



# 廣東園林

# Guangdong Landscape Architecture

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风景园林中的设计实践与研究：从概念的再定位到三条可行路径

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刊首语：设计研究

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对于风景园林专业而言，设计研究是既陌生又熟悉的议题。如果从发表的学术论文或者完成的学位论文来看，以“设计研究”为研究主题的成果并不多，但是，对于持续关注该议题的研究者而言，“设计研究”却是清晰的研究领域。人们普遍认可设计研究可以分为 3 种类型：1) 关于设计的研究，即运用科学的手段，探究“设计”的本质特性，是一种元理论的研究；2) 为了设计的研究，在设计实践的过程中展开，是为设计项目的实施而进行的前期研究；3) 通过设计的研究，以“设计”作为媒介，借助设计思维开展特定的研究，即设计是“科学研究”的工具。风景园林研究基本不涉及第一种类型，设计学则作为学科本体的基础进行探究。在风景园林硕士学位论文中，常见的是第二种类型，作为一个方案设计的前期调研和案例研究的形式出现，但是由于难以产生“高深的学问”，这些研究难以在高水平的期刊上发表。第三种类型是“设计研究”的核心，或者说是狭义的“设计研究”，最难开展，本文拟讨论的正是这种类型。

设计研究如何做呢？首先，研究者需要一个具体的设计项目。这个项目可以是在真实环境下的方案设计，即“真题假做”；也可以是实施的工程设计，即“真题真做”。只有基于真实的环境，研究者才有具体的信息用于研究的实施。其次，设计研究本来是期待借用科学研究的方法获得理性的结果，基于证据的设计是基本的准则，即循证设计。最后，借鉴科学研究的信度和效度的验证方法，验证方案设计或工程设计的科学性。这是设计研究的难题。对于“真题假做”的方案设计，验证通常是非常困难的，尽管可以借用一些软件模拟和评估其绩效，但是由于不在真实的物理世界中测评，存在明显的局限。对于“真题真做”的工程设计，验证相对容易一些，可以采用使用后评价的方法，收集数据和测评。在研究需要的时间上，方案设计可长可短，工程设计常常受限于各种条件，耗时相对较长，难以在特定的研究周期内完成，这就是在风景园林教育中开展“通过设计的研究”的困难之处。

如果风景园林师掌握“设计研究”的基本理论和方法，就可以在工程实践中运用，提升自身的科学研究素养和设计项目的合理性。笔者指导的学生团队，在 2023 年的广州园林博览会大学生园林设计竞赛中荣获金奖，获奖方案得以实地建造。该项目位于中国广州

市儿童公园内，将一个迷你高尔夫球场改造为一个适合儿童游憩的场所，名为“儿童花园”。学生提出了研究问题——“何种儿童游戏场地设计有利于儿童游戏行为的开展”，确定将促进游戏行为作为本次设计的目标。通过儿童户外玩耍测评工具对广州市儿童公园现有游戏类型进行了评估，并结合文献研究，提出了促进儿童游戏行为的理论假设。然后，拟定设计原则，确定设计方案。在项目营建之后，学生对设计方案与建成方案进行了详细的对比，总结了设计经验，评估了建成方案的效果和效益。最后，学生通过定量研究的方法评估建成后的儿童户外游戏场地中的游戏行为，验证之前提出的儿童户外游戏场地环境要素与游戏行为关系的理论假设，并进行设计反思和提出优化策略。

总之，设计不仅是一个结果，更是一个知识创造的过程。这种研究方式强调将设计作为一个动态和实践性的过程，研究者通过设计活动的参与，不仅解决实际的设计问题，还能够从中提取理论上的见解，进而推动知识的积累。

林广思

主编：林广思



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## Integrating Design Praxis and Research in Landscape Architecture: From Redefining Concept to Discussing Three Possible Pathways

蔡淦东  
CAI Gandong

摘要

为重拾对风景园林“设计实践（Design praxis）”的全面理解，纠正将实践狭义地等同于技术劳动的常见误解，以概念解读与案例剖析为研究方法，将设计实践重新界定为“行动－反思－再行动”的动态循环，探讨研究与实践在风景园林学科中的融合路径，并将其总结为3类：在设计实践中进行研究（Research through Design Praxis）、研究设计实践方法论（Design Praxis Method Research）以及对设计实践的研究（Research of Design Praxis）。研究发现，路径一通过跨学科研究与设计的深度嵌合，将项目作为实验平台以积累可量化、可共享的知识；路径二强调推动设计工具、协作流程及决策逻辑的系统化与创新；路径三则立足于学科的强大实践性，通过对项目的综合剖析提炼理论与设计逻辑。3类路径在实际操作中并非彼此割裂，而是在项目研究、方法创新与经验总结中相互交叠，并需依托开放协同的平台建设持续推动学科知识生产。

关键词

风景园林；设计实践；在地实践；设计方法论；案例研究

Abstract

This study aims to restore a comprehensive understanding of 'design praxis' in landscape architecture and to correct the common misconception that practice is narrowly equivalent to technical labor. Using conceptual interpretation and case analysis as research methods, this paper redefines design praxis as a dynamic cycle of 'action-reflection-re-action,' explores the pathways through which research and practice are integrated within the discipline of landscape architecture, and summarizes them into three categories: Research through Design Praxis, Design Praxis Method Research, and Research of Design Praxis. The findings indicate that Path I embeds interdisciplinary research deeply into design, using projects as experimental platforms to accumulate measurable and shareable knowledge; Path II emphasizes the systematization and innovation of design tools, collaborative processes, and decision-making logics; and Path III, grounded in the discipline's strong practical orientation, extracts theories and design rationales through comprehensive analyses of projects. The discussion suggests that the three pathways are not isolated from one another in actual operation, but overlap across project-based research, methodological innovation, and experience synthesis, and require open and collaborative platform-building to continuously advance disciplinary knowledge production.

Keywords

Landscape architecture; Design praxis; Local practice; Design methodology; Case study

文章亮点

1) 从“行动－反思－再行动”的动态循环出发，重新界定风景园林中的设计实践概念，纠正将实践等同于技术劳动的狭义理解。2) 提出研究与设计实践融合的3条可行路径，分别对应实践中研究、实践方法论研究与设计实践研究。3) 指出实践者自发的行业交流与协同平台建设可作为补充机制，推动经验共享、知识生产与未来实践创新。

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# 鸟类友好城市策略探析：以跨学科共创设计项目为例

## Exploring Strategies for the Bird Safe City: A Case Study of Transdisciplinary Co-design

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### 摘要

全球鸟类种群数量因人类活动持续下降。为识别鸟类友好设计在专业实践中进行跨学科整合的障碍，并发现增强相关行业技术能力的机会，研究以设计工作坊为方法论，结合政策与地理空间分析、文献综述、实地调研、案例研究、面向相关专业人士的在线问卷及互动研讨会等方法，旨在为从业者与政府部门开发应用工具提供思路。研究成果强调了共创型设计方法在促进跨学科协作、减少鸟类碰撞与生物多样性损失等方面的有效性，亟需采取包括政策变革和公众宣传在内的积极措施，以减少鸟类与周边建筑结构发生碰撞的风险，恢复生态网络并支持城市地区的野生动物栖息。

### Abstract

Global bird populations are declining as a result of human activities. The objectives of this research are to characterize barriers to transdisciplinary integration of bird safe design into professional practice, and to identify opportunities to improve technical proficiency among relevant sectors. This study employs a design studio methodology to inform the development of practical and accessible tools for practitioners and governments. Findings of these studio initiatives were informed through a combination of policy, geospatial, and literature analyses, case study examinations, field research, as well as an online survey circulated to relevant professionals across North America, and an interactive online workshop. This research underscores the effectiveness of co-creative design-based methodology in bridging disciplinary siloes in response to complex socioecological challenges, such as mitigating bird collisions and biodiversity loss in cities. To restore ecological networks and sustain wildlife in urban areas, active mitigation efforts, including policy change and outreach programs must be made to reduce the risk of birds colliding with surrounding built structures.

