rationale for each:

(1) Characteristics of individuals: Personal factors, social norms, past experiences, and knowledge can influence what people notice about L-SWMPs, their understanding of them, and their subsequent behaviors (Gobster et al. 2007). A better understanding of how individual characteristics affect perceptions and attitudes can help managers identify potential participants in L-SWMP programs (Shin and McCann 2018b), address the specific concerns of different communities, and meet their expectations of landscape appearance.
(2) Characteristics of the landscape context in which L-SWMPs are seen: Contextual characteristics can set different expectations and norms for landscape appearance (Gobster et al. 2007; Nassauer et al. 2009). Assessments of an L-SWMP's appropriateness and benefits may be influenced by the appearance of its surrounding environment and existing amenities. Understanding how contextual characteristics influence perceptions and attitudes can guide spatial allocation and selection of L-SWMPs in retrofitting programs.
(3) Visible characteristics of the L-SWMP: The appearance of an L-SWMP can be described by a combination of visible characteristics such as size or the presence of vegetation types. Preferences for some

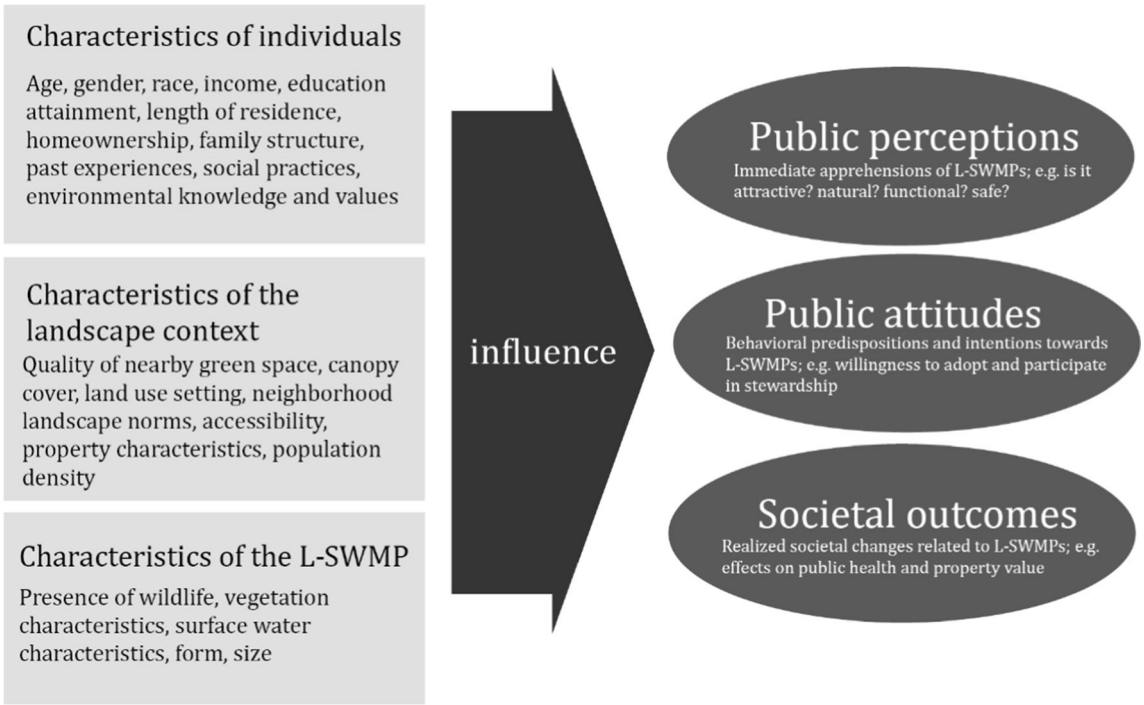

Fig. 1 Conceptualization of this review. We investigate how characteristics of individuals, landscape context and L-SWMPs influence public perceptions, public attitudes, and societal outcomes

L-SWMP characteristics may be near-universal, while others may vary, depending on individual perceivers or landscape context (Kaplan 1987). Knowing public perceptions of specific characteristics and preferences for L-SWMP appearance can help designers innovate practices that will be more widely accepted.

METHODS

Literature search

We searched for relevant literature using these landscape-based stormwater management practices and their synonyms as search terms: rain gardens and bioretention systems, swales, constructed wetlands, remnant urban wetlands, and detention basins (wet and dry). We excluded practices that are not landscape-based, e.g., rain barrels and permeable paving systems, green roofs, and other forms of vertical greenery systems. We also excluded urban green infrastructure that does not have the primary purpose of managing stormwater (e.g., urban forests or nature preserves). In addition, we excluded stream and shoreline interventions, which have been described in previous review papers (e.g., Kondolf and Yang 2008; Lee 2017; Flotemersch and Aho 2021). See Table S1 (supplementary materials) for search terms used.

We first used Web of Science to identify relevant English-language peer-reviewed literature published before January 2021. To more fully access professional literature, we then supplemented these results with a similar keyword search in Google Scholar, focusing on the first 300 results (Haddaway et al. 2015). Finally, backward citation searching of relevant articles returned by Web of Science and Google Scholar was used to identify articles that were not returned by either search engine. This involved manually searching for additional articles in reference lists.

Screening procedures and inclusion criteria

Article types returned included: peer-reviewed journal articles, conference proceedings, undergraduate and graduate dissertations, and reports from public organizations. We screened these results by title to rapidly exclude results that did not discuss human dimensions of L-SWMPs. Then, we screened abstracts to exclude:

(1) Studies not including primary empirical research (e.g., reviews, expert-only evaluations).
(2) Studies focusing only on experts or decision-makers rather than the public.

	Perceptions	Attitudes	Outcomes
Quantitative	*Type 1 evidence*: quantitative evidence for the factor's influence on public perceptions	*Type 2 evidence*: quantitative evidence for the factor's influence on public attitudes	*Type 3 evidence*: quantitative evidence for the factor's influence on societal outcomes
Qualitative	*Type 4 evidence*: qualitative evidence for the factor's influence on public perceptions	*Type 5 evidence*: qualitative evidence for the factor's influence on public attitudes	*Type 6 evidence*: qualitative evidence for the factor's influence on societal outcomes

Fig. 2 Classification system for evidence presented in each study included in our review

We performed a full-text review of the remaining studies, further excluding articles for the two reasons above, or if:

(3) It was unclear if study participants had seen the practice, whether in person or through visualizations. We made this requirement because our approach is attentive to the effects of L-SWMPs' visible characteristics.
(4) Multiple publications derived from the same research project using the same dataset, with similar analytical methods and conclusions (e.g., a journal publication and its associated dissertation). To avoid duplicates, we included only the most methodologically robust publication from the study.
(5) Study reported only on L-SWMP perceptions, attitudes, or outcomes but did not explicitly investigate or discuss how characteristics of individuals, landscape context, or L-SWMPs may have influenced the results.
(6) Study did not include any L-SWMP practice types ("Literature search" section).

