Integration of ecological knowledge in European landscape architecture:

a systematic project-description review

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Research highlights:

1. There is a growing trend towards the inclusion of ecological considerations in landscape architecture when reviewing project descriptions.

2. Evidence from the widely recognised project-platform Landezine suggests that ecological integration remains the exception rather than standard practice in reporting.

3. Dispersal and abiotic factors are more frequently addressed than biotic factors and feedback mechanisms.

4. Critical ecological knowledge areas to support biodiversity and optimizing ecosystem functions are largely absent in project descriptions.

Abstract

Landscape architecture has a strong environmental focus and clearly states the ambition to integrate ecological knowledge in its practice and theory. This study aims to assess the state of the art in integrating ecology in landscape architecture project design, identifying well-integrated ecological knowledge areas and potential knowledge gaps, to support future development of this integration.

This systematic review sampled project descriptions published between 2010 and 2023 on the platform Landezine. The project descriptions were assessed by a team of ecologists to identify and categorize presented ecological knowledge. The categories (dispersal, abiotic, biotic factors and feedback mechanisms) were based on the Ecological Filters Framework, derived from a well-established concept in community ecology.

Out of 579 project descriptions, 30% included one ecology keyword, while 13% met the inclusion criteria and were reviewed. The proportion of ecological-content descriptions has increased over time. Dispersal factors, including landscape ecological considerations, were the most frequently mentioned; followed by abiotic factors, with water availability being the most common. However, biotic factors and feedback mechanisms, were largely absent in the descriptions.

This study highlights that the inclusion of ecological content in landscape architecture project descriptions is becoming more prevalent but remained extraordinary in the assessed timeframe, contrary to clearly stated ambitions. Notably, knowledge categories critical for optimizing ecosystem functions (biotic factors) and predicting long-term ecological community development (feedback mechanisms) are significant gaps. Addressing these gaps is essential for advancing ecological integration and promoting sustainability.

Introduction

Landscape architecture, the art and practice of planning, designing and building environments, is, due to the nature of its work, at the forefront of tackling challenges posed by the crises of the Anthropocene. *The profession** has a strong focus on environmental matters (IFLA World 2014; IFLA Europe 2025a) and aims to be a leading force towards the 17 sustainable development goals with inherently interdisciplinary approaches to solve multilayered problems (IFLA World 2021). The European branch of the International Federation of Landscape Architecture (IFLA Europe) subscribes to the 2030 objectives of the EU Biodiversity Strategy (EU 2021) and the targets of the post-2020 Global Biodiversity Framework (CBD 2023) in emphasizing the landscape architect's roles in promoting biodiversity (IFLA Europe 2023). Goals and strategies include to "improve and restore ecosystems" by "using ecologically sensitive management and maintenance practices" to realize "ecosystem-based designs" and "ensure ecosystem services" (IFLA Europe 2025b). This agenda, to design for ecological sustainability, implicates the need for a strong integration of ecological knowledge in landscape architecture.

Landscape architecture practitioners design real-world, site-based interventions for environmental, social-behavioural, and aesthetic outcomes on many scales (Jellicoe and Jellicoe 1995). This includes e.g. urban green infrastructure, parks, plazas, regional planning, and habitat restoration. On a conceptual level, projects can find guidance for ecological sustainability in global frameworks and recommendations, such as set forth by e.g. Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Service (IPBES). The IPBES report (IPBES 2019) highlights the urgency of halting biodiversity loss and restoring ecosystems without landscape specific advice but provides general recommendations on building sustainable cities. These include to "engage in sustainable urban planning" by

78 “including biodiversity protection”, “promoting nature-based solutions”, “ecosystem based-
79 adaptation” and “maintaining and designing for ecological connectivity”. However, design for
80 ecological sustainability needs knowledge that can guide interventions relevant to the given
81 site context. The scientific discipline of ecology* can provide this knowledge with foundational
82 principles applicable to varying contexts which is necessary to shape landscapes as
83 ecosystems that support biodiversity, people and their interconnected well-being (Lundholm
84 2015).
85 With the escalating biodiversity crisis, developing and managing landscapes demands
86 increasing focus on *ecosystem integrity** and *ecosystem functions** to sustain biodiversity and
87 *ecosystem services**/*nature’s contributions to people** (Ellis, Pascual, and Mertz 2019).
88 *Community ecological** theory can provide guidance in this regard, for instance with how
89 organisms assemble to *ecological communities** (Götzenberger et al. 2012) and how
90 community assemblies are related to ecosystem integrity (Jochum et al. 2020). However, the
91 workings of communities in their ecosystems* are highly complex and context dependent
92 (Riva et al. 2023) making the endeavour of integrating community ecology in the
93 multidimensional problem solving of landscape architecture a non-trivial task (Reed et al.
94 2021; Riva et al. 2023).
95 The need for guiding frameworks to approach this task is increasingly recognized (Musacchio
96 2009; Ahern 2013; Qiu et al. 2025). One such framework is the Ecological Filters Framework
97 (Breitschopf, Clemmensen, and Bråthen, in prep) that structures community ecological
98 knowledge into tangible categories (dispersal, abiotic, biotic factors, feedback mechanisms,
99 and aesthetic considerations (Figure 1)). It thereby aims to ameliorate the challenge of
100 complexity when integrating ecology in landscape architecture.

In this study we recognize this challenge and seek to support further integration of ecology in landscape architecture. We analyse the state of the art in integrating ecology in landscape architecture projects from the perspective of ecologists and identify gaps that can guide future efforts. We employ the Ecological Filters Framework (Breitschopf, Clemmensen, and Bråthen, in prep) in a review of 75 contemporary landscape architecture project descriptions.