### 文章亮点

1) 从全球鸟类种群面临的挑战与城市“鸟撞”问题的关系出发，指出鸟类友好设计在城市建设与专业实践中的现实紧迫性。2) 以鸟类友好城市项目为例，展示了该项目如何通过政策分析、案例研究、专业问卷与在线研讨等方式推动研究成果转化的过程。3) 总结鸟类友好设计在专业认知、政策理解、实施评估与传播教育中的缺口，提出以共创型设计和跨学科协作连接研究、教育与实践。

### 关键词

鸟类友好型设计；设计实践；设计工作坊；跨学科研究；城市环境；鸟撞

### Keywords

Bird safe design; Design praxis; Design studio; Transdisciplinary research; Urban environment; Bird collision

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由人类活动驱动的物种加速消失现象已被广泛报道，据估计，目前已有一百万种动植物面临灭绝威胁，其中许多将在未来几十年内消失<sup>[1]</sup>。在全球范围内，候鸟种群正努力应对人类开发与改造景观所带来的威胁。相关研究已证实，鸟类物种不仅数量普遍下降，内部的遗传多样性也在减少<sup>[2~4]</sup>。在北美乃至全球，鸟类种群面临严峻挑战，数量急剧下降，即便是通常被认为分布普遍且适应力强的“生境广适种”（habitat generalists），如雀科、森莺科、拟鹂科、百灵科和燕雀科等，也同样显著减少<sup>[5]</sup>。这一发现亦在关于北美鸟类数量下降的综合评估中得到印证<sup>[6]</sup>：自1970年以来，北美鸟类总量已累计减少接近30亿只，其中超过90%的损失集中于12个鸟科（包括生境广适种）。

鸟类数量减少的原因在不同地区和物种之间存在差异<sup>[7]</sup>。栖息地丧失是导致鸟类种群数量下降及整体生物多样性丧失的主要驱动因素<sup>[8]</sup>。在残存的自然鸟类栖息地碎片之间，建成环境也带来了新型人工栖息地，例如授粉花园、植被廊道和绿色基础设施，但这些空间有可能被编织进城市结构之中。虽然这些城市栖息地能够吸引并支持长年留鸟与候鸟生存，但它们也可能成为“生态陷阱”，将动物引向潜在的危险。多个关键的人类环境压力因子在建成环境中尤为突出，尤其是在位于关键候鸟“迁飞航道”<sup>①</sup>上的城市中<sup>[9]</sup>。在每年的迁徙高峰期，候鸟种群在这些沿迁飞航道分布的城市中更为集中<sup>[10]</sup>，进一步加剧了风险。

为应对候鸟种群数量普遍下降的趋势，并恢复种群，相关的鸟类友好型设计、政策与项目正在地方、区域、国家及国际等多重尺度上逐渐获得推动力<sup>[11~12]</sup>。既有的鸟类友好型设计由多种循证技术与方法组成，旨在减少鸟类与玻璃的碰撞<sup>[13]</sup>。例如，在玻璃上使用视觉标识和图案，利用建筑构件遮挡玻璃（如在窗户外加装格栅、百叶或遮阳板），以及完善夜间照明规范，减少来自建筑内部的人工光线外泄。在单体建筑层面实施的防碰撞措施，若能与城市范围内的公共宣传、倡导和教育项目相结合<sup>②</sup>，将发挥更大效用。然而，在相关行业领域（如城市设计、建筑学、风景园林和城市规划等），鸟类友好型设计仍存在诸多问题：从业者对鸟类在人居环境中的严峻生存境遇认知不足，对相关法规政策及其更新了解不深，在为业主提供咨询与进行设计决策时缺乏共识，以及对新技术和新设计方法运用不熟练等。

鸟类友好城市项目<sup>③</sup>（Bird Safe City Project: Advancing Bird Safe Design in Policy, Planning, and Education, BSCP）于2023年由多伦多都会大学（Toronto Metropolitan University, TMU）城市与区域规划学院的生态设计实验室发起并实施。该实验室由妮娜·玛丽·利斯特（Nina-Marie Lister）教授领导，是一个跨学科的

实践－研究工作室。作为该实验室正在进行的研究计划之一，BSCP旨在弥补前文所述的设计实践不足，更有效地遏制城市化所导致的鸟类种群下降，尤其是减少与建成环境相关的致命性鸟类碰撞问题。该项目也是生态设计实验室与加拿大“危险光污染意识计划（Fatal Light Awareness Program, FLAP）”长期研究合作的一部分<sup>④</sup>。此外，BSCP通过设计工作坊的形式持续发展。这种设计工作坊模式源自19世纪布扎艺术学派（Beaux-Arts），长期以来被视为培养协作性设计思维和创造性应用的成熟范式<sup>[14~15]</sup>。设计工作坊既是一种空间，也是一种方法论，其通过创造性的动手实践和体验式学习来推进知识生产，一直是建筑学、风景园林、城市设计与城市规划等专业教育的重要基石<sup>[14]</sup>。

因此，本文将鸟类生存环境恶化与设计实践有效落实之间的鸿沟作为研究问题，通过研究结合实践的方式，以BSCP为案例，探索鸟类友好型设计的实操性。本文旨在探索一种融合了研究与实践的新模式，并将其作为方法论路径，用于开发实用且易于获取的工具，帮助从业者与政府部门共同营造鸟类友好型城市。

### 1 鸟类在城市环境中遭受的威胁

鸟类在全球范围内占据着多样的生态位，并提供对生态系统健康至关重要的多种服务与效益（如授粉、种子传播、害虫控制等）<sup>[16~18]</sup>。鸟类所发挥的生态功能不仅惠及其他动植物，也直接增进了人类的健康与福祉。研究表明，感知鸟类可让人们获得身心健康方面的益处，日常的观鸟体验（如欣赏啼叫等休闲活动）能够缓解焦虑、抑郁及生态焦虑等心理问题<sup>[19~21]</sup>。因此，鸟类物种丰度与多样性下降带来的影响远超环境退化本身，还包括对人类活力的削弱，以及经济、社会与文化层面的损失，这在候鸟跨国迁徙范围覆盖的地区尤为突出<sup>[3,18]</sup>。

在城市地区，鸟类面临的最严重的威胁之一是与建筑物发生碰撞。碰撞多发生在建筑外立面的玻璃上<sup>[22~23]</sup>。北美地区的研究记录显示，大部分碰撞事件发生在白天<sup>[24~27]</sup>。研究已识别出多种与碰撞相关的环境因素，包括建筑物的特征、建筑周边可能吸引鸟类的景观设计、玻璃材料的性质，以及室外或从建筑内部透出的强烈人工光源<sup>[24,28]</sup>。这些因素的共同作用会在建成环境中造成显著且广泛的风险。鸟类被光源吸引，在夜间迁徙时可能出现迷向，从而在清晨及日间更易与玻璃发生碰撞<sup>[29~30]</sup>。