Quality appraisal and inclusion criteria

Study quality varied in the pool that met our screening criteria. To focus on higher-quality studies in our analysis, we imposed minimum quality criteria for quantitative, qualitative, and mixed-methods studies. These criteria were related to sampling strategy (representativeness and sample size), data collection methods, appropriateness of analytical methods, and validity of conclusions drawn based on findings (Table S2 in supplementary materials). The most common reason for exclusion was an inadequate sample (e.g., response rates too low ($< 10\%$) or reliance on a convenience sample introduced bias). Studies that did not meet all criteria for the relevant method were not included in our analysis but were considered as additional evidence in the related discussion, especially for characteristics for which there was limited high-quality research. Where reporting was insufficient for us to appraise quality according to these criteria, we treated the study as not meeting minimum quality requirements.

Data extraction and analysis

For each publication selected for analysis, we manually flagged all study variables that related to perceptions, attitudes, or social outcomes of L-SWMPs. We compiled all of these variables as a list in Microsoft Excel (see Table S3 in supplementary materials) and aggregated synonymous ones from different studies into factors (see Table S4 in supplementary materials). For example, for the factor, informal neighborhood landscape norms, we included variables such as "neighborhood aesthetics/character", "concerns about neighbor's opinions" (Shin and McCann 2018b), and "normative beliefs" (Drescher and Sinasac 2021). Then, for each factor, we assessed the evidence that was presented in each study. To describe that evidence, we developed the following classification system (Fig. 2).

Evidence Types 1, 2, and 3 are generated by using quantitative analytical methods to directly assess the statistical relationship between a factor and public perceptions, attitudes, or outcomes. They rely primarily on social survey data and may include image sorting and choice experiment components. Evidence Types 4, 5, and 6 are generated by qualitative research offering insight into why certain factors may affect perception, attitudes, or outcomes. They typically rely on semi-structured interviews, focus group interviews, open-ended items in surveys, or descriptions of L-SWMP project implementation. Evidence Types 1 and 4 focus on perceptions, Types 2 and 5 focus on attitudes, while Types 3 and 6 focus on outcomes ("Definitions " section). We employed this classification system to code the evidence provided in each study by factors

(Table S5 in supplementary materials) in Microsoft Excel 2016.

RESULTS

Search and screening results

Fifty-eight articles were selected for full inclusion, and 34 others were drawn on as supplementary qualitative support (Fig. 3). Most studies included were conducted in the USA (31 of 58). Eight were in the UK, seven in Australia, five in Canada, two in Europe (Sweden and France), and four in Asia (China, Malaysia, and South Korea). The location of each study is included in Table S4 in the supplementary materials. Forty-two studies were quantitative, nine were qualitative, and the remaining seven used mixed methods. Twenty-nine studies included rain gardens and bioretention facilities, thirteen included urban wetlands, ten included wet stormwater basins, and six included dry detention basins. Twenty-nine studies focused mainly on public perceptions, fifteen primarily focused on attitudes, and fourteen primarily described social outcomes.

Factor identification

From these 58 articles, we identified 32 factors related to individual characteristics, landscape context characteristics, or noticeable characteristics of L-SWMPs (Tables 1, 2 and 3). Studies may provide evidence for multiple factors and effects. In the following sections, we summarize the evidence for each factor.

Characteristics of individuals

Demographic characteristics

Few quantitative studies on public perceptions reported effects of demographic characteristics, and none were statistically significant (Mungur 1997; Dobbie 2016; Shi et al. 2017). In contrast, studies on public attitudes toward adoption and stewardship often found significant effects of demographic variables. However, results were inconsistent across these studies. For example, Baptiste et al. (2015) found that older respondents were more likely to participate in a free rain garden adoption program in Syracuse, New York. They postulated that age was indicative of greater environmental knowledge and self-efficacy, which influenced willingness to adopt. However, other willingness to adopt studies in Missouri and Maryland found negative correlations with age (Newburn et al. 2016; Shin and McCann 2018b). We also found inconsistent results for other demographic characteristics hypothesized to influence attitudes towards L-SWMPs, including length of residency and homeownership.

In their relationship to public attitudes, gender, income, and educational attainment were partially consistent across studies. For these demographic characteristics, directionality was consistent, but relationships were not always statistically significant. In three out of six studies, women were more likely to participate in the implementation and maintenance of raingardens (Peng 2010; Baptiste et al. 2015; Shin and McCann 2018b), while gender was not significant in the rest (Baptiste 2014; Chui and Ngai 2016; Coleman et al. 2018). Few explanations have been proposed for the influence of gender. Baptiste et al. (2015), referencing larger environmental psychology studies (e.g., Dietz et al. 1998), suggested that women may be more pro-environment. Where income and education were included as covariates in studies, higher income and higher educational attainment were typically significantly associated with willingness to adopt (Thurston et al. 2010; Baptiste 2014), higher willingness to pay (Chui and Ngai 2016; Newburn and Alberini 2016) and stated intent to engage with L-SWMP stewardship (Shandas 2015).

The presence of children in a household may influence both perceptions of safety and amenity value of larger L-SWMPs such as wetlands and ponds. Qualitative evidence from several studies indicates that parents of young children may be particularly concerned about drowning risks (Baxter et al. 1985; Apostolaki 2007; Bastien et al. 2012). Syme et al. (2001)s' finding that families with children under 14 years old were significantly less likely to visit urban wetland parks may support this argument. On the other hand, qualitative and anecdotal evidence suggests that families with children may have a greater appreciation for the educational and recreational value of wetlands and ponds (Manuel 2003; Leonard et al. 2014; Williams et al. 2019). This alternate perspective is supported by Abramovic (2000), who found that families with children were significantly more likely to engage in recreational activities at residential stormwater ponds.

Environmental values and knowledge

There is substantial research on how environmental values and knowledge affect public perceptions and attitudes toward L-SWMPs. Our analysis distinguished between (1) prior environmental knowledge, (2) stated environmental values and orientations, and (3) effects of informational interventions.