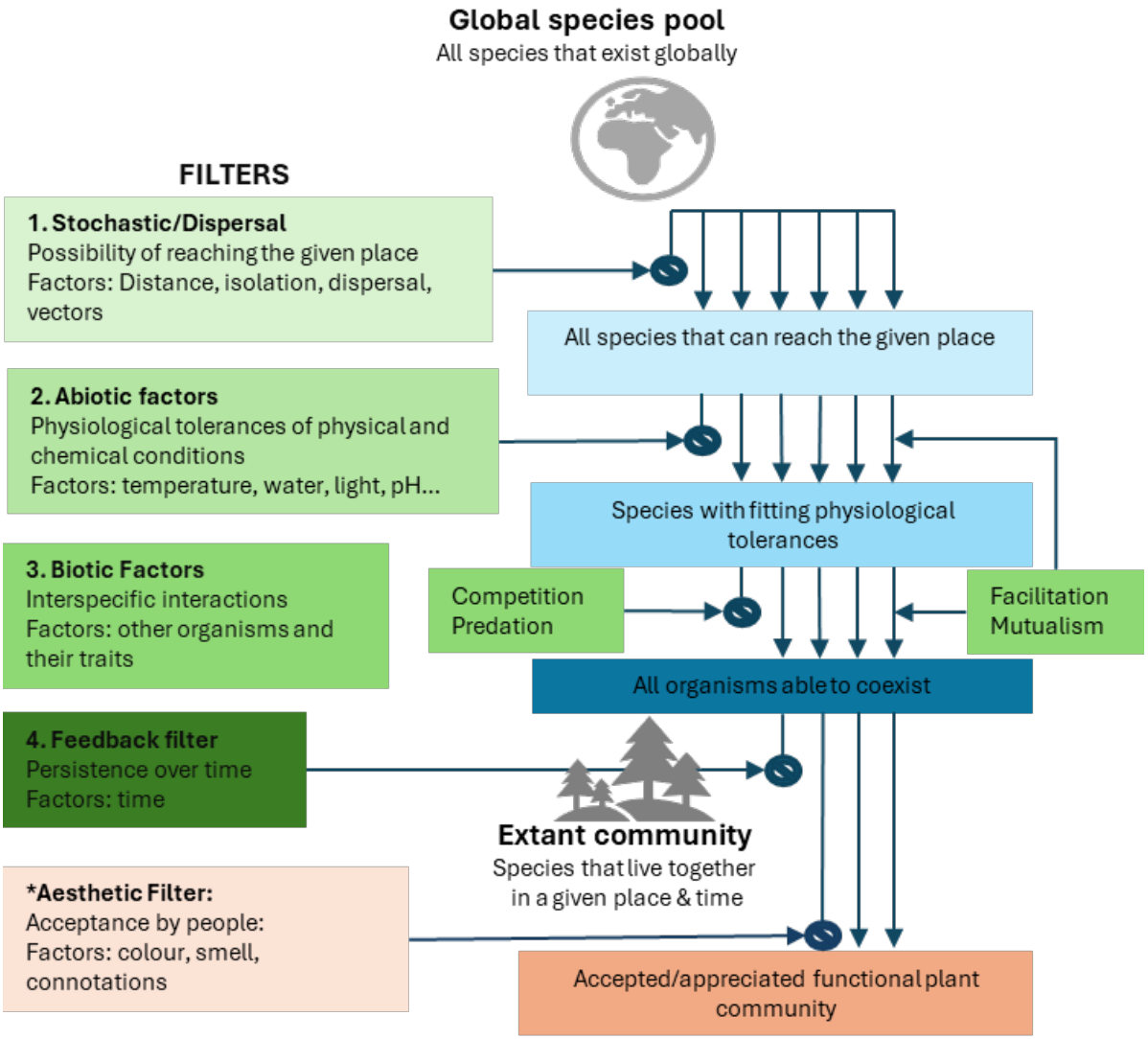

***Figure 1**: The Ecological Filters Framework is intended as a design tool to aid decision-making in landscape architecture with insights from community ecology. It draws inspiration from the integrated community theory (ICT) (Lortie et al. 2004), which uses the metaphor of filters that "filter" the global species pool, allowing only species that "pass" these filters to become part of the local community. Considering these filters on a conceptional level, e.g. for species selection, site modification and design strategies, could enhance ecological functioning in landscape architecture projects. This illustration is originally presented in Breitschopf, Clemmensen, and Bråthen (in prep) with a detailed description of the EFF.*

TERMS AND DEFINITIONS

Landscape Architecture profession

"Landscape Architects plan, design and manage natural and built environments, applying aesthetic and scientific principles to address ecological sustainability, quality and health of landscapes, collective memory, heritage and culture, and territorial justice. By leading and coordinating other disciplines, landscape architects deal with the interactions between natural and cultural ecosystems, such as adaptation and mitigation related to climate change and the stability of ecosystems, socio-economic improvements, and community health and welfare to create places that anticipate social and economic well-being." (IFLA Europe 2025a)

Ecology

"The study of relationships between living things and their environment" (Oxford English Dictionary 2025; Bowman and Hacker 2024)

"Science that studies how the distribution and abundance of organisms on Earth is shaped by both biotic and abiotic factors" (Begon and Townsend 2020).

Community Ecology

Subdiscipline of ecology studying the origin, maintenance, and consequences of biological diversity within local communities. (Morin 2011)

Landscape Ecology

The study of the structure (spatial relationships among distinctive landscape elements), function (flows of energy, materials, and species among landscape elements), and dynamics (temporal change in landscape structure and function) of landscapes. (Forman 1986)

Ecosystem

All the organisms in a given area as well as the physical environment in which they live; an ecosystem can include one or more communities (Bowman and Hacker 2024)

Ecological community

A group of interacting species that occur together at the same place and time (Bowman and Hacker 2024)

Ecosystem integrity

"The ability of an ecosystem to support and maintain ecological processes and a diverse community of organisms" (IPBES 2019)

Ecosystem functions

Ecological processes such as primary productivity, decomposition and nutrient cycling (Jax 2005)

Ecosystem services

Natural processes that sustain human life and that depend on the functional integrity of natural communities and ecosystems (Bowman and Hacker 2024)

Natures contribution to people

All the contributions, both positive and negative, of living nature (i.e. all organisms, ecosystems, and their associated ecological and evolutionary processes) to people's quality of life. Beneficial contributions include e.g. food provision, water purification, flood control, and artistic inspiration, whereas detrimental contributions include e.g. disease transmission and predation that damages people or their assets. NCP may be perceived as benefits or detriments depending on the cultural, temporal or spatial context (IPBES 2019)

Material and Methods

Study design

Systematic Review

To systematically review descriptions of realized landscape architecture projects in Europe for ecological content we applied the Ecological Filters Framework (EFF (Breitschopf, Clemmensen, and Bråthen, in prep). This framework is based in the Integrated Community Theory (ICT) formalized by Lortie et al. (2004) and was developed as a tool to facilitate the integration of ecology in landscape architecture. It structures community ecological knowledge into four categories: dispersal, abiotic and biotic factors, feedback mechanisms additional to the fifth category concerning aesthetic factors. We developed the review protocol (Appendix) based on the framework's ecological categories to investigate which categories of ecological knowledge relevant for ecologically sustainable design are described in project descriptions on the online landscape architecture platform Landezine (landezine.com). This international platform provides an arena to publish articles, products and descriptions of landscape architecture projects. It claims to feature the largest collection of landscape projects online and to be the most visited in the field (Landezine 2019). We chose to restrict the review of project descriptions to Landezine to ensure comparability between the projects given by the format, language and intention of the platform and a focus on the most common way of portraying projects to the public.

Project descriptions were sampled online. The descriptions meeting the inclusion criteria were reviewed by our team of ecologists systematically applying the review protocol.

This approach analyses how the integration of ecology is described and communicated to the public in the setting of showcasing a project. We assume a correlation to the actual integration

of ecology in on-site interventions but acknowledge that what is communicated is not necessarily a full representation of actual integration.

Sampling project descriptions for review

In June 2023 we sampled Landezine for project descriptions.

By using the platform's own filter function, we sampled project descriptions from the 34 member countries of IFLA Europe of which 28 were represented (Figure 4 and 5). Available descriptions were sampled and saved as text files. We sampled up to a maximum of 40 descriptions per country to ensure an appropriate sample size maintaining feasibility. The reference list for sampled projects is available with the archived dataset.