尽管已采取防范措施，玻璃碰撞依然是人类导致鸟类死亡的重要原因<sup>[31]</sup>。在建成环境中，玻璃存在于多种场景，包括但不限于建筑物的窗户与幕墙、交通候车亭、玻璃护栏

① 迁飞航道（flyway）被定义为“由支撑迁徙水鸟生存及其年度生活周期必不可少的一切生态系统所构成的整体生态系统<sup>[9]</sup>”。

② 为降低鸟类碰撞风险而设立的公共教育项目包括多伦多市的“熄灯行动”（Lights Out Initiative）以及“世界候鸟日”（World Migratory Bird Day）。

③ 鸟类友好城市项目可通过生态设计实验室（Ecological Design Lab）的页面查询：<https://ecologicaldesignlab.ca/project/bird-safe-city/>。

④ FLAP是加拿大的非营利性专业组织，由鸟类与建筑物碰撞领域的顶尖专家组成。

系统及隔音屏障等。在一天中的不同时段，玻璃表面因外部光照不同而变化。当玻璃呈现透明状态时，鸟类难以察觉并尝试飞越，从而发生碰撞。玻璃还可能反射周边的栖息地（如植被）或开阔空间（图 1），致使鸟类将倒影误认为是真实空间，尝试飞向而发生碰撞<sup>[29-30]</sup>。此外，虽然鸟类碰撞的风险与玻璃面积大小正相关，但在较小的窗户上也可能发生碰撞。

## 2 鸟类友好城市项目

在生态设计实验室的领导下，目前鸟类友好城市项目包含 2 个研究计划，均以工作坊形式展开——鸟类友好城市工作坊和鸟类友好建筑工作坊。该项目由多伦多都会大学城市与区域规划学院的本科生和研究生参与，并与专业人士开展合作。

### 2.1 鸟类友好城市工作坊

“鸟类友好城市：自然城市的鸟类友好设计指南”（Bird Safe City: Bird Safe Design Guidelines for the Biophilic City）工作坊开展于 2023 年，由多伦多都会大学城市发展规划硕士项目的 6 名研究生共同完成。该工作坊聚焦于鸟类友好规划与设计，通过详细分析安大略省多伦多的市政开发审批流程，探讨鸟类友好设计指南如何在其中得到应用。多伦多市是全球首个在政策中实施鸟类友好设计的城市，于 2006 年通过了自愿性质的《多伦多绿色标准》（Toronto Green Standard, TGS）<sup>①</sup>，并于 2010 年将其转为强制性要求<sup>[32]</sup>。

鸟类友好城市工作坊作为生态设计实验室所采用的设计实践方法论的一部分，其目标是向多伦多市提出修订《鸟类友好型开发指南》（Bird-Friendly Development Guidelines）<sup>②</sup>的建议，将循证鸟类友好设计实践纳入城市政策，从而减少鸟类撞击玻璃事件，并更广泛地缓解城市化对生物多样性的负面影响。该工作坊采用多种研究方法，包括政策梳理、案例研究、地理空间分析、与 FLAP 合作开展实地调研，以及系统的文献综述等，这有利于团队全面理解本地与全球鸟类友好设计方法，并应用于多伦多的城市语境。

研究团队梳理了加拿大市级、省级和联邦三级政府的政策，以识别相关的环境保护立法。随后，团队考察了一系列多伦多市以外不同司法辖区的案例，这些案例涉及生物多样性保护与鸟类友好设计，其中首先分析了“亲自然城市网络（Biophilic Cities Network）”<sup>③</sup>的 15 个成员城市。接着从上述城市中选取出 3 个市政案例进行深入分析，选择

标准包括政策的可执行性、亲自然城市成员资格、地形特征以及与候鸟迁飞航道的接近程度。此外，研究团队还使用了地理空间分析法（geospatial analysis）识别多伦多地区与地理位置相关的风险阈值，特别考虑了建筑周边植被的影响。这进一步凸显了植被对生物多样性恢复的重要性，以及其在鸟类友好设计中的应用价值。与此同时，研究团队与 FLAP 中注册并受训的志愿者共同在多伦多市中心开展实地调研，记录、救助或妥善处理与建成环境发生碰撞的鸟类个体<sup>④</sup>（图 2）。这一实地工作使团队获得了关于建筑设计如何影响鸟类安全、健康与生存的第一手经验。

### 2.2 鸟类友好建筑工作坊

“鸟类友好建筑：专业培训需求评估”（Bird Safe City Building: A Professional Training Needs Assessment）工作坊始于 2024 年，由多伦多都会大学城



图 1 可能导致鸟类碰撞的建筑立面玻璃应用示例

Fig.1 Example of a building facade with various glazing applications that may result in bird collisions

市与区域规划本科项目的 12 名学生共同完成。该工作坊聚焦于鸟类友好设计的教育与意识提升，开发了面向规划师、建筑师、风景园林师、城市设计师等相关专业从业者的资源。

鸟类友好建筑工作坊的研究旨在评估实践中关于鸟类友好型建筑解决方案的关键知识，识别认知缺口，推动相关专业在鸟类友好设计方面的发展。基于认知缺口，项目进一步提出在专业教育中加强循证研究的建议。研究还计划为 FLAP 提供支持，帮助其开展面向行业的宣传与教育工作。该工作坊的研究基于 2 类数据：一是针对北美地区相关专业人士开展的在线问卷调查；二是互动式的在线设计工作坊。

研究首先开展了资料的收集工作，梳理了加拿大现行规划政策以及与鸟类安全相关的建筑设计标准。随后，研究团队针对相关从业者开展了问卷调查，以评估其在各自领域中对鸟类友好规划与建筑设计的水准及专业参与程度。问卷以定量封闭式问题

为主，辅以少量定性开放式问题。研究共收集了 133 份问卷，但并非所有问卷均填写完整，因此未全部纳入最终数据集。最后，研究团队还组织了一场跨学科在线设计工作坊，邀请多方专业人士和市政代表参与，共同探讨问卷揭示的趋势。此次在线设计工作坊共有 31 名参与者，重点在于总结鸟类友好型设计在实践中的成功经验与局限，并识别参与者在接受专业发展教育方面的偏好。在线设计工作坊采用定性研究与描述性定量研究结合的方法，主要包括开放式提示问题和半结构化问题，其中部分问题为封闭式回答，可进行定量描述分析。

## 3 研究成果的实践转化

### 3.1 鸟类友好城市设计导则

鸟类友好城市工作坊的首项研究成果被汇编为《鸟类友好城市：亲自然城市设计指南规划报告》（Bird-Safe City: Design Guidelines for the Biophilic City Planning Report）<sup>[33]</sup>，该报告适用于全球条件相似的高密度