Studies consistently find that greater prior environmental knowledge positively influences both perceptions and attitudes towards L-SWMPs. For example, Kim and An (2017) found that visitors to bioretention facilities in South Korea had higher ratings of the aesthetics of these practices

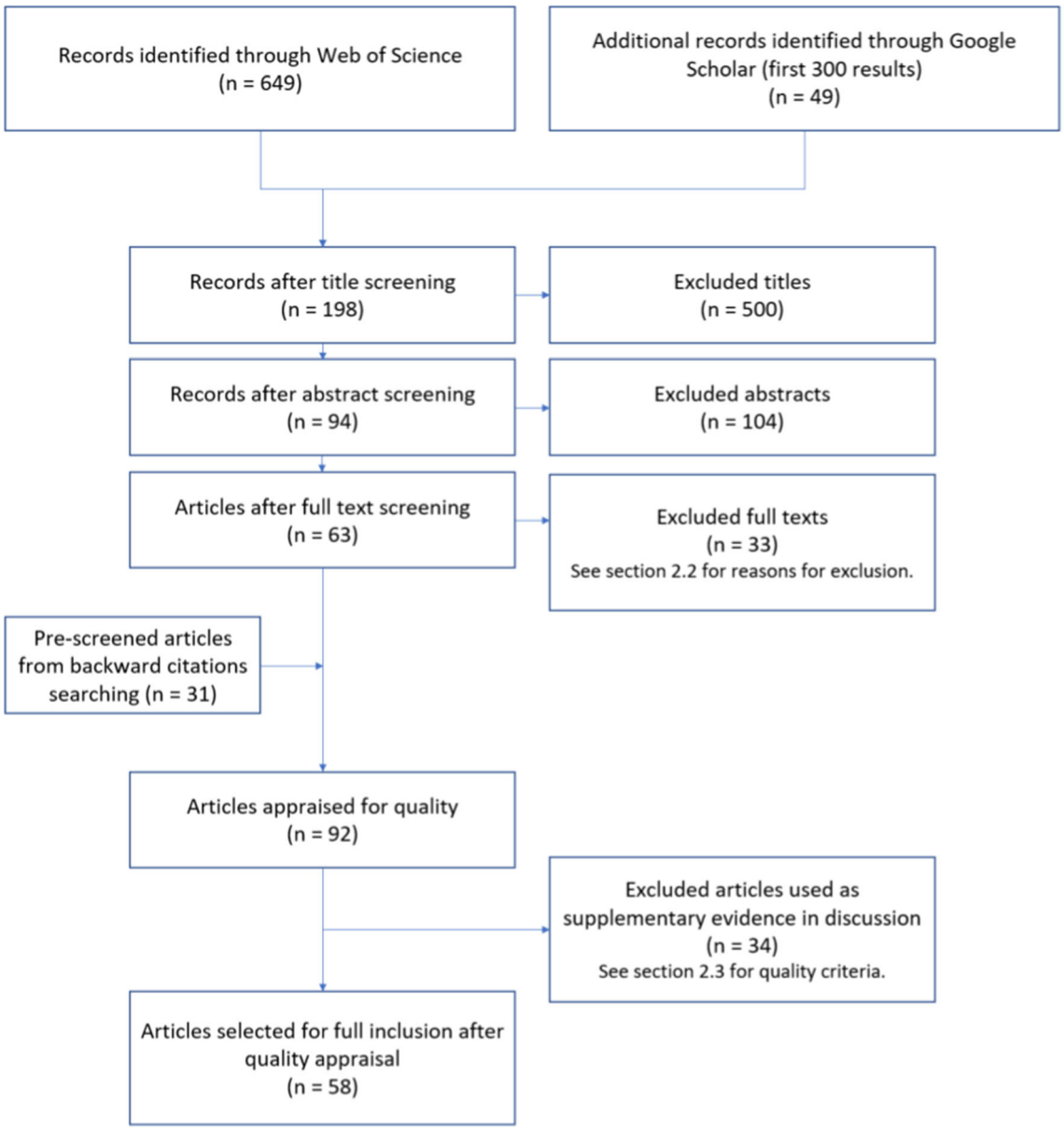

Fig. 3 Screening process and quality appraisal to arrive at final set of 58 studies for full inclusion. 34 studies that did not fully meet quality criteria (Table S1) were used as supplementary evidence where relevant

if they had prior knowledge of bioretention systems. In Portland, Church (2015) found that formal educations in the natural sciences helped some respondents recognize habitat value for insects and microorganisms in small bioretention features. Significant differences between the perceptions of experts and laypeople have been described in multiple studies (Maulan 2006; Cottet et al. 2013; Zhang 2013), suggesting that prior knowledge can influence what people notice and value about what they see. The positive influence of prior environmental knowledge on public attitudes is widely documented in quantitative studies on adoption intent (Peng 2010; Baptiste et al. 2015; Shin and McCann 2018b; Mason et al. 2019). It is also emphasized in case studies. A post-implementation study of a Melbourne-based stormwater residential retrofitting program, for instance, noted that prior knowledge of stormwater management through formal education or farming experience was linked with householders' willingness to install raingardens (Brown et al. 2016).

A few studies have investigated if stated pro-environmental values and concerns about the degradation of downstream water bodies influence attitudes and social outcomes, but results are mixed. A survey in Maryland found that environmental attitudes toward the Chesapeake Bay were highly significant in influencing stated willingness to pay for rain gardens on residential property

Table 1 Tables 1, 2 and 3 show the number of studies providing each type of evidence (Fig. 1) for results related to each characteristic identified in the literature. Each of the 58 unique studies included may provide evidence for multiple charateristics. Table S5 (supplementary materials) shows how we coded evidence from each study. We emphasize that a "vote-count" (Hedges and Olkin 1980) approach should not be taken in interpreting quantitative evidence owing to heterogeneity in study design and methods. Instead, we refer readers to the columns "Consistency of correlations" and "Causal relationships proposed". table 1 collates characteristics of individuals identified in the literature