Inclusion criteria for project descriptions for analysis

Project descriptions published between 2010 and 2023 were included to capture the development after and around landmarks in global environmental science and policy such as the Millennium Ecosystem Assessment in 2005 (Millenium Ecosystem Assessment 2005), the establishing of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services in 2012 (IPBES 2013) and the Paris Agreement in 2015 (UNFCCC 2016).

To sample the projects most likely to contain ecological content we scanned all the project descriptions for the keywords "biodiversity", "species", "habitat" and all words starting with "eco", excluding "econ" in order to include all words of the ecology family ("ecology", "ecological", "eco-friendly") without including words of the economy family. We henceforth refer to the keyword indicating inclusion of ecology as "ecology keywords". Only texts containing a minimum of three ecology keywords were included for analysis. Further, we only included texts with 250 words or more, excluding descriptions likely too short to contain analysable ecological content. This process yielded 76 project descriptions for analysis.

Project description analysis

Reviewers and reviewer calibration

The project descriptions were analysed by eight reviewers in pairs in a workshop setting. All reviewers had a background in ecology at minimum Master level, specializing in differing subdisciplines (Table 1) ensuring expertise to spot the inclusion of ecological knowledge in a wide range of fields. The reviewers received an introductory presentation on the logic of the research design and the EFF additional to an introduction to the structure of the review protocol prior to the workshop.

To ensure comparability in the reviewers' assessments we started the workshop with a calibration session. All reviewers calibrated by applying the review protocol on a common project description in plenum which resulted in clarifications in the protocol. Following this, each reviewer analysed the same project description independently, followed up by a discussion in plenum to further calibrate and practice reaching a consensus.

Further facilitating assessment comparability, avoiding individual reviewer bias we analysed the project descriptions in different pairings, changing partners throughout the workshop. A maximum of 8 project descriptions was analysed by the same pair. After analysis of each project description the reviewer pairs self-assessed their level of discrepancy ("high", "moderate", "low") reflecting the amount of discussion needed to reach consensus.

Table 1: *Reviewers with their field of expertise.*

REVIEWER	EXPERTISE
AJ	Plant ecologist; plant phenology, remote sensing, vegetation monitoring, microclimate
EB	Plant ecologist; ecology for landscape architecture, biodiversity, community ecology
FB	Ecologist; climate change ecology, plant ecology, herbivore-environment relationships, Arctic ecology
IP	Ecologist; remote sensing, herbivore-environment relationships, ecological monitoring
LB	Ecologist; socio-ecological systems, climate mitigation, public participatory mapping, local and indigenous knowledge
SS	Landscape ecologist/geographer; climate change ecology, ecosystem processes, remote sensing
SZ	Plant ecologist/geographer, ecosystem processes, climate trends, carbon cycles
ZK	Wildlife ecologist; nature-based solutions, socio-ecological systems, natural resource management

Review protocol

The project descriptions were accessed on https://landezine.com directly to include image material provided on the platform. The reviewer pairs read the project descriptions independently and followed the review protocol to analyse them collaboratively.

The review protocol was structured based on the EFF and in the form of questions with yes/no, multiple choice or Likert-scale like answers and one free text answer (Appendix).

The first set of questions (A, 1-8) aimed at ensuring relevance of the project description and characterizing the described projects. The second set of questions (B, 9-20) assessed the overall inclusion and importance given to ecology in the description, and focus and resolution

of the project guided by the EFF. Here questions were structured into subtopics reflecting the filters in the EFF (dispersal, abiotic, biotic, feedback) and multiple-choice options were given. The third set of questions (C, 20-32) asked for an interpretation from an ecologist's point of view on how ecological content was described. The last subset (29 – 32) asked the reviewers to assign points for considerations in each filter that was detectable in the project description.

Sampling project descriptions for wider context

To enable setting the results gained from this review of project descriptions on Landezine in a wider context we surveyed European landscape architects' expert opinion on the most important ecology-related projects. We created an online survey (Table 2) with nettskjema.no, developed and hosted by the University of Oslo. The invitation to participate was sent out to 743 email addresses publicly available across the IFLA Europe member countries. We sampled the email-addresses on official websites of institutions teaching landscape architecture or landscape architecture firms and included the main offices of the IFLA Europe member countries with the kind request to distribute it further. The invitation informed that participation is voluntary, that participants will remain anonymous and that they consent to their answers being used in the study by sending in their response.

We looked up the project descriptions of the suggested projects and investigated whether they are found on Landezine, even when this was not the source given by the survey participants.

Table 2: *Survey on expert opinion, question 1 to 3*

1.	Which ecology-related landscape architecture project, realized in Europe between 2010 and 2023, would you consider as the most important? Any information to identify the project (e.g. title, firm, names, country, city,...or a link to a description) is highly appreciated.
2.	Which are the next 2 (or more) ecology-related projects, realized in Europe between 2010 and 2023, that come to mind? Any information to identify the projects (e.g. title, firm, names, country, city,...or a link to a description) is highly appreciated.
3.	Which country do you work in?

Statistical analysis

All statistical analysis was performed in R 4.4.2 (R Core Team 2024).

Text files containing the project description were analysed using the "stringr" package (H Wickham 2023). We calculated frequencies and proportions to describe the temporal, geographic distributions of project descriptions with ecological content. To describe the distribution of ecological content we used percentages.

We produced the figures relying on the packages "plotly" (Sievert 2020), "ggplot2" (Hadley Wickham 2016), "ggforce"(Pedersen 2024) and "rnaturalearth" (Massicotte and South 2023). The projects recommended in the expert-survey were described with frequencies and percentages.

Results

Sample overview

A total of 579 project descriptions were sampled, of which 76 met the inclusion criteria and were reviewed (Figure 2). During the review process, one additional project description was excluded as it referred to an unbuilt project.

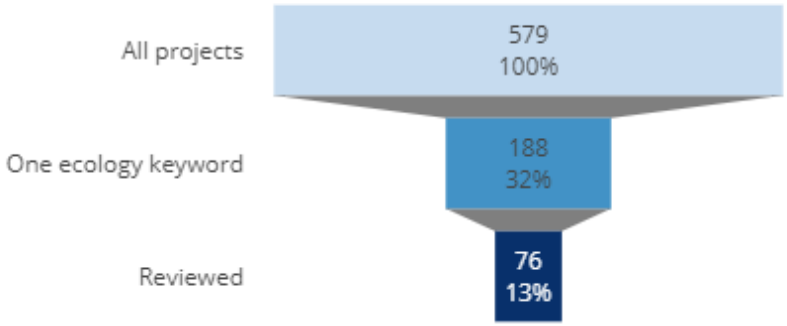

Figure 2: Sample distribution: *Total number and percentage of all sampled project descriptions, the project descriptions with one ecology keyword, and the descriptions that were reviewed (including three keywords in a wordcount of at least 250)*

Temporal development

The number of project descriptions published annually on Landezine has steadily increased; as has the number of descriptions per year that include one ecology keyword, and the number of descriptions per year that were included for review (Figure 3). The proportion of descriptions containing one keyword, as well as the number of descriptions included in the review, relative to the total number of descriptions per year also exhibited an upward trend (Figure 3).