大都市区，可扩展现有工具，并为专业规划师在城市环境中保护鸟类提供多样化的策略。报告分析了多伦多市在制定鸟类友好设计指南及相关法规过程中的关键机遇与挑战，并提出将鸟类友好标准纳入《多伦多绿色标准》的建议。报告建议修订多伦多市《鸟类友好型开发指南》，使其与应用更广泛的新版《鸟类友好型建筑设计》（Bird-friendly building design）标准（CSA A460:19）<sup>[11]</sup>保持一致。目前，《多伦多绿色标准》的下一轮修订仍在等待中<sup>①</sup>，因此报告中所提出的建议尚未得到落实，但 FLAP 已基于研究成果向多伦多市政府工作人员提供了反馈意见。工作坊的另一项研究成果是《鸟类友好城市：规划师鸟类友好设计工具包》（Bird-Safe City: Planner's Bird-Safe Design Toolkit）<sup>[34]</sup>，其旨在帮助规划师、建筑师及公务人员等从业者理解鸟类友好设计的实施方式与具体要求。该工具包中包含 1 份面向设计与规划人员的问卷，用于判定某个地块是否受《多伦多绿色标准》的约束，进而明确该地块在设计规划过程中是否需要遵守通过场地规划管控所执行的鸟类友好设计要求。

### 3.2 鸟类友好建筑评估报告

鸟类友好建筑工作坊的研究成果被汇编为《鸟类友好城市建筑：专业培训需求评估报告》（Bird-Safe City Building: A Professional Training Needs Assessment Report）<sup>[35]</sup>。通过对专业从业者（表 1）与工作坊参与者（表 2）的调查与分析，该报告揭示了从业者在鸟类友好设计方面的实践知识与政策理解均存在显著缺口，凸显了推进专业培训的迫切性。尽管超过 60% 的受访者对更主流的策略（如鸟类友好玻璃与光照减弱）有所了解，但研究显示，从业者缺乏评估干预措施或政策有效性的必要知识。大多数从业者认为其所在领域对鸟类友好设计的认知度较低，在自认为具备鸟类友好设计经验的受访者中，61% 的人认为同行



图 2 志愿巡逻员收集的鸟类

Fig.2 Birds collected by volunteer patrollers

① 《多伦多绿色标准》经历了多次更新，其中包括对鸟类友好型设计规范的修订，目前已进入第四版：<https://www.toronto.ca/city-government/planning-development/official-plan-guidelines/toronto-green-standard/toronto-green-standard-version-4/>。  
② 2007 年，多伦多市发布了最早的《鸟类友好型开发指南》，这是首份系统提出减少候鸟风险的综合性策略文件。此后，多伦多市又制定了 2 份文件以取代最初的版本，并进一步支持在《多伦多绿色标准》中落实“防止鸟类碰撞（Bird Collision Deterrence）”和“光污染控制（Light Pollution）”等绩效要求。  
③ “亲自然城市网络”是一个汇聚了全球性伙伴的社区，包括城市、组织和个人，其共同致力于规划与设计有利于自然的城市。  
④ 实地调研获得的知识被团队加以转化，并应用于随后启动的校园项目——“鸟类友好 TMU（Bird Safe TMU）”，该项目旨在将鸟类友好型设计策略引入多伦多都会大学市中心校区。资料来源：<https://ecologicaldesignlab.ca/project/bird-safe-city/>。

认知度较低；而在自认为缺乏相关经验的受访者中，这一比例高达 88%。综合来看（包含有经验与无经验的受访者），约 70% 的受访者将其所在行业对鸟类友好设计标准与实践的认知程度评为 5 分或以下（其中 1 表示“完全不了解”，10 表示“非常了解”）。此外，36% 的受访者认为在其所在地区的法规体系下，鸟类友好设计要求“有效”或“非常有效”，但仍有 24% 的受访者表示“不确定”。这一结果表明，对于干预措施成效的不确定性可能是限制鸟类友好设计实践的重要障碍。问卷与工作坊所得结果共同为研究团队向 FLAP 提出的专业培训建议提供了依据。基于此，FLAP 计划编制教育资料，以支持鸟类友好设计相关的专业发展与能力建设。鸟类友好建筑工作坊所提建议为后续培训材料的开发奠定了基础，弥补了从业者的知识空白，并指导其策略选

择，从而提升干预措施的有效性，促进更广泛的行业参与。此外，研究旨在帮助 FLAP 建立高于现行水平的鸟类防碰撞标准，并推动加拿大及其他地区的可持续城市规划实践。

**3.3 从专业教育到实践行动：多伦多鸟类友好校园**

研究发现，专业人士在鸟类安全设计实践方面缺乏培训与认知，这一现状为将鸟类安全设计策略、政策与实践纳入学生培养体系提供了契机。为促进研究成果向实践转化，鸟类友好城市项目（BSCP）于 2025 年扩展，启动了鸟类友好校园项目（Bird Safe TMU）。这是一项协作性倡议，旨在将鸟类友好建筑设计策略引入多伦多都市大学（TMU）校园。作为该倡议的一部分，生态设计实验室于 2025 年 9 月举办了一场参与式的窗户壁画绘制工作坊。在一栋已知存在鸟类碰撞问题的校园建筑物上，参与者们共同使用油性涂

料在玻璃上绘制图案，以减少鸟类碰撞（图 3）。该活动为不同专业的学生、教职员工提供了直接参与实践学习与设计倡导的机会。这幅壁画具有特殊意义，其位于土木工程学院大楼的窗户上，而该建筑正对着建筑学院。壁画设置在未来工程师与建筑师的培训场所旁，创造了一个拓展从业者鸟类友好设计意识的契机。这一工作坊的举办，恰逢北美地区越来越多的高等教育机构承诺在校园内提升可持续发展水平与心理健康支持的时期，这是对年轻群体心理困境，尤其是生态焦虑不断上升的回应<sup>[36~38]</sup>。虽然在巡逻过程中目睹鸟类碰撞事件可能对人类的心理健康与福祉产生负面影响，但此次窗面绘制活动为参与者提供了行动的机会。通过集体行动和环境管理，参与者共同为保护鸟类作出贡献，增强了校园社区的凝聚力。这幅壁画不仅提醒人们城市发展对野生动物的影响，也让未来的从业者了解到鸟类安全设计标准的相关知识。

4 讨论：鸟类友好设计的跨学科协同发展

鸟类友好城市项目（BSCP）作为典型案例，展示了如何将工作坊作为设计实践路径，弥合实践与研究之间的脱节，从而推动专业发展，其对风景园林专业的从业者具有重要意义。该项目提出了共创型设计方法，强调通过循证设计与政策协作，促进建筑师、风景园林师、规划师及政策制定者之间的跨学科整合，将研究成果转化为可实施的设计策略，为减少鸟类碰撞和生物多样性损失、构建安全且可持续的城市生态网络提供支撑。只有实现跨设计专业的真正整合，才能推进野生动物安全宜居的“自然积极型城市（nature-positive cities）”（图 4）。若建成基础设施的设计无视风景园林师所营造的生态意图，便会削弱支持生物多样性恢复与气候韧性的努力；反之，如果在城市环境中吸引并滋养城市野生动物，却忽略了与建成环境相关的潜在风险，则可能造成动物致命条件，引发不良环境效应。



图 3 高碰撞风险建筑的鸟类友好临时窗面处理  
Fig.3 Bird-friendly temporary window treatments at a collision-prone building