		Quantitative evidence				*Qualitative evidence*			
Characteristics of individuals		**Type 1**	**Type 2**	**Type 3**	**Consistency of correlations**	**Type 4**	**Type 5**	**Type 6**	**Causal relationships proposed**
Demographic characteristics	**Age**	3	9	5	Inconsistent	-	-	-	
	Gender	4	6	4	Women have more positive attitudes toward L-SWMPs	-	-	-	
	Race	-	3	1	Limited evidence.	-	-	-	
	Income	1	5	3	Higher income associated with more positive attitudes toward L-SWMPs.	-	-	-	
	Education attainment	3	6	-	Higher education associated with more positive attitudes toward L-SWMPs.	-	-	-	
	Length of residence	2	4	1	Inconsistent	1	-	-	
	Homeownership	-	6	3	Inconsistent	1	-	-	
	Family structure	1	1	2	Inconsistent	3	-	-	Presence of children may enhance safety concerns surrounding L-SWMPs, but parents may also perceive greater educational and amenity value.
Past experience	**Experience of flooding**	-	3	-	Having experienced flooding associated with more positive attitudes toward L-SWMPs.	1	3	-	Past experience of flooding may be a source of environmental knowledge and help the public recognize the relevance of L-SWMPs.
Social practices	**Landscape management practices**	-	2	1	More gardening experience associated with more positive attitudes toward L-SWMPs.	1	1	1	People may not wish to give up existing gardens and lawn space or change management habits to accommodate L-SWMPs.
	Visitation and recreation	1	2	1	More frequent visits and certain recreational activities associated with more positive attitudes toward L-SWMPs.	-	-	-	
Environmental values and knowledge	**Prior environmental knowledge**	6	1	1	More environmental knowledge associated with more positive perceptions and attitudes.	3	1	2	People with more environmental knowledge may better appreciate the utility and environmental functions of L-SWMPs.
	Pro-environment values	1	1	2	Pro-environment orientations associated with more positive attitudes toward L-SWMPs.	1	1	-	Despite stated pro-environmental values, people may not feel it is their responsibility to translate these values into behaviors in their private property.
	Informational interventions	1	-	-	Informational interventions can influence public perceptions and attitudes.	2	-	1	Informational interventions may be more effective in changing perceptions of L-SWMPs in public space than changing behavior in private contexts.

Table 2 Table 2 collates characteristics of landscape context identified in the literature

		Quantitative evidence				*Qualitative evidence*			
Characteristics of landscape context		**Type 1**	**Type 2**	**Type 3**	**Consistency of correlations**	**Type 4**	**Type 5**	**Type 6**	**Causal relationships proposed**
Nearby greenspace	**Quality of nearby greenspace**	2	1	-	Qualities of nearby greenspace may affect perceptions of the amenity and recreational value of large L-SWMPs.	-	-	-	
	Canopy cover	-	1	1	Greater neighborhood canopy cover associated with more positive attitudes.	-	-	-	
Land use	**Immediate land use setting**	3	-	1	Greenspace context associated with more positive perceptions towards L-SWMPs.	6	-	-	L-SWMPs may be perceived as being more natural and attractive in a greenspace context.
Neighborhood landscape norms	**Informal**	-	1	2	Neighborhood landscape norms influences attitudes towards L-SWMPs.	3	-	1	People are concerned about neighbors' opinions of their practices and prefer to adhere to neighborhood landscape norms.
	Formalized	-	1	-	-	1	-	-	
Other context factors	**Accessibility**	7	-	3	Having more direct access associated with more positive perceptions and attitudes. Less accessible places associated with more negative perceptions and attitudes.	3	-	-	Less accessible places may be perceived as being less safe, and people may not see any amenity value in them, especially if they are minimally maintained.
	Property characteristics	-	4	3	Inconsistent.	-	-	-	
	Population density	-	3	3	Inconsistent.	1	-	-	

Table 3 Table 3 collates characteristics of L-SWMPs identified in the literature

		Quantitative evidence				*Qualitative evidence*			
Characteristics of the L-SWMP		**Type 1**	**Type 2**	**Type 3**	**Consistency of correlations**	**Type 4**	**Type 5**	**Type 6**	**Causal relationships proposed**
Presence of wildlife	**Birds**	7	-	-	Observing birds associated with more positive perceptions.	4	-	-	When the public observe birds in a practice, the L-SWMP is perceived as being more natural and contributing to urban habitat.
	Insects	4	-	1	Insects associated with more negative perceptions.	5	-	-	Insects are often seen as pests, and in some contexts may raise health concerns, especially when standing water is present.
Vegetation characteristics	**Trees**	1	-	1	Presence of trees associated with more positive perceptions, with exceptions.	2	-	-	Trees are appreciated, but may also block sightlines, which may not be appreciated in certain contexts.
	Planting structure	9	-	1	Higher planting density associated with more positive perceptions, with exceptions.	7	-	3	Lush and mature vegetation generally enhances perceptions of naturalness, but may also be associated with messiness.
	Planting species	11	-	4	Plant species influence perceptions of L-SWMPs.	6	-	2	Flowering species, visibly diverse planting palette preferred. Tall grass species may be perceived as messy.
Surface water characteristics	**Water quantity**	5	-	4	Observing temporary pooling of runoff associated with more negative perceptions. Low water levels in basins and "dry" basins are associated with more negative perceptions.	5	-	2	Temporary pooling of runoff in infiltration-based practices may lead some to interpret the practice as malfunctioning. Open water widely seen as attractive and natural. Low water levels in wetlands and ponds, accompanied by a muddy appearance, may be associated with poor ecological health. Dry detention basins are seen as unattractive.
	Water quality	4	-	1	Perceptible indicators of poor water quality associated with negative perceptions.	5	-	-	People are highly sensitive to turbidity, color and odors in L-SWMPs.
Other noticeable characteristics	**Size**	3	-	2	Larger practices associated with more positive perceptions.	3	-	-	Larger L-SWMPs tend to be seen as being more natural, and can potentially provide more amenity benefits.
	Form	-	-	1 (*)	Areal practices may be preferred over linear practices.	4	-	-	Visibly steep slopes in basins may raise safety concerns.

(Newburn and Alberini 2016). In Indiana, Gao et al. (2018) found that adopters of rain gardens were more likely to have protective attitudes towards their local river. However, case studies of rain garden retrofitting programs suggest that stated pro-environmental values may not predict actual rain garden adoption. For example, Turner et al. (2016) reported lower-than-expected resident participation in their retrofitting program in Ohio. The post-implementation survey showed that non-participants and participants had similar stated pro-environmental values. Relatedly, Johnston (2017) found some homeowners did not believe that their pro-environmental values should translate into environmentally beneficial management of their private yards.