No descriptions for projects built before 2004 included ecology keywords. The highest proportion of descriptions containing one ecology keyword was observed in 2020 (45.83%). The maximum proportion of reviewed descriptions was 24.49%, also in 2020. Data for 2022 and 2023 were excluded from the temporal analysis due to a likely publication time lag, which resulted in unrepresentatively low total numbers of sampled description in these years.

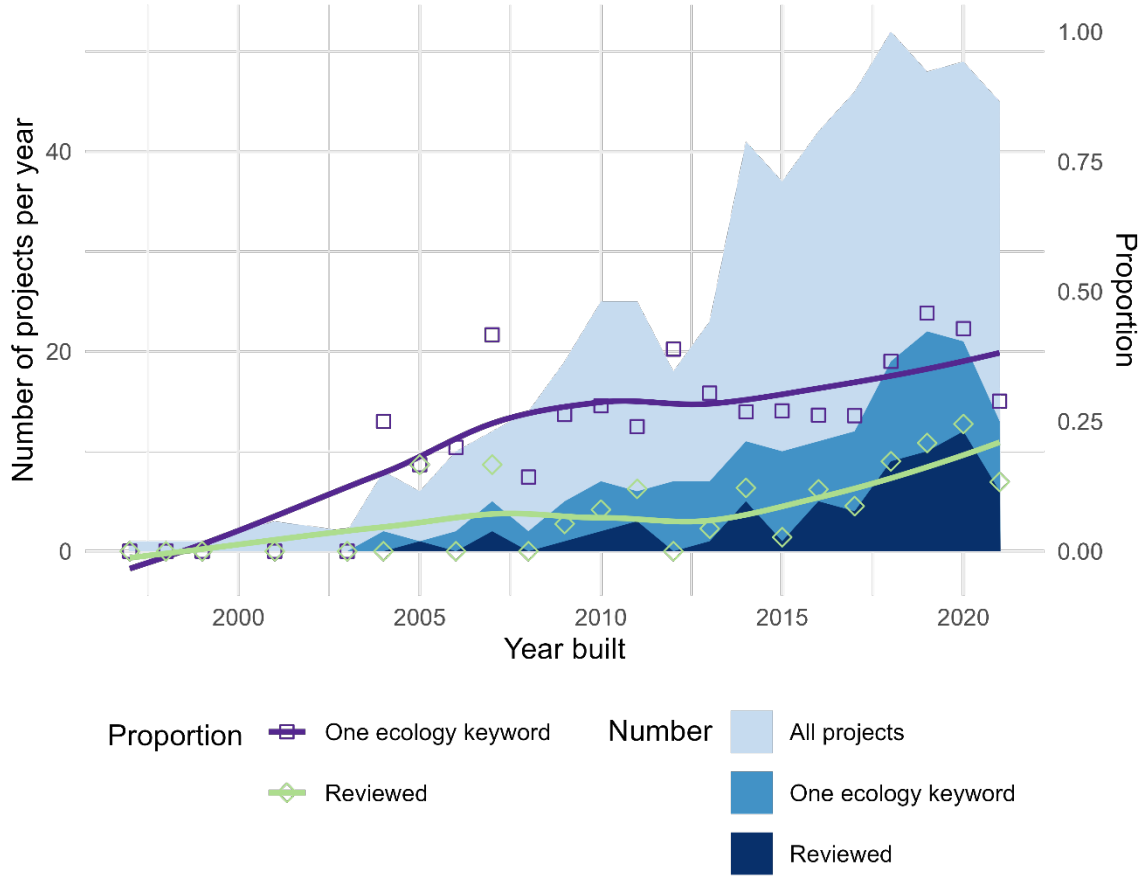

Figure 3: Temporal distribution. *Total numbers of project descriptions over time by the year the project was built (shades of blue, axis left). Proportion of all descriptions per year of descriptions that contain one ecology keyword (purple squares) and the reviewed projects (green diamonds). Smoothed trendlines show an increase of proportion over time. Data points for 2022 and 2023 were excluded to avoid skewing the temporal trends due to low numbers of published descriptions likely caused by a publication time lag.*

Geographic distribution

The number of project descriptions published per country varied strongly, with ecology keywords unevenly distributed among IFLA Europe member counties (Figure 4). The United Kingdom accounted for the highest number of descriptions containing one ecology keyword (n = 27, 67.5%) and the highest number of reviewed descriptions (n = 18, 45%). For several countries, no ecology keywords were detected in the published descriptions (Figure 4 and 5).

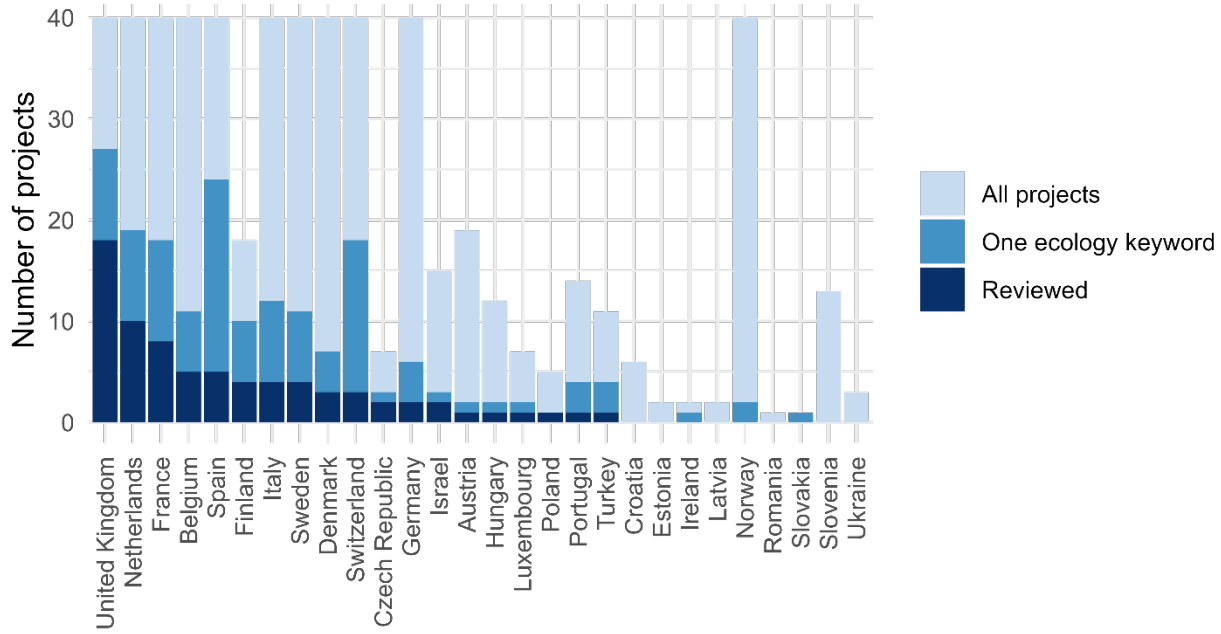

Figure 4: Geographical distribution. *Number of project descriptions per country, ordered by the number of reviewed project descriptions.*