图 4 鸟类友好建筑立面示例  
Fig.4 Examples of bird-friendly building facades

| 表 1 在线问卷中部分定量问题及其汇总结果<br>Tab.1 A subset of quantitative questions included in the online survey, along with aggregate responses |                                                                                                                          |
|---------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------|
| 问卷问题                                                                                                                            | 问卷回答                                                                                                                     |
| 以下哪项最能描述您的专业工作？（可多选）                                                                                                            | 规划师（1）；建筑师（2）；风景园林师（3）；工程师（11）；建筑检查员 / 场地规划技术员（4）；野生动物清理 / 害虫控制服务提供者（5）；设施管理人员（6）；建筑服务承包商（7）；研究人员（8）；环境顾问（9）；其他（请说明）（10） |
| 您多常遇到那些被认为是鸟类友好的景观和 / 或建筑，但实际效果不佳的情况？                                                                                           | 总是（0）；经常（23）；偶尔（18）；不经常（4）；从不（6）；不确定（18）                                                                                 |
| 哪些资源或补充信息最有助于提升您对鸟类安全的理解？（可多选）                                                                                                  | 与客户和利益相关者沟通鸟类友好设计价值的工具（61）；鸟类友好景观与设计策略（57）；建筑技术设计指南（54）；有关特定干预措施的后勤信息（52）                                                |
| 您觉得以下哪类信息或训练最有帮助？（可多选）                                                                                                          | 部门或在职培训（1）；基于课程的教学（在线模块）（2）；基于课程的教学（线下课堂）（3）；特邀讲座（4）；基于设计的培训练习（5）；指南与参考资料（7）；其他（请说明）（6）                                  |
| 在您所在的行政辖区（市级、省级等）中，您认为鸟类友好设计要求和指南在减少鸟类与建筑物碰撞方面的效果如何？                                                                            | 完全无效（3）；效果不明显（12）；偶尔有效（12）；中立（5）；有效（18）；非常有效（10）；不确定（19）；不适用（0）                                                          |
| 注：括号内的数值表示选择该选项的参与者数量。受访者可选择跳过某些问题，因此各问题的答复总数不一致。完整数据集可参阅《鸟类友好城市建筑：专业培训需求评估报告》 <sup>[35]</sup> 。                                |                                                                                                                          |

| 表 2 在线工作坊中的部分讨论议题与参与者回应<br>Tab.2 A subset of discussion prompts and responses received during the online workshop |                                                                                 |
|-------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------|
| 讨论议题                                                                                                              | 回应                                                                              |
| 您如何从美学与功能性角度定义一个成功的鸟类友好设计？                                                                                        | “一个成功的鸟类友好设计应使视觉标识成为整体设计中不可分割的一部分；换句话说，鸟类友好设计不应是事后补充！”                          |
| “鸟类友好设计”对您意味着什么？                                                                                                  | “法规与指南不应仅限于让事物避免被鸟类碰撞，还应考虑如何为鸟类创造新的安全空间。”                                       |
| “到 2050 年，鸟类友好型建筑设计已成为北美主要城市的标准做法，鸟类与建筑物碰撞率降至历史最低”，为了实现这一目标，需要在哪些关键节点上取得进展？                                       | “应建立某种形式的专业认证或资质体系，使具备识别与降低风险能力的专业人士获得相应资格。”<br>“鸟类友好建筑标准应被纳入气候适应规划与生物多样性战略之中。” |
| 在鸟类友好建筑与防碰撞设计中，为支持专业工作，是否有您希望进一步了解的方面？                                                                            | “在与开发商合作时，如何在保留树木的前提下处理未经防撞处理的窗户，以及在配置植被、树木等元素时进行合理布局。”                         |
| 注：所有回答均被纳入主题分析。完整数据集可参阅《鸟类友好城市建筑：专业培训需求评估报告》 <sup>[35]</sup> 。                                                    |                                                                                 |

有效落实鸟类友好设计策略的根基在于以研究为基础的支持性政策。为采取更整体性的路径，加强跨学科在野生动物友好设计中的协同，从业者需从应用集体知识出发，共同开发共享的工具与资源，进而形成基础性政策与实践，将理论与研究落实到行动之中。

5 结论

鸟类友好设计并不仅仅是为玻璃表面添加标识，更是能推动城市发展超越单纯美化、营造具备生态与气候韧性景观的政策框架与设计实践。鸟类友好城市项目（BSCP）的研究揭示了鸟类友好设计在政策、实施与传播等方面的不足与机遇，其设计实践模式能够支撑“自然积极型城市”的建设，不仅具有功能完善的人居环境，还对城市野生动物安全友好。此外，该项目通过工作坊形式，在不同学科之间转译知识，并将理论不断迭代为可操作、可实施的策略。

目前，鸟类友好城市项目研究仍局限于北美地区的校园，且受限于政策落实与推动速度，以及工作坊的举行周期等因素，收集到的量化数据仍然较少。但在项目持续推进过程中，随着影响力的加大与业界鸟类友好意识的逐渐加强，该局限将被逐渐突破，最终鸟类友好城市策略将推广至更多地区。本文在树立典范的同时，展望未来研究的可能性：通过对生态数据的解读，将其转化为指导设计的准则，从而推动风景园林设计、规划及政策制定的专业发展；将循证的鸟类友好设计原则深度融入专业的规划、设计与建筑维护实践，将有效促进人类与野生动物的互惠共生，并推动城市化地区的生物多样性恢复。

注：图片均为作者自摄。

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Exploring Strategies for the Bird Safe City: A Case Study of Transdisciplinary Co-design

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The accelerating rate of species loss driven by human activities is widely published, with estimates warning that one million animal and plant species are now threatened with extinction, and many within the coming decades<sup>[1]</sup>. Throughout the world,

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challenges facing bird populations in North America and globally are resulting in a sharp decline, even for species considered common and adaptable (also called ‘habitat generalists’ ) which include sparrows, warblers, blackbirds, larks and finches<sup>[5]</sup>. Such findings were echoed in a comprehensive assessment of declines in North American avifauna by Rosenberg et al<sup>[6]</sup> who reported a total cumulative loss approaching 3 billion birds since 1970, with more than 90 percent of the total loss attributed to 12 bird families (including those considered habitat generalists).

Factors contributing to the decline of birds vary around the world and between species<sup>[7]</sup>. Loss of habitat is a principal driver of bird population declines and loss of biodiversity generally<sup>[8]</sup>. Between remaining fragments of natural bird habitat, the built environment has brought the introduction of novel forms of artificial habitats for birds that have potential to be woven into the fabric of cities, such as pollinator gardens, vegetated corridors and green infrastructure. While these urban habitats attract and support birds, including both year-round residents as well as migratory species, they may also create ecological traps or sinks that draw animals towards hazards. Several key anthropogenic stressors that pose direct threats to wild birds are heightened in urban areas, especially in communities situated along key migratory routes<sup>[9]</sup> known as ‘flyways’<sup>①</sup>. Migratory bird species are present in higher abundance in cities along flyways during seasonal peaks at particular times each year, such as while birds are moving between their breeding and non-breeding ranges<sup>[10]</sup>.