There is some evidence that informational interventions may help improve perceptions of existing L-SWMPs in public spaces, but limited support that community education can change attitudes about adopting L-SWMPs. Two studies suggest that passive informational interventions (e.g., signage) may enhance public support for L-SWMPs located in public spaces when their landscape appearance is unconventional, by acting as both a "cue to care" and enabling spontaneous learning about their function (Church 2015; Dobbie 2016). No study in our review specifically examined the effect of informational interventions on public attitudes. Some authors have speculated that observed neighborhood-level differences in attitudes toward L-SWMPs might be attributed to differences in outreach and educational efforts between different communities (Baptiste et al. 2015; Shandas 2015; Coleman et al. 2018). However, case studies of L-SWMP programs often describe limited participation despite engagement and outreach efforts (Brown et al. 2016; Monaghan et al. 2016b; Turner et al. 2016). Educational programs for enhancing household L-SWMP participation may be more effective if they can distinguish between likely adopters and persistent non-adopters of L-SWMPs (Shin and McCann, 2018b).

Past experience of flooding

Studies are largely consistent in supporting that past experience of flooding positively influences public attitudes towards L-SWMPs. Observing that knowledge of stormwater issues in certain Syracuse, NY, neighborhoods was unusually high and not explained by demographic variables, Baptiste (2014) suggested that past experience of localized flooding might affect community members' knowledge, which may drive receptiveness to adopt rain gardens. Subsequent studies support Baptiste's interpretation. In Hong Kong, Chui and Ngai (2016) found that respondents living in city districts with a history of flooding were willing to pay more for green stormwater infrastructure. Coleman et al. (2018) found that Vermont residents who perceived flooding or stormwater problems in their neighborhood were more likely to be willing to adopt rain gardens and infiltration trenches. Only Drescher and Sinasac (2021)'s findings on flood experience were inconsistent. They did not find any significant differences in green infrastructure adoption behavior between neighborhoods with and without a known history of flooding. However, they suggested that it may be because knowledge of the floods had spread across the town through the media and social relationships.

Social practices

Attitudes toward L-SWMPs may be influenced by existing landscape management practices. Flower garden ownership was significantly associated with a higher willingness to pay for rain gardens in a Maryland study (Newburn and Alberini 2016). Shin and McCann (2018a) found that adopters of rain gardens in Columbia, Missouri were likely to spend more time gardening and water their lawns more frequently. However, yard management behavior was less useful as a predictor of adoption intention in the study as it did not distinguish between those who are knowledgeable about raingardens and adopters (Shin and McCann 2018a, b). It is possible that some residents who are serious gardeners may prefer maintaining their existing gardens over adopting an L-SWMP. In case studies, loss of gardening space and confusion over how the practice affects current yard management routines is sometimes cited as a reason for non-participation in rain-garden retrofitting programs (Brown et al., 2016; Turner et al., 2016).

There is also burgeoning evidence that social practices, or routinized behaviors, influence community perceptions and attitudes towards stewardship of L-SWMPs. In a survey of households living near two parks with integrated SuDS features in England and Northern Ireland, Lamond and Everett (2019) found that stated willingness to engage in stewardship practices increased significantly when respondents actively engaged with the site for leisure and recreational activities (e.g., wildlife activities, families playing games). Respondents who used the site for more transitory or functional purposes (e.g., dog-walking, jogging, cycling) were less willing to engage in stewardship behaviors and slightly less concerned about aesthetics.

Characteristics of landscape context

Nearby greenspace

A few studies suggest that public perceptions and attitudes can be influenced by the availability of other types of greenspace. Pedersen et al. (2019) found that a wetland located in a municipality with no other large greenspace

nearby was perceived as more suitable for physical activities and providing more quality-of-life benefits than wetlands in municipalities with access to urban forests and city parks. Shandas (2015) found that residents were more likely to participate in stewardship activities when they had identified their neighborhood as having fewer parks and green spaces. When access to good quality greenspace is lacking, the public may perceive greater amenity value in L-SWMPs, and be more willing to participate in their stewardship.

Two studies have also found significant associations between canopy cover in residential streets and stated willingness to adopt rain gardens (Peng 2010), as well as actual adoption in certain neighborhoods (Lim 2018). However, these findings may indicate a sorting effect, in which people who are inclined to engage with green stormwater infrastructure choose to live in areas with more canopy cover, rather than a causal association.

Land use setting

Several studies discuss land use setting as a potential influence, but studies designed to examine its effects explicitly are limited. Land use setting may modify public perceptions of L-SWMPs by drawing attention to certain characteristics. Greenspace settings, for instance, may help L-SWMPs be more readily recognized a being a 'natural' amenity by the public. Nassauer (2004) found that wetlands located in a natural context in Minnesota were perceived to be significantly more attractive than comparable wetlands located in non-natural settings. Apostolaki (2007) also found that stormwater ponds located in established greenspace or against a backdrop of mature vegetation in Scotland and England were perceived more favorably. In contrast, industrial land use settings may prevent the public from recognizing the practice as a 'natural' feature (Manuel 2003). In residential settings, the public may be particularly attentive to the amenity value and aesthetics of large L-SWMPs. Large L-SWMPs that are well-integrated in a residential neighborhood are seen as important aesthetic and recreational amenities (Leonard et al. 2014; Williams et al. 2019). Pedersen et al. (2019) found that while wetlands located in the residential outskirts of Swedish cities were seen as more suitable for nature appreciation, urban wetlands within a residential context were perceived as being more suitable for social activities.

Neighborhood landscaping norms

Studies consistently highlight the importance of neighborhood landscaping norms in the success of L-SWMP implementation programs. Homeowners may be hesitant to implement novel landscape design and management practices that might lead to disapproval from neighbors or lower their property value (Monaghan et al. 2016a). Spatial clustering of L-SWMP adoption in neighborhoods observed in several studies further supports the importance of landscaping norms and social influence on attitudes towards L-SWMPs (Green et al. 2012; Turner et al. 2016; Lim 2018). Concerns about neighbors' opinions on yard landscaping practices can be even more influential than residents' own perceptions of L-SWMP's utility or attractiveness in determining homeowner adoption intentions and behaviors (Descher and Sinasac 2021). Early and potential adopters of L-SWMPs tend to be less concerned about neighbors' opinions of the practice (Gao et al. 2018; Shin and McCann 2018b).

Other context characteristics

Other aspects of landscape context that have been examined in some studies include accessibility, property characteristics, and population density. Studies have found that people living adjacent to stormwater ponds tend to have more favorable assessments of their amenity value (Emmerling-DiNovo 1995; Abramovic 2000; Bastien et al. 2012; Monaghan et al. 2016a). This effect may reflect sorting in the residential location decisions of people who value access to ponds rather than a causal association.