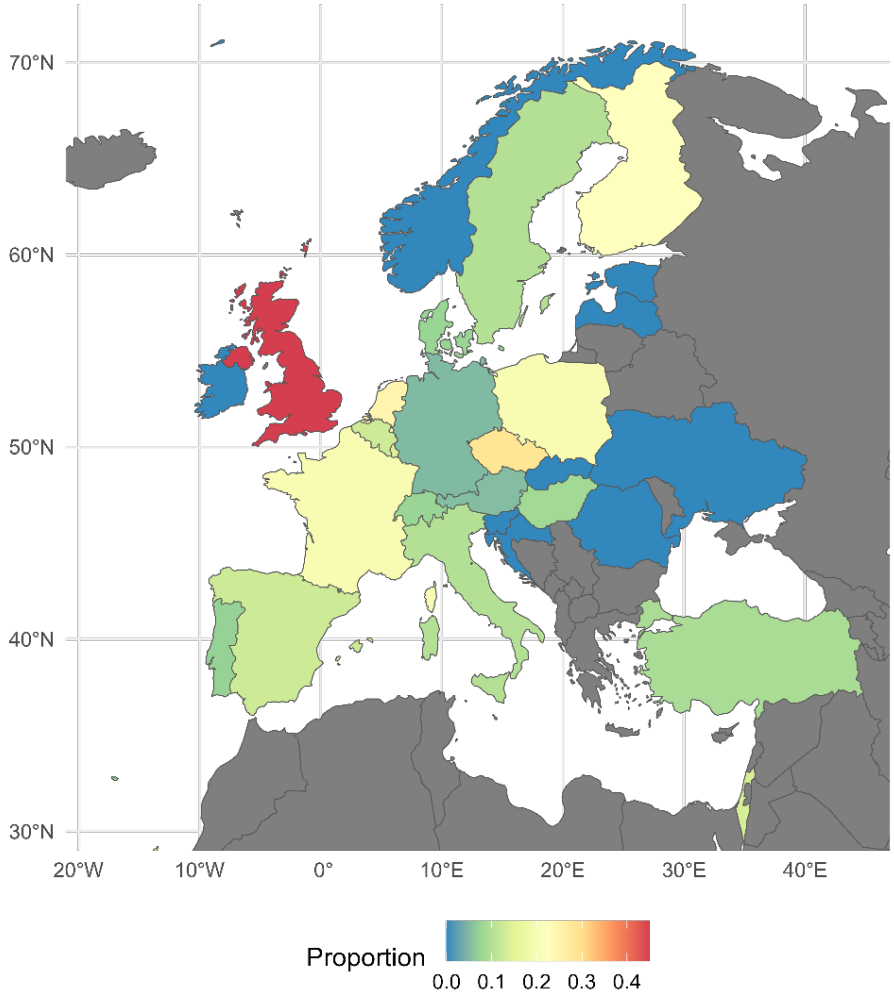

Figure 5: Heatmap geographical distribution*. Colours refer to the proportion of reviewed project descriptions to the total number of sampled project descriptions per country.*

Ecological content

Points

Of the reviewed project descriptions, 12 did not receive any points, indicating no ecological content was described despite the inclusion of three or more ecology keywords. Most descriptions received one point (n = 23, 30.67%), followed by 11 descriptions (14.6%) that received two points. The maximum score for a single project description was 12 points (Figure 6). We assigned a mean score of 2.59 across all descriptions and filters.

The highest score within a single filter was five points (abiotic filter), followed by four points (dispersal filter) and three points in the biotic and feedback filters respectively (Figure 6). Average points per description varied across filters: dispersal, 0.91; abiotic, 0.80; biotic, 0.47; and feedback 0.41.

Content

The dispersal filter was the most comprehensively addressed, primarily due to the frequent description of local species pools, particularly plant species (Figure 7). However, invasive species were mentioned in only three descriptions. Habitat fragmentation was also commonly addressed, with many projects focusing on connectivity within the project area (n = 17).

The abiotic filter was the second most frequently described, with 56% of project descriptions addressing at least one abiotic factor. Water was the most frequently mentioned abiotic factor, appearing in 38.66% of the project descriptions (Figure 7).

The biotic and feedback filters were least frequently addressed. While the biotic filter received slightly more attention, biodiversity was often described only superficially, rarely more precise than the present nature type. Most project descriptions (n = 59, 78.66%) did not describe biotic interactions. Similarly, 73.33% of project descriptions did not mention ecological content related to the feedback filter. Within this filter, succession was included by

the highest number of projects (n=9, 12%) while other feedback mechanisms were included by only five or less projects.