To address widespread declines in migratory bird populations and support population recovery, bird safe building design measures, policies, and programs are gaining momentum across local, regional, national and international scales<sup>[11-12]</sup>. Bird safe design measures consist of various evidence-based techniques and technologies to reduce bird-glass collisions<sup>[13]</sup>. For instance, bird safe design

strategies include the use of visual markers and patterns on glass, and architectural features which occlude glazing (e.g., grilles, shutters or solar shades applied over windows), as well as dark sky lighting specifications aimed at reducing the extent of architectural uplighting and artificial light emanating from building interiors. Mitigation of collisions applied at the scale of individual buildings may be especially effective when complimented by other citywide campaigns and programs<sup>②</sup> that enlist public participation through advocacy and education on the adoption of bird safe practices. Yet, awareness and adoption of new technologies and design practices by relevant industry sectors that interact with the planning and maintenance of buildings (e.g., urban design, architecture, landscape architecture, and planning, etc.) remains limited. As a result, effective implementation of bird safe design in practice is constrained by a lack of technical proficiency on the part of practitioners who are responsible for making building design decisions and advising property owners.

The *Bird Safe City Project: Advancing Bird Safe Design in Policy, Planning, and Education*<sup>③</sup> (BSCP) was initiated and undertaken in 2023 by the Ecological Design Lab, a collaborative design-research and practice studio based at Toronto Metropolitan University’s School of Urban and Regional Planning, directed by Professor Nina-Marie Lister. As one of the lab’s ongoing research initiatives, this project aims to address the aforementioned shortcomings in design practice to effectively address and reduce bird population decline resulting from urbanization, specifically fatal bird collisions with the built environment. The BSCP is part of a longstanding and ongoing research partnership between the Ecological Design Lab and the Fatal Light Awareness Program (FLAP) Canada<sup>④</sup>. The BSCP has been advanced through applications of the design studio. Derived from the 19th century Beaux-Arts movement, the studio is an established model to cultivate the

pedagogy of collaborative design thinking and its creative application<sup>[14-15]</sup>. The design studio is a space for, and an approach to, learning by employing a creative “hands-on” and experiential practice, and has long been a valued foundation of professional architectural, landscape, urban design, and urban planning education<sup>[14]</sup>.

Using the BSCP as a case study, here we explore how the design studio as a methodological approach was used to inform the development of practical and accessible tools for practitioners and governments in creating bird safe cities. This paper offers critical insights and presents a model for bridging gaps between research and practice to advance evidence-based design principles critical for sustainable urban planning and development.

### 1 Threats to Birds in Cities

Birds fill ecological niches throughout the world and provide diverse services and benefits that are essential to healthy functioning ecosystems (e.g., pollination, seed dispersal, pest control, etc.)<sup>[16-18]</sup>. The services performed by birds in turn contribute to a range of benefits for other animal and plant species, as well as to human health and well-being. For instance, studies have revealed the mental and physical benefits that birds provide to people who perceive them, demonstrating the ability of everyday encounters through birdsong and recreation to treat mental health conditions such as anxiety, depression and ecodistress<sup>[19-21]</sup>. Consequently, declines in the abundance and diversity of bird species has far-reaching effects beyond environmental degradation and include detriments to human vitality, as well as economic, social and cultural impacts, in regions throughout the international ranges of migratory species<sup>[3,18]</sup>.

Among the most significant threats to birds in urban areas is the risk of collisions with buildings. Collisions occur frequently with glazed surfaces (i.e., glass) on building exteriors<sup>[22-23]</sup>, with studies from North America recording most collisions taking place during daytime hours<sup>[24-27]</sup>. Numerous environmental correlations of collisions have been identified, including characteristics of buildings, landscaping around buildings (which may attract birds), properties of glazing materials and the presence of bright artificial lights outdoors or emanating

from the interior of buildings<sup>[24,28]</sup>. When present in combination, these conditions create significant risks that are widespread across the built environment. As birds are attracted to lights, they may become disoriented during their nocturnal migrations and are susceptible to colliding with glass in the early morning and daylight hours<sup>[29-30]</sup>.

Despite being preventable, bird collisions with glass remain a leading direct source of bird mortality by humans<sup>[31]</sup>. Glazed surfaces exist in diverse contexts within the built environment, including and not limited to building windows and spandrels, as well as transportation shelters, glass railing systems and sound barriers. The appearance of glass is influenced by outdoor lighting conditions throughout the day. Glass may appear transparent, resulting in collisions where birds fail to detect the glass and attempt to fly through it. In other conditions, glass may appear to reflect habitat (e.g., the surrounding vegetation) or open space, resulting in collisions where birds mistake the reflection for the real thing and attempt to fly towards a perceived extension of open space<sup>[29-30]</sup> (Figure 1). While the risk of causing bird collisions is positively correlated with the size of the glazed surface, collisions may still occur even at small windows.

### 2 The Bird Safe City Project

At present, the BSCP comprises two research initiatives: the Bird Safe City studio and the subsequent Bird Safe City Building studio. Led by the Ecological Design Lab, these two initiatives were undertaken using the design studio as a form of design-research praxis, engaging undergraduate and graduate level students in the School of Urban and Regional Planning at Toronto Metropolitan University, in collaboration with subject matter experts on bird collisions and relevant professionals in active practice.

#### 2.1 The Bird Safe City Studio

The first study, the 2023 *Bird Safe City: Bird Safe Design Guidelines for the Biophilic City*, centered on planning and design through a detailed analysis of how bird safe design guidelines are applied within the municipal development approval process in Toronto, Ontario, Canada. The City of Toronto is noteworthy as the first municipality in the world to enact bird safe design in policy through the *Toronto*

① A flyway can be defined as “the totality of the ecological systems that are necessary to enable a migratory waterbird to survive and fulfil its annual cycle”<sup>[9]</sup>.

② Examples of public-oriented education and awareness programs to reduce bird collisions include: The City of Toronto’s Lights Out initiative and World Migratory Bird Day.

③ The Bird Safe City Project webpage can be viewed on the Ecological Design Lab’s website at: <https://ecologicaldesignlab.ca/project/bird-safe-city/>.

④ FLAP Canada is a non-profit specialist organization consisting of leading subject matter experts on bird-building collisions.

*Green Standard*<sup>[32]</sup>, initially implemented as a voluntary standard in 2006 and later as a mandatory requirement in 2010<sup>①</sup>.

As part of the design praxis methodology employed by the Ecological Design Lab, the initial Bird Safe City studio was undertaken by six graduate students in Toronto Metropolitan University’s Master of Planning in Urban Development program. The purpose of this pilot study was to inform recommendations for the City of Toronto supporting a future update of its *Bird-Friendly Development Guidelines*<sup>②</sup> (which provides specifications for bird safe design regulated under the Toronto Green Standard) integrating current evidence-based bird safe design practices into city policies to reduce bird-glass collisions, and more broadly, mitigate the adverse impacts of urbanization on biodiversity. The findings of this first studio initiative were informed by a policy scan, case study examination, geospatial analysis, field research with FLAP Canada consisting of building surveys, and a comprehensive literature review. This methodological framework provided the research team with a comprehensive understanding of local and global bird safe design approaches in contexts applicable to Toronto.