Property characteristics, such as lot size and property type (i.e., single- or multi-family residential), are also thought to influence attitudes and perceptions. However, while property characteristics have been found to influence structural stormwater practices such as green roofs, strong relationships are not typically found for L-SWMPs (e.g., Ren et al. 2020). Where property characteristics are significant, these findings may also be explained by related factors such as household income or family characteristics. For example, Thurston et al. (2010) found that bid price submitted by residents for rain gardens in a reverse auction was significantly correlated with parcel value, but the study did not control for household income. Syme et al. (2001) found that owners of small lots were significantly more likely to visit wetlands than large lot owners. However, they attributed this finding to family characteristics rather than dissatisfaction with home gardens as there was no significant difference in time spent in home gardens between the two groups.

Finally, results are inconsistent about differences in attitudes and perceptions of people living in urban, suburban, and rural areas (Rooney et al. 2015; Coleman et al. 2018; Shin and McCann 2018b). For instance, Coleman et al. (2018) found that urban respondents were more likely to express intention to adopt rain gardens, while Shin and McCann (2018b) found that suburban residents were more likely to do so.

Noticeable characteristics of L-SWMPs

Wildlife

Studies consistently find that observation of wildlife, particularly birds, is highly valued in L-SWMPs. Observable bird species richness significantly enhanced perceptions of wetland attractiveness in two studies (Mungur 1997; Nassauer 2004). Attracting wildlife and supporting biodiversity is among the most highly valued benefits of ponds and wetlands in surveys of communities living near these practices (Apostolaki 2007; Bastien et al. 2012; Jarvie et al. 2017). Qualitative evidence indicates that the public associates the presence of charismatic wildlife (birds and newts, in one instance) with naturalness and a healthy ecosystem (Leonard et al. 2014; Monaghan et al. 2016a; Williams et al. 2019). However, not all forms of wildlife are welcome. Residents often cite concerns over insects and pest species such as rodents as reasons for non-adoption and disapproval of small L-SWMPs (Brown et al. 2016; Turner et al. 2016; Everett et al. 2018). Some studies report the presence of insects as a perceived disadvantage of living close to a pond or wetland system. Jarvie et al. (2017), for example, found that residents ranked "attracts insects" and "attracts rodents" as the two most significant disadvantages of living near stormwater ponds. In tropical contexts where mosquito-borne illnesses are endemic, creating breeding habitat for these pests is a great concern (Maulan 2006; Tukima 2008).

Vegetation characteristics

Public perceptions of vegetation in L-SWMPs have been widely studied. For certain vegetation characteristics such as plant species selection, findings are consistent across studies. For instance, vividly flowering plants are consistently recognized as attractive by the public (Nassauer 2004; Kim and An 2017; Shi et al. 2017; Nassauer et al. 2021). Mixed reactions from the public are consistently reported for planting schemes that include tall wetland grasses and shrubs, with a majority of respondents finding them messy or unattractive and a minority appreciating their more "natural" appearance (Church 2015; Kim and An 2017; Everett et al. 2018).

Public perceptions of other vegetation characteristics may be context-dependent. In several studies, the presence of trees in L-SWMPs is widely appreciated. In Victoria, Australia, Dobbie and Green (2013) found that the presence of trees was highly noticeable to respondents, and their presence may be associated with perceptions of naturalness, healthiness, and attractiveness in wetlands. In Portland, Oregon, Netusil et al. (2014) found higher property sale prices when tree canopy coverage in the facility is greater. However, a Detroit study found that raingarden designs which included only mown turf or flower beds were preferred over designs with trees (Nassauer et al. 2019). This study concluded that, in contexts where personal safety is a concern, planting designs that obscure sightlines may be perceived as undermining personal safety.

Public perceptions of planting density are similarly context-dependent. In UK and Australian studies, well-established L-SWMPs that are more densely planted with mature vegetation are associated with naturalness and healthiness, especially in greenspace contexts (Apostolaki 2007; Dobbie and Green 2013; Straka et al. 2016). Even for small streetside L-SWMPs, some studies found a preference for densely planted designs with mature vegetation and recognizable diverse species (Netusil et al. 2014; Kim and An 2017). Adkins et al. (2012) in Portland, Oregon found that streets with "deluxe" bioretention facilities were given higher walkability scores than those with "regular" facilities. "Deluxe" facilities were large and heavily planted with shrubs and forbs, while "regular" green street facilities were mown landscape depressions with simple planting. However, dense planting can obscure desirable views and be associated with messiness and neglect. In Florida, residents in a residential community expressed reservations about shoreline vegetation as they obscure views of the "lakes" (Monaghan et al. 2016a; Hu et al. 2017). In Maryland, Irwin et al. (2017), suggested that vegetation overgrowth and other maintenance issues accrued as stormwater basins age 3.5.3 Surface water characteristics.

Studies consistently find that surface water characteristics affect public perceptions and preferences for L-SWMPs. Across studies, residents believe that proximity to L-SWMPs with perennial open water increases their property value (Adams et al. 1984; Baxter et al. 1985; Emmerling-DiNovo 1995; Monaghan et al. 2016a). Proximity to large open water bodies may contribute to residential location choices (Abramovic 2000; Bastien et al. 2012). Studies on the property effects of different urban wetland types also indicate that the public prefers those with open water (Doss and Taff 1996; Mahan et al. 2000). Some studies find that the public more readily recognizes the aesthetic benefits of open water L-SWMPs than stormwater management benefits (Adams et al. 1984; Apostolaki 2007). When hydraulic or ecological improvements affect open water views, conflicts between stormwater managers and property owners can arise (Monaghan et al. 2016a).

Qualitative findings indicate that the public may have more negative perceptions of L-SWMPs with more dynamic surface water regimes, such as infiltration-based practices and wetlands with noticeable fluctuations. When

water levels are drawn down in wetlands during dry seasons, the public may express concern over ecosystem health and dissatisfaction with muddiness and browning vegetation (Manuel 2003; Leonard et al. 2014). The appearance of standing water in infiltration-based practices after storm events may be perceived as local flooding or a malfunction (Church 2015; Everett et al. 2018). Concerns about raingardens potentially causing water damage to property are commonly cited as a reason for non-adoption (Brown et al. 2016; Turner et al. 2016).

Studies are also consistent on public perceptions of dry stormwater basins. While the public recognizes that they perform essential flood control functions, they are widely considered unattractive (Adams et al. 1984; Emmerling-DiNovo 1995). About half of respondents in an Illinois study felt that dry detention basins negatively influenced the image of a subdivision, and estimated homes adjacent to these practices were estimated to be worth 9.6% less on average (Emmerling-DiNovo 1995). These results are consistent with hedonic price analyses of dry detention basins in Texas and Maryland, which found lower property values for homes with a view of or nearby these practices (Lee and Li 2009; Irwin et al. 2017; Sohn et al. 2020).