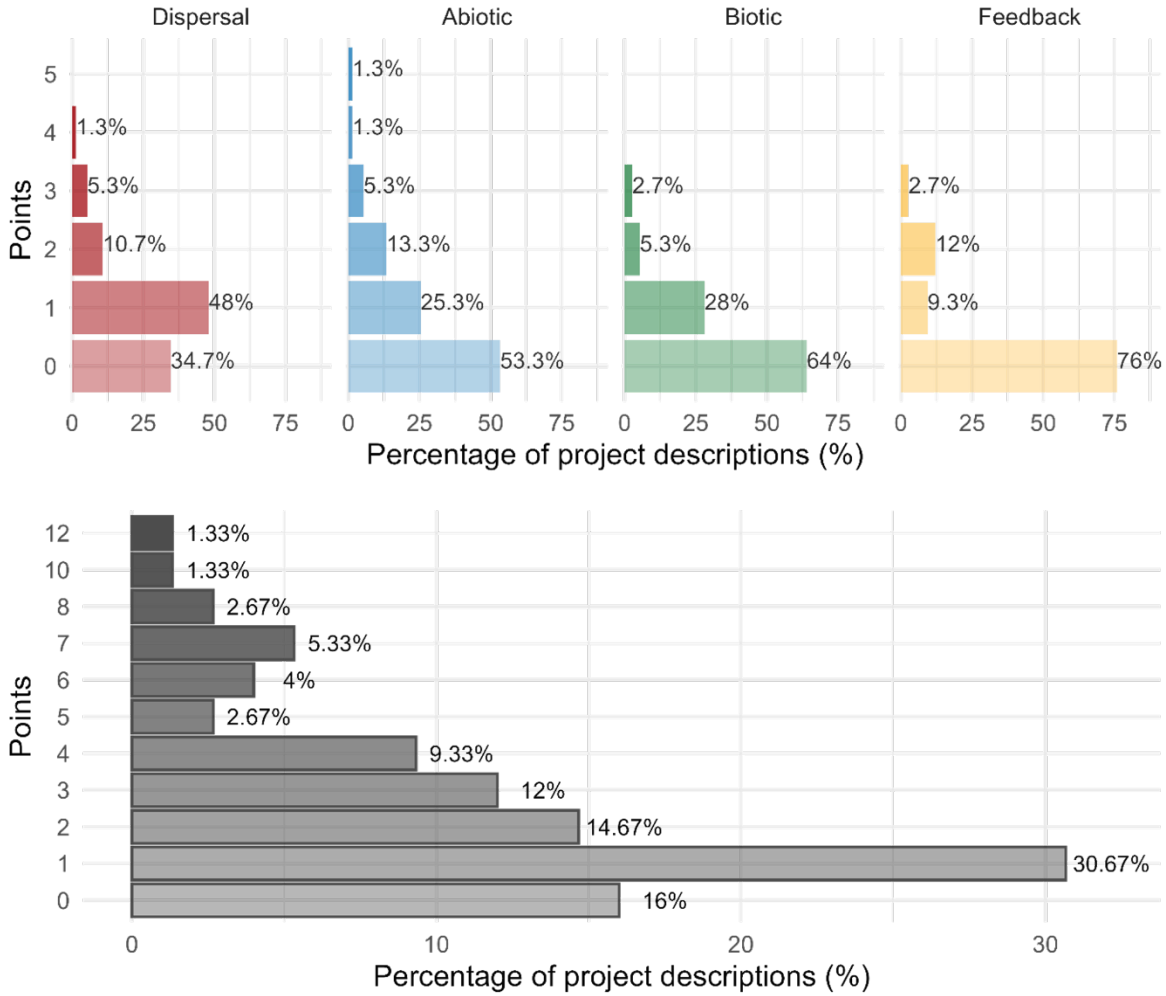

Figure 6: *Cumulative EFF point distribution. Bars show the percentage of project descriptions that received the respective number of points per filter (top) and across all filters (bottom).*

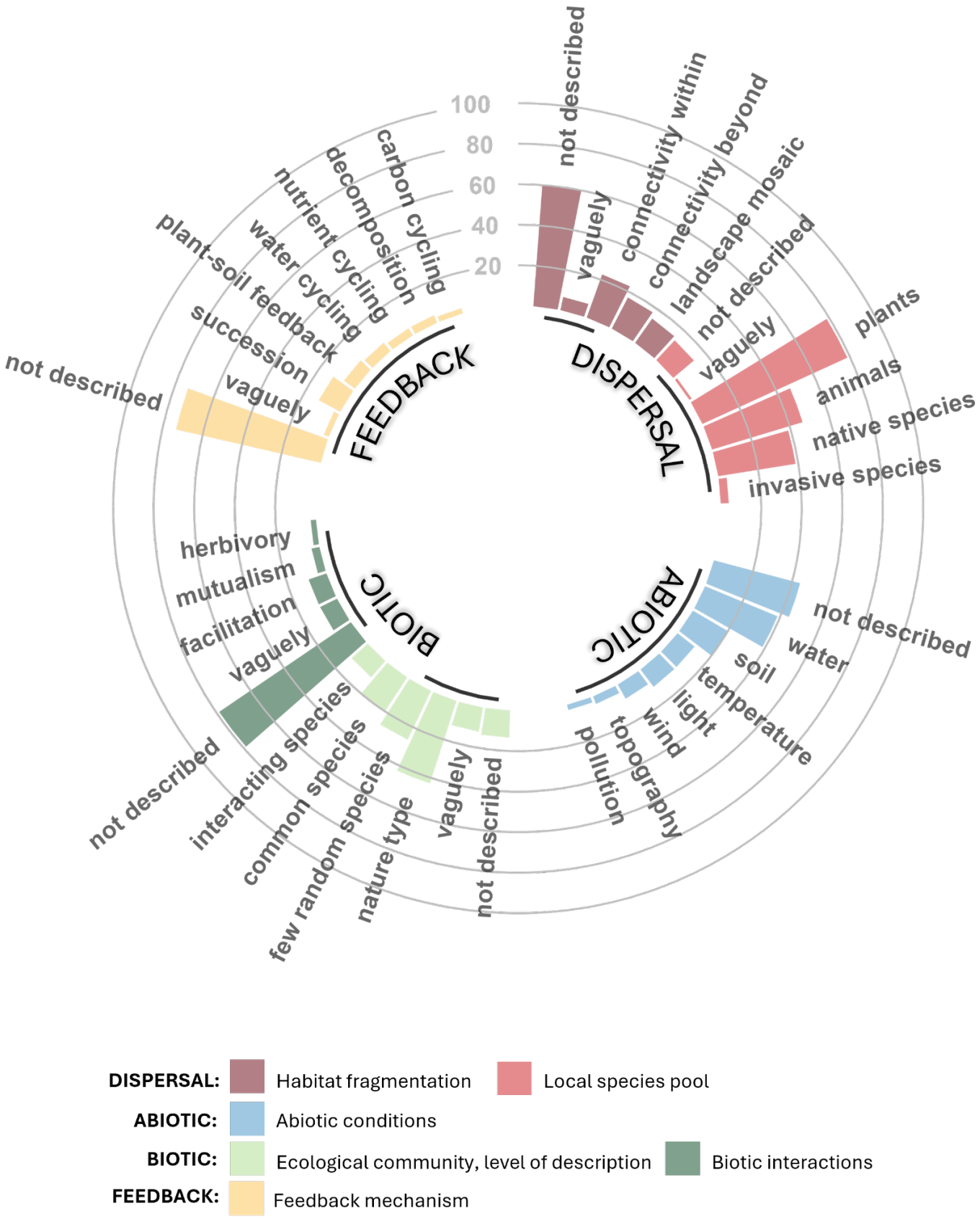

Figure 7: Distribution of ecological content. *Percentage of project descriptions with content in the respective category. A project description could score in several categories. Categories are ordered with decreasing percentage after "not described" and "vaguely". "vaguely" indicates the percentage of project descriptions that had detectable content within the filter without further detail to categorize.*

Projects suggested by landscape architecture experts

We received 35 responses to the survey containing 77 recommendations with 67 unique projects. We found 41 (53,25 %) of the recommended projects published on Landezine. Ten of the recommendations stated Landezine directly as reference . For 11 projects available on Landezine a different source was referred to with mostly longer description texts. In total 36 projects were recommended without a direct reference.

Discussion

With this systematic review we could show a notable mismatch between strong ambitions to integrate ecological knowledge into landscape architecture practice (IFLA Europe 2025b) and the ecological content communicated in project descriptions published on the platform Landezine. While we found evidence of increasing awareness and effort, as seen in the growing use of ecology keywords over time, the overall proportion of descriptions including ecological content seemed to remain low. We identified biotic factors and feedback mechanisms as the most noteworthy gaps in the inclusion of key ecological knowledge categories. These findings suggest that ecological integration, while improving, is not yet standard practice in the dissemination of landscape architecture projects.

Temporal and geographical distribution of project descriptions with ecological content

Approximately one-third of the sampled project descriptions included an ecology keyword, with only 13% referencing three of the most common terms in ecological literature.

Since it is possible that projects considered ecological aspects without describing them, this at least indicates a low priority for reporting on ecological knowledge informing on-site interventions. This observation stands in contrast to the clearly stated ambitions in e.g. the constitution of IFLA World, to "establish, develop and *promote* the highest standards of education and professional practice […] including but not limited to planning, design, *ecology, biodiversity* […]" (IFLA World 2014). While the disciplinary boundaries between ecology and landscape architecture may hinder both its implementation and reporting, this mismatch may also stem from a lack of incentives or perceived necessity to highlight an ecology-based approach when promoting projects.