The policy scan gathered information from the Canadian municipal, provincial and federal levels of government to identify legislation relevant to environmental protection and building construction. The research team then examined a series of case studies on biodiversity protection and on bird safe design from jurisdictions outside of Toronto, beginning with 15 cities part of the Biophilic Cities Network<sup>③</sup>. The scope of this analysis was then narrowed to three municipal case studies based on the themes of enforceability of policies, biophilic city membership, topography, and proximity to a bird migration flyway. Geospatial analysis was also used

to identify location-related hazard thresholds for Toronto, considering the presence of vegetation near buildings, further underscoring the significance of vegetation on biodiversity recovery and its relevance to applications of bird safe design. In addition, the research team participated in fieldwork by accompanying a registered and trained volunteer of FLAP Canada during building patrol sessions to survey, report and record data from observed bird-window collisions. This fieldwork allowed the team to gain first-hand experiences with the impacts of building design on bird safety. The sessions consisted of patrolling downtown Toronto to document, rescue or secure birds that collided with built infrastructure<sup>④</sup> (Figure 2).

### 2.2 The Bird Safe City Building Studio

The second initiative of the project, the Bird-Safe City Building: A Professional Training Needs Assessment, was undertaken by 12 undergraduate students in Toronto Metropolitan University’s Urban and Regional Planning program. This study aimed to assess critical gaps in knowledge and awareness among professionals responsible for implementing bird safe building solutions in their respective practice.

Based on defining these gaps, the project produced evidence-based recommendations for advancing professional education about bird safe design. These outcomes were intended to support FLAP Canada with their goal to advance the organization’s industry-focused outreach and education. This studio project included data obtained by the research team through an online survey of relevant professionals sampled from across North America, as well as an interactive online workshop.

This study began with secondary data collection, starting with a policy scan of current planning policy and building design standards related to bird safety

across Canada. Next, the research team circulated an online survey to relevant practitioners to assess their awareness, knowledge, and professional involvement in bird safe planning and building design within their respective fields. The survey consisted of predominantly quantitative, close-ended questions with few qualitative, open-ended questions. While 133 responses were logged by Qualtrics, not all responses to all questions were considered complete and included in the dataset. Finally, a transdisciplinary online workshop was held with various professionals, subject matter experts and municipal representatives to elaborate upon the trends revealed by the survey. This workshop included 31 participants and focused on characterizing successes and limitations in implementing bird safety in practice and identifying participants’ preferences for receiving professional development education. The workshop used a mixed-methods approach of both qualitative and descriptive quantitative research methods, consisting primarily of open-ended prompts and semi-structured questions, some of which had closed-format responses which could be described quantitatively.

## 3 Results and Outputs

### 3.1 Bird-Safe City Design Guidelines

In building upon the practices initially developed in the City of Toronto, the findings of the Bird Safe City studio are intended to be applicable across dense metropolitan areas of similar conditions globally. The studio can help expand existing tools and provide an array of strategies for professional planners to protect bird life in urban environments. Findings of the initial study were compiled into the *Bird-Safe City: Design Guidelines for the Biophilic City Planning Report*<sup>[33]</sup> presenting key opportunities and challenges for bird safe design guidelines and associated regulations for the City of Toronto. The recommendations for updating the City of Toronto’s Bird-Friendly Development Guidelines include modifications to specifications that would align the seminal municipal document with the newer *CSA A460:19 Bird-friendly building design* standard, which is more universally applied in other national and subnational planning

jurisdictions<sup>[11]</sup>. As of the time of writing, the next scheduled revision to the *Toronto Green Standard* remains pending<sup>①</sup>. As such, the recommendations outlined in the report have not yet been implemented; FLAP Canada has provided feedback consistent with this research for the update to the City of Toronto staff. The accompanying *Bird-Safe City: Planner’s Bird-Safe Design Toolkit*<sup>[34]</sup> was developed to provide practitioners such as planners, architects and civil servants with key information on the implementation and requirements for bird safe design. This resource includes an applicant questionnaire (specific to the City of Toronto) which can be used to determine if a property is subject to the *Toronto Green Standard* and is thus required to comply with bird safe design requirements enforceable through site plan control.

### 3.2 Bird-Safe City Building Assessment Report

The findings of the second initiative were compiled into the *Bird-Safe City Building: A Professional Training Needs Assessment Report*<sup>[35]</sup>. Through its collection of data from surveyed professionals (Table 1) and workshop participants (Table 2), this preliminary study illuminates gaps in both practical knowledge and policy understanding of bird safe design among practitioners, underscoring the critical need to advance professional training. While 60% of participants in the survey reported being generally familiar with more mainstream strategies, such as bird safe glass and light pollution reduction, they indicated that they lacked the knowledge required to assess the effectiveness of interventions or policies applicable to mitigation of bird collisions. Most practitioners rated awareness of bird safe design in their field as low: 61% of respondents who self-identified as experienced with bird safe design measures rated their peers as having low awareness, while 88% of respondents who identified as inexperienced rated awareness of their peers as low. When combined (experienced and inexperienced respondents), approximately 70% of all respondents rated professional awareness of bird safe design standards and practice in their field at 5 or below (1 indicating unaware, 10 indicating highly aware). While 36% of all respondents believe bird safe

① The *Toronto Green Standard* has undergone several updates, including revisions to the bird safe design specifications, and is currently in its fourth version: <https://www.toronto.ca/city-government/planning-development/official-plan-guidelines/toronto-green-standard/toronto-green-standard-version-4/>.

② In 2007, Toronto’s original Bird-Friendly Development Guidelines provided the first comprehensive strategies to reduce risks to migratory birds. The City has since produced two documents that supersede the original and support the application of the *Toronto Green Standard*, the *Bird Collision Deterrence* and *Light Pollution* performance measures.

③ The Biophilic Cities Network facilitates a global community of partner cities, organizations and individuals committed to collectively planning and designing nature-positive cities.

④ Knowledge gained through the fieldwork component was adapted by the team and applied in the subsequent and recent launch of a campus-based project titled “Bird Safe TMU” which will bring bird safe design strategies to the Toronto Metropolitan University downtown campus: <https://ecologicaldesignlab.ca/project/bird-safe-city/>.

① As of the time of writing, the status of the *Toronto Green Standard* remains unclear. In May 2025 the Government of Ontario passed Bill 17, the *Protect Ontario by Building Faster and Smarter Act*, which was intended to remove the authority of municipalities to enforce green building standards. Regulations to implement Bill 17 remain pending.

design requirements are effective or very effective within their regional jurisdiction, 24% recorded that they are unsure. This result suggests that uncertainty about the efficacy of interventions may be a barrier to adopting bird safe design measures in practice. Importantly, the findings from the survey and the workshop informed a series of recommendations for professional training developed by the research team

for FLAP Canada. Based on these recommendations from the preliminary study, FLAP Canada plans to produce educational materials to support professional development and competency in bird safe design. The recommendations provide a foundation upon which new training materials for practitioners can be established to fill knowledge gaps and guide strategies that increase engagement and ultimately

drive the adoption of effective interventions. The broader impact of these outcomes is in supporting FLAP Canada to establish a higher standard than what presently exists for preventing bird collisions, promoting sustainable urban planning practices in Canada and beyond.