Finally, water quality is frequently discussed in many qualitative studies of public perceptions of L-SWMPs. Experts and non-experts alike prefer water that is transparent, yellow-green to blue, with low turbidity, and without emergent vegetation (Cottet et al. 2013). When the appearance of water deviates from these standards, the public may raise concerns, especially if they notice unpleasant odors, algae overgrowth, muddiness, fish kills, and the presence of litter (Baxter et al. 1985; Mungur 1997; Walker et al. 2013; Leonard et al. 2014; Monaghan et al. 2016a).

Other noticeable characteristics

Few studies have examined public preferences for shape, side slope, distribution, or size—immediately noticeable characteristics of L-SWMPs. Larger practices present more opportunities for integrating recreation and amenity functions and may be more likely to be recognized as urban nature, depending on context (Nassauer 2004; Church 2015; Kim and An 2017). In contrast to the negative effect smaller dry basins have on property value, Lee and Li (2009) found that a large dry basin integrated with recreational facilities had a significant positive effect on nearby property prices in Texas. In a hedonic model estimating the effects of wetland proximity on property price, Mahan et al. (2000) found higher property values associated with larger nearby wetlands. Comparative case studies of water sensitive developments in UK and Australia also found that respondents living in developments with large ponds and wetlands were more likely to indicate that L-SWMPs affected their home choice and were more positive about their residential landscape (Bastien et al. 2012; Walker et al. 2013; Leonard et al. 2014; Williams et al. 2019). Property price effects of practice size have also been found for bioretention features (Netusil et al. 2014). Respondents in a Portland study pointed out larger rain gardens as more representative of nature in the city with greater habitat value than smaller streetside facilities (Church 2015).

Evidence is limited about other noticeable characteristics that may influence perceptions. Steep side slopes of wet and dry detention basins can raise concerns about the safety of children and pets (Apostolaki 2007; Tukima 2008). Linear forms may be less preferred than areal shapes, at least for larger wetlands (Mahan et al. 2000). There may also be positive property price impacts when small L-SWMPs are more spatially clustered together (Netusil et al. 2014).

DISCUSSION

The relevance of public perceptions and attitudes for environmental management has been emphasized in recent reviews on natural and constructed hydrological systems (Venkataramanan et al. 2020; Flotemersch and Aho 2021). Our review aims to assist policy-making and innovation by directing attention to characteristics of individuals, landscape context, and noticeable characteristics of L-SWMPs that are objective, measurable, and can affect public response to L-SWMP proposals and implementation. Here, we consider the implications of our findings and identify important research gaps.

Demographic characteristics are widely examined in quantitative studies, but they are generally poor predictors, only indirectly and inconsistently related to L-SWMP perceptions, attitudes, or social outcomes (Baptiste 2014; Lamond and Everett 2019). In our review, education attainment is the most consistently predictive demographic variable. Across studies, highly educated individuals are more likely to have positive attitudes toward L-SWMPs. The effect of gender is consistent directionally but weak. Gender is significant in only a few studies. In those, women are more likely to have positive attitudes toward L-SWMPs. Age, homeownership, length of residency, and family structure are significant in many studies, but the directionality of their effect varies, with different causal explanations proposed. For example, older people may have greater environmental knowledge and self-efficacy (Baptiste 2014), but they also may have more health and mobility challenges that affect their attitudes (Shin and McCann 2018b). Homeowners might show more interest in L-SWMPs to protect their property from flooding, but they

also may be more risk-averse in adopting practices that could reduce property values. Future research to examine causality can help decision-makers and designers develop L-SWMP policies and innovations to meet the needs and expectations of different communities.

Greater environmental knowledge is associated with more positive perceptions and attitudes. Over time, as the public develops greater environmental knowledge, their perceptions and attitudes may become more similar to those of experts (Flotemersch and Aho 2021), but this similarity cannot be assumed. For decision-makers, an important question is whether informational interventions can effectively increase public support and participation. The literature suggests that informational interventions may be more effective in influencing perceptions of L-SWMPs in public property than in private property. Informational signage and "artful" designs (Echols 2007; Church 2015) may enable spontaneous learning about the function and benefits associated with labeled L-SWMPs, while simultaneously communicating intentionality behind unconventional landscape appearances (Nassauer 2004; Dobbie 2016). Incorporating such design elements in L-SWMPs in public spaces can positively influence perceptions. In the context of private property, informational interventions (e.g., public education campaigns) are limited in effectiveness. Members of the public generally do not consider stormwater management their responsibility (Dobbie 2016; Johnston 2017; Nassauer et al. 2021). They may be reluctant to change current landscape management practices or take on perceived risks of adopting an L-SWMP in their own yards (Brown et al. 2016; Turner et al. 2016) when they do not perceive direct benefits. However, experience of flooding has been associated with more positive attitudes toward L-SWMPs in several studies (Chui and Ngai 2016; Dean et al. 2016; Coleman et al. 2018; Mason et al. 2019). Personal experience may help the public appreciate the value of L-SWMPs.

L-SWMP pilot projects may help increase community interest in adoption. Leveraging the visibility of L-SWMPs through attractive pilot projects in high-traffic areas may increase knowledge of these practices and interest in adoption (Montalto et al. 2013; Lim 2018). For success, pilot L-SWMP programs also need to pay close attention to the ease of maintaining L-SWMPs with existing landscape management routines (Nassauer et al. 2021). People's attitudes towards L-SWMPs may change over time with experience and engagement (Shandas 2015). Positive to neutral experiences with L-SWMPs will likely foster long-term community acceptance, while poor experiences (e.g., declining maintenance standards) may harden community attitudes against them (Hammitt 2010). Paying closer attention to how L-SWMP pilot projects may disrupt or enhance customary behaviors and practices may help stormwater managers develop L-SWMP designs and retrofitting programs that local residents will widely welcome.

Landscape context has implications for what types of L-SWMPs should be located in different contexts. The availability of other nearby greenspaces may reduce the perceived amenity value of new L-SWMP greenspaces, possibly dampening residents' willingness to participate in their stewardship. Locating L-SWMPs where greenspace amenities are lacking may lead to more positive community perceptions, particularly if new greenspaces are within residential areas. This approach could also support more equitable access to urban greenspace (Wendel et al. 2011; Meerow and Newell 2017).