However, this appears to be changing. The increasing proportion of project descriptions that include ecological keywords over time suggests that reporting on ecological considerations is becoming more important and more common.

The strong geographical variation in ecological content points to uneven prioritization across countries. Language and publication biases may contribute to this disparity, warranting further investigation of the underlying causes.

Ecological content: categories and gaps

The presence of three ecology keywords in the reviewed projects highlights the relevance that their authors place on the integration of ecology in the projects and their dissemination. This is confirmed by the average score of 2.59, with most projects scoring at least once in our analysis.

However, this appears to reflect a modest integration of ecological knowledge. As a comparison, a score of at least four would cover the breadth of ecological knowledge spanning all four filters. The maximum score of 12, assigned to a single project description in this review, illustrates the range of depth (i.e. multiple points per filter) with which ecological aspects have been addressed. Nevertheless, the majority of projects fall on the lower end of this spectrum.

This suggests that while there is growing awareness for the importance of ecology, descriptions of how it is integrated remain limited in scope. This may result in missed opportunities to enhance biodiversity, ecosystem functioning, and ecological sustainability in landscape architecture projects, particularly if the lack of description reflects a lack of implementation. However, we acknowledge that there might often be competing priorities in

386 landscape architecture, which may lead to descriptions prioritizing aesthetic and technical
387 choices over ecological matters.
388 Our further in-depth analysis within the ecological filters provides insights on where the most
389 notable gaps lie: While most project descriptions included dispersal factors and many included
390 abiotic factors, biotic factors as well as feedback mechanisms were not detectable in the
391 description of most projects.

392 *Dispersal*

393 The dispersal filter emerged as the most represented. It was primarily included by reports on
394 the local species pool, describing planned or existing plant and animal species with the
395 noteworthy absence of descriptions on invasive species in more than 90% of projects. With
396 invasive species as one of the main threats to biodiversity globally (IPBES 2019), we consider
397 this an important finding.
398 Approximately 40% of project descriptions addressed habitat configuration, further
399 contributing to the prominence of the dispersal filter. Despite that the majority of project
400 descriptions did not mention this subsection of dispersal factors, our findings demonstrate
401 that knowledge from the field of landscape ecology integrated in the foundational ecological
402 frameworks for landscape architecture (Dramstad 1996; Makhzoumi 2000; Leitao and Ahern
403 2002; Reed et al. 2021) has informed many landscape architecture projects, enabling
404 improvements in habitat and dispersal conditions for various species. The prominence of the
405 dispersal filter suggests a large-scale and coarse-resolution focus in the integration of ecology
406 in landscape architecture.

407 *Abiotic*

408 The abiotic filter was the second most frequently integrated ecological filter. Water availability
409 emerged as the most frequently mentioned factor, likely reflecting a general awareness of its

410 critical importance and the recurring challenges it poses. These challenges, often linked to
411 increasingly frequent weather extremes and climate change adaptation efforts, were
412 highlighted in many projects.
413 Other abiotic factors, such as temperature, light, and topography, were mentioned less
414 frequently. In many cases, these factors may have been considered too basic or irrelevant to
415 include in project descriptions.
416 Notably, physiochemical soil conditions were absent in approximately 80% of descriptions,
417 despite their fundamental role in influencing plant growth and, by extension, any terrestrial
418 landscape architecture project. With soil acidification, salinization, sodification, compaction
419 and sealing as main causes for environmental degradation and loss of habitat caused by land
420 use change (Kraamwinkel et al. 2021), we want to point out this gap together with the lack of
421 reports on pollution, mentioned by only two projects.

422 *Biotic*

423 Only 36% of all projects mentioned biotic factors in their description. While most projects
424 described the ecological community on site in some way, the resolution rarely was more
425 precise than mentioning the present nature type. Which species were common, or which
426 species would be interacting on site was mentioned only by 20% and 10.67% respectively.
427 Since we included this description of biodiversity as a sub-category in this filter, the low
428 representation of biotic factors is somewhat surprising, especially because biodiversity
429 seemed to be an important and common theme among the ecology-keyword projects.
430 Interspecific interactions were not described in 78% of the projects, indicating a low
431 integration or priority to report on strong drivers shaping ecological communities.
432 Interestingly, it was positive interactions that were reported on most, even though, historically
433 in ecological research, negative interspecific interactions were considered the primary biotic

434 drivers of community assembly (Grinnell 1917; Elton 1927; Grime 1973) until the significant
435 roles of positive interactions started to be increasingly recognized around the 2000's (Crotty
436 and Bertness 2015).
437 We assess the low representation of biotic interactions as the most significant gap in the
438 reviewed project descriptions. The absence of references to biodiversity and biotic
439 interactions suggests that the role of ecosystem functioning—shaped by the number, identity,
440 and interactions among species (Tilman, Reich, and Knops 2006; Reich et al. 2012; Weisser et
441 al. 2017)—may not be recognized as important to emphasize. This omission potentially
442 overlooks a powerful tool for landscape architecture to foster thriving, biodiverse ecological
443 communities. Projects may miss opportunities to enhance ecosystem integrity, by optimizing
444 ecosystem functions and consequently ecosystems' ability to provide ecosystem services (Díaz
445 et al. 2006; Cardinale et al. 2012; IPBES 2019). This could point to valuable opportunities for
446 future landscape architecture projects to harness ecological principles.

447 *Feedback*

448 With 76% of projects not including any description of feedback mechanisms, this filter was
449 the least represented. This illustrates a general focus on describing establishing a project but
450 not maintenance and long-term development. Multiple publications in landscape journals
451 (Qiu et al. 2025; Pedroza-Arceo, Weber, and Ortega-Argueta 2022) and magazines (Van
452 Valkenburgh 2013; Zhorov 2025) criticize the lack of long-term agendas in landscape
453 architecture projects caused by the dominant practice of employing designers to only create
454 but not to be involved in managing a project's development over time (showcased in practice
455 by e.g. Voskamp et al. (2023)). Our analysis confirms that the emphasis tends to be on static
456 end-goals as pointed out by e.g. Nassauer and Opdam (2008) and Ahern (2013).

Including ecological feedback mechanisms already in the planning phase could help to reduce and anticipate needed maintenance efforts and to communicate these to clients to manage expectations and possibly advocate for a long-term involvement of the designer for more sustainable outcomes.

Wider context

The majority of recommended projects were found on Landezine, which was also frequently referenced by respondents. This suggests that, while Landezine does not represent all relevant projects, it serves as an appropriate source for this review, offering a diverse array of projects and ensuring comparability between project descriptions. However, the platform's short description format, compared to other sources recommended by landscape architecture experts, should be taken into account.

Projects with a particularly strong ecological focus appear to be described in greater detail elsewhere. Combined with our findings on the limited number of projects featuring ecological keywords, this suggests that the integration and description of ecological principles remains the exception rather than being standard practice. This discrepancy highlights the need for further investigation expanding the scope to gain deeper insights into the current state of integrating ecology in landscape architecture.

Summary and Conclusion

This review highlights a promising trend in the growing use of ecology-related keywords in landscape architecture project descriptions over the last two decades, suggesting increasing awareness for the importance of ecological considerations. However, the integration and reporting of ecological principles have not yet become standard, particularly on widely used platforms like Landezine. Ecology-focused project descriptions remain the minority and are often reported in more detail elsewhere, indicating that adoption of ecological principles remains uneven and limited in scope.

One barrier to broader integration might be the complexity of ecological systems. To address this, structuring frameworks like the EFF, which aims to streamline ecological integration landscape and community ecology, offer a practical tool for integrating ecological knowledge into design and reporting. It also proofed instrumental for this review. Particular attention is needed for biotic interactions and feedback mechanisms, which are critical for optimizing ecosystem functions but remain largely unaddressed in the dissemination of landscape architecture projects. Whether this lack of integration is due to these categories being particularly difficult to incorporate or due to a potential low awareness about their usefulness, addressing them may require strong transdisciplinary collaboration between ecologists and landscape architects.

The ambitions set forth by IFLA Europe provide a strong motivator to advance the integration of ecology in both project planning and dissemination. We hope that these ambitions in combination with the revealed gaps in this review inspire practitioners to implement ecological principles and, not less importantly, communicate them to the public, thereby fostering a culture of ecological awareness and accountability. This may help pave the way for ecology integration in landscape architecture to become standard, thereby contributing to the

498 persistence of functional ecosystems that support biodiversity and people in Europe and
499 beyond.

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504 Author's Contributions

505 EB, KAB and TJC conceived the ideas and designed the study and the review protocol. EB
506 prepared and led the review workshop. EB, AJ, FB, IGP, LB, SS, SZ and ZK refined the review
507 protocol and reviewed the projects. EB analysed and interpreted the data with support from
508 all reviewers and KAB. The online survey was prepared, performed and analysed by EB. EB led
509 the manuscript writing. All authors contributed critically to the drafts.

510 Conflict of interest

511 We have no conflicts of interest to declare.

512 Data availability statement

513 The data set and corresponding code for statistical analysis will be made available on
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515

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All sampled project descriptions are referenced in a separate list available with the supporting dataset on DataverseNO (https://doi.org/10.18710/6SKZKX)

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Appendix

Review Protocol

A: General questions about the project:

Questions assessing whether the project is in the scope of the review:

Here we are interests in whether the project qualifies as built landscape architecture

1. Does the description state a landscape architecture office/a landscape architect? YES / NO
2. Does the project include a human or aesthetic dimension? YES / NO
3. What type of project is this (landscape typology)? Playground, park, water feature… (several possible)

Characteristics

4. What is the area of the project [m^2] ?
5. Does the project consist of several sites/units/sub-projects, a network of projects? YES/NO/NA
6. Which is the main ecological system of the project? (several possible) Terrestrial/Freshwater/Marine
7. Does the project in any way state to aim for sustainability? *YES/NO*
8. Does the project mention area or nature positivity? *YES/NO*

B: What do the Landscape Architects describe?

Questions assessing the overall inclusion and importance given to ecology in the description.

Here we are interested in how much weight ecology has in the project description

9. Does the project in any way state to use ecology? YES / NO
10. Which proportion of the text is dedicated to describing ecological context? [5% intervals]
11. Does the description use any ecological terms other than "biodiversity", "species", "habitat" or words of the "eco.."-family? YES / NO
12. Which ecosystem services/nature's contributions to people are mentioned? (several possible)
    Supporting/regulating/provisioning/cultural/disservices

Questions assessing the focus and resolution in the project description

Here we are interested in the scope and level of detail that is given in the project description. The following questions refer to the filter-framework (part C) but aim for a more qualitative and descriptive analysis.

Dispersal

13. How does the project describe habitat fragmentation/connectivity? (several possible)

Connectivity within the project/connectivity beyond the project area/dispersal barriers/landscape mosaic/ecological traps/vaguely/NA

14. How does the project describe the regional species pool? (several possible)

Plants /animals /native species/invasive species/vaguely/NA

Abiotic

15. Which abiotic factors does the project mention? (several possible)

Water availability/temperature regimes/light regimes/wind conditions/soil conditions/NA

Biotic

16. At which level is biodiversity described? (several possible)

Nature type level / Functional groups/ Species level/ Population level/ Genetic level/Vaguely/NA

17. How is the ecological community described? (several possible)

Nature type / Trophic levels / Interacting species / Common species / few or single species/Vaguely/NA

18. How are biotic interactions described? (several possible)

Competition/Predation/Herbivory/Parasitism/Facilitation/Mutualism/Niche complementarity/food web/food chain/vaguely/ NA

Feedback:

19. How are the ecological processes described? (several possible)
    Carbon cycling/ nutrient cycling/ decomposition/succession/plant-soil feedback/vaguely/NA

Information sufficiency

20. Does the project supply enough information on ecological context for an in-depth analysis?

    YES/NO

C: Interpretations from an ecologist perspective

Here we are interested in how you interpret the description including pictures and illustrations from an ecologist's point of view.

20a Does the project deteriorate/neutral/improve biodiversity/a ecosystem functions?

20b Does the project aim to support or improve biodiversity/ecosystem functions? YES / NO

Questions assessing the overall quality of how ecology was included

21. Would you say the project description included ecology in a meaningful way? YES / NO
22. How would you (based on this description) characterize the inclusion of ecology in this project?

    Buzzwords/superficial/neutral/sufficient/well integrated
23. Does the project description show good understanding of ecology? YES / NO

Questions asking for your interpretation of the ecological context (continued from 20 a and b)

24. Can you detect any application of ecological context or principles in this project? YES / NO
25. Is this application described explicitly? YES / NO
26. If there is application of ecological context detectable, what are the main themes (up to 3)?

    FREE ANSWER, FREE ANSWER, FREE ANSWER
27. Comments: please give a short comment on your main thoughts concerning this project

    FREE ANSWER

Filter framework

INTERPRETATION: In the following you are asked to assign points for the inclusion of ecological knowledge categorized by the concept of ecological filters. Please assign a point for each intervention/consideration that addresses a separate theme within one filter. That means you can assign several points per filter:

Dispersal filter:

1. (29) Does the project consider dispersal patterns and the local species pool?
   Examples: Habitat fragmentation and connectivity; invasive species, native species.?
   TOTAL POINTS - dispersal

Abiotic filter:

2. (30) Does the project consider the abiotic limitations for species that are used/present?
   Examples: water availability, cold/heat tolerance, light regimes
   TOTAL POINTS - abiotic

Biotic filter

3. (31) Does the project consider biotic interactions of the species in the project area?
   Examples: predation/herbivory, competition, facilitation, mutualism; species rich design and niche complementarity, symbiotic partners …
   TOTAL POINTS - biotic

Feedback filter:

4. (32) Does the project describe/consider its development over time?
   Examples: nutrient cycling and decomposition, succession, (intermediate) disturbance, plant soil feedbacks?
   TOTAL POINTS – feedback

Review process

33. Did your team reach a consensus in the assessment? YES/NO

34. How was the discrepancy between the individual assessments? HIGH/MODERATE/LOW