Land use context likely influences how L-SWMPs are perceived, but quantitative studies are limited. There is consistent evidence from multiple studies that L-SWMPs in greenspace settings are perceived as 'natural' and attractive, and more positively than in other land uses. However, it is unclear if this means that retrofitting existing greenspaces with L-SWMPs will be well-received. In an Italian study, Reynaud et al. (2017) suggested that there may be positive synergistic effects of incorporating stormwater treatment features in greenspace. However, other hedonic price studies did not find any significant effects of retrofitting L-SWMPs in existing parks (Hoover et al. 2020). In some cases, the public may even prefer greenspace without these practices. In an image-based UK study, O'Donnell et al. (2020) found that greater preference for greenspace without SuDS, which were perceived as more attractive, tidier, and safer. From this, we infer that L-SWMPs may be most welcomed in, or adjacent to, underutilized urban spaces or as part of establishing new parks or open spaces rather than in visible areas of well-established parks. For other land use contexts, further research is needed to anticipate how L-SWMPs can be perceived as benefiting local communities.

There is consistent evidence that neighborhood landscape norms affect public attitudes toward L-SWMPs. Internalized social rules and conventions govern many landscaping practices in residential areas (Li and Nassauer 2020), both informally and through neighborhood associations that hold members to certain yard maintenance standards. Neighborhood landscape norms may be even more important than the individuals' perceptions of a practice in determining landscape management behaviors (Drescher and Sinasac 2021). This implies that persuading individual homeowners to adopt L-SWMPs that deviate from existing neighborhood norms may not be the most effective way to scale up L-SWMP implementation. Instead, design and engagement efforts should be focused at the scale of a neighborhood development. A unified neighborhood-scale plan may help to circumvent

individual householders' concerns about affecting "neighborhood character"(Turner et al. 2016).

More quantitative studies are needed that address public perceptions and attitudes specifically influenced by noticeable L-SWMP. Evidence that is well-established for aquatic systems more generally is also consistent for a few characteristics of L-SWMPs. For example, the presence of birds and large areas of open water in a practice are well-received. Vividly flowering species are consistently recognized as attractive. Larger practices tend to be perceived as more natural and providing more amenity benefits (Nassauer 2004; Lee and Li 2009). L-SWMPs that incorporate each of these characteristics are most likely to be well-received by the public. However, noticeable characteristics of L-SWMPs are often minimally or not described in the studies reviewed. Survey instruments do not always provide example images to establish an understanding of the appearance of the practice. This can be problematic, given typically low levels of public awareness and knowledge about L-SWMPs (Venkataramanan et al. 2020). Where study outcomes vary, we suggest this may be related to unexamined differences in the appearance of L-SWMPs. Visually important characteristics such as size, presence of open water, and vegetation design can vary greatly in L-SWMP case studies. However, studies seldom examine these distinctions in their research design and analyses. Critically, opportunities to modify or innovate L-SWMPs designs to respond to community preferences remain unrealized.

LIMITATIONS

Some limitations of our review affect its applicability to practice and policy. First, the studies reviewed are predominantly conducted in North America (specifically the US and Canada), Europe (UK), and Australia. There may be broader cultural differences influencing public perceptions and attitudes that limit the generalizability of this review to other cultural contexts. In addition, the geography of these studies over-represents temperate and continental climates. Differences in hydrologic regimes and human experiences in places with tropical and arid climates may lead to differences in functional requirements for L-SWMPs and differences in public perceptions and attitudes (Burmil et al. 1999). For instance, in tropical and subtropical regions where diseases spread by mosquito vectors are endemic, the public may be especially concerned about surface water characteristics and planting designs that can enable stagnant water to accumulate. Finally, the characteristics we have reviewed are not conceptually exhaustive but include only those that have been explicitly examined in the literature we selected.

CONCLUSION

This review sought to synthesize L-SWMP literature to identify research gaps and inform practitioners and decision-makers about how public perceptions, attitudes, and behaviors might better support desired hydrologic outcomes. We conclude with some key conclusions for practice, policy, and future research.

Considering characteristics of individual community members of the public, we found that an individual's environmental knowledge and past experience of stormwater problems like flooding has a stronger and more consistent influence on public perception, attitudes, and outcomes than demographic variables. The effectiveness of informational interventions and public education campaigns may differ between L-SWMPs in private and public contexts. Providing information about their socioenvironmental benefits may improve community perceptions of L-SWMPs in public spaces, but may not be sufficient to change attitudes and landscape management behaviors on private property when direct personal benefits are not obvious.

The landscape context of an L-SWMP is likely to influence its perceived amenity value, which influences public attitudes and outcomes. Practices placed in residential contexts that lack access to high-quality greenspace may be more valued and could address existing greenspace inequities. The strong influence of neighborhood landscape norms suggests that L-SWMP retrofitting plans that target individual householders may not be well-received if the practice deviates from existing landscape norms. Instead, retrofitting or developing L-SWMPs with respect for norms at the neighborhood scale may be more effective. We urge greater attention to existing community preferences, practices, and customary behaviors when L-SWMPs are proposed and implemented. We highlight the importance of reliable maintenance of L-SWMPs that fits with neighborhood norms.

Finally, we identified some widely-valued L-SWMP characteristics—the presence of birds, large areas of open water, and vividly flowering plants. Incorporating these characteristics in L-SWMPs may improve perceptions, attitudes, and societal outcomes. More attention to noticeable characteristics is needed to inform L-SWMP design and maintenance decisions and innovations. This attention should extend to relationships between these noticeable characteristics and the ecological and hydrologic functions of L-SWMPs. Our review suggests that perceptions, attitudes, and behaviors are affected by noticeable landscape characteristics, but the implications of these characteristics for design and management should be considered in concert with their environmental and hydrologic effects. For instance, meeting community

preferences for open water that fluctuates minimally has implications for storage volume and pollutant removal (Wong et al. 1999). Several characteristics of L-SWMP vegetation impacting their aesthetic appeal are also biologically significant in affecting water uptake and nutrient assimilation (Rippy et al. 2021). Contrasting the amenity benefits of larger L-SWMPs with limited success in pervasive adoption of small L-SWMPs has implications for implementing a hydrologically optimal mix of practices under different stormwater management contexts. With more complete knowledge of the influence of L-SWMP characteristics on public perceptions, attitudes, and behaviors, decision-makers may be able to design innovations that ensure community acceptance while supporting ecological functions and meeting stormwater performance requirements.

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