3.3 Operationalizing insights through professional education: Bird Safe TMU

The lack of training and awareness about bird safe design practices among professionals, as identified by this study, presents an opportunity to incorporate education on bird safe design strategies, policies and practice into student training curricula. To further the project’ s goals of applying research into practice, the BSCP expanded in 2025 with the launch of Bird Safe TMU, a collaborative initiative aiming to bring bird safe building design strategies to the Toronto Metropolitan University (TMU) campus. As part of this initiative, the Ecological Design Lab hosted a participatory window mural painting workshop in September 2025 – an initial step towards normalizing visual markers on glass to reduce bird collisions in an institutional setting (Figure 3). This event offered an opportunity for students, faculty and staff across various programs to engage directly in hands-on learning, design advocacy and activism by co-creating a custom window treatment using oil-based paint applied to a building known to cause bird collisions. The completed mural is of particular significance because of its location on the windows of the Civil Engineering building, which directly faces the building that houses the school’ s architecture program. Situating this installation immediately adjacent to where the next generations of engineers and architects receive their training creates opportunities for expanding awareness of bird safe design among practitioners entrusted with the responsibility of shaping the built environment. This workshop occurred at a time when a growing number of higher educational institutions across North America have made commitments to improving both campus sustainability and mental health support for students and staff, in response to rising psychological distress, particularly eco-anxiety, among young peoples<sup>[36–38]</sup>. While experiencing bird collisions first-hand through patrols may negatively impact human mental health and wellbeing, the window treatment workshop provided an outlet for participants to take

action to protect birds, cultivating hope and building a greater sense of community on campus through collective action and environmental stewardship. The mural serves as a reminder of the impacts of urban development on wildlife and educates future practitioners on standards for bird safe design.

4 Discussion: Bird Safe Design and Transdisciplinary Coordination

The BSCP provides a model that exemplifies how the studio method as design praxis can reconcile research with practice, by refining and contributing to professional development for practitioners of design fields, most notably the landscape architecture profession. The project underscores the need for continuous learning in practice about advanced topics, and the necessity of interdisciplinary synergies between design professions such as architects, landscape architects, planners, and policy makers, to achieve integrative approaches that can advance nature-positive cities that are safe for wildlife (Figure 4). Built infrastructure that disregards the surrounding ecological objectives of the landscape architect, undermines efforts to support biodiversity recovery and climate resilience. Conversely, designing landscapes which attract and nourish urban wildlife without attention to hazards associated with built infrastructure, may result in conditions that are harmful to wildlife and cause undesirable negative effects on the environment. Fundamental to effective implementation of bird safe design strategies are the research-based supportive policies which underpin these actions. A holistic approach, one that facilitates critical transdisciplinary coordination for wildlife safe design, begins by integrating collective knowledge to develop shared tools and resources, which in turn inform foundational policies and practices that put theory and research into action.

5 Conclusion

Bird safe design is more than placing markers on glass: it is about the policy frameworks and the design practices that move urban development beyond beautification into ecologically-rich and climate resilient landscapes. The research conducted under BSCP identified a multitude of shortcomings and opportunities with respect to policy, design,

Tab.1 A subset of quantitative questions included in the online survey, along with aggregate responses

| Survey Question                                                                                                                                                                                       | Responses                                                                                                                                                                                                                                                                                               |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Which of the following best describes your professional work? (Select all that apply)                                                                                                                 | Planner (1); Architect (2); Landscape Architect (3); Engineer (11); Building Inspector/Site Plan Technician (4); Wildlife Removal / Pest Control Service Provider (5); Facility Manager (6); Building Service Contractor (7); Researcher (8); Environmental Consultant (9); Other (please specify) (10) |
| How often do you encounter landscapes and/or buildings that are meant to be bird-safe but fall short?                                                                                                 | Always (0); Very often (23); Sometimes (18); Not often (4); Never (6); Unsure (18)                                                                                                                                                                                                                      |
| What resources or additional information would most benefit your understanding of bird safety? (Select all that apply)                                                                                | Tools to communicate value to clients and stakeholders (61); Bird-safe landscape and design strategies (57); Technical building design guidelines (54); Logistic information regarding specific interventions (52)                                                                                      |
| What formats of information or training would you find most helpful? (Select all that apply)                                                                                                          | Departmental or on-the-job training (1); Course-based instruction (online modules) (2); Course-based instruction (in-person) (3); Guest speaker lectures (4); Design-based training exercises (5); Guides and reference materials (7); Other (please specify) (6)                                       |
| Within your regional jurisdiction(s) (municipal, provincial, etc.), how effective do you believe that bird-safe design requirements and/or guidelines are at reducing bird collisions with buildings? | Ineffective (3); Not very effective (12); Somewhat effective (12); Neutral (5); Effective (18); Very effective (10); Unsure (19); Not applicable (0)                                                                                                                                                    |

Note: Values in brackets indicate the number of participants who selected that response option. Respondents had the option to skip questions, so the number of responses varied. The full dataset can be accessed in the report *Bird-Safe City Building: A Professional Training Needs Assessment*<sup>[35]</sup>.

Tab. 2 A subset of discussion prompts and responses received during the online workshop

| Prompt                                                                                                                                                                                                                                                | Response                                                                                                                                                                                                                         |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| How would you define a successful bird-safe design in terms of aesthetics and functionality?                                                                                                                                                          | “A successful design for bird-friendly is one in which the visual markers are integral to the overall design: in other words, bird-friendly is NOT an afterthought!”                                                             |
| What does bird safe design mean to you?                                                                                                                                                                                                               | “Regulations and guidelines not limited to making how things can be avoided by the birds; creating new safe space for birds needs to be considered as well.”                                                                     |
| In 2050, bird-safe building design is standard practice across all major municipalities across North America. Bird-building collision rates are at a record low. What separates us from this future? Identify key milestones to achieve this by 2050. | “Having some sort of professional certification / designation for those qualified to identify and mitigate risks.”<br><br>“Bird-safe building standards are identified in climate adaptation plans and biodiversity strategies.” |
| Are there aspects of bird-safe building and collision prevention that you would like to understand better to support your professional work?                                                                                                          | “Placement of vegetation, trees etc. when working with developers without treated windows and treating windows without having to remove the trees.”                                                                              |

Note: All responses were included in thematic analysis. The full dataset can be accessed in the report *Bird-Safe City Building: A Professional Training Needs Assessment*<sup>[35]</sup>.

implementation, and communication for advancing bird safe design in practice. This project presents a model for design praxis to fill these gaps and support the development of nature-positive cities that are ecologically functional and safe for both humans and urban wildlife. By applying the studio methodology to translate knowledge between disciplines, and move theory into practical, implementable strategies, the BSCP exemplifies an iterative process for interpreting ecological data to inform design guidelines, thus contributing the development of professional practice in design and landscape architecture, as well as planning and policy development.

This application signifies a duality in how design praxis can be used to advance research: design informs practice, and in turn practice informs design. In this way, the integration of evidence-based bird safe design principles into professional planning, design and building maintenance practices help to facilitate a broader movement towards reciprocal human-wildlife coexistence and biodiversity recovery in urbanized areas.

Note: All photographs were taken by the authors.

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多重增效目标下的光绿复合屋面一体化设计研究

Research on Integrated Design of Photovoltaic-Green Roofs under Multiple Efficiency Goals

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摘要

为应对全球气候变暖与能源危机加剧的挑战，屋面绿化与建筑光伏技术策略被广泛运用于城市建成环境，导致有限屋面资源在绿色利用方式上出现矛盾。光绿复合屋面成为这一背景下的创新解决方案，但该技术在国内的研究与应用有限。研究整理光绿复合屋面的发展历程与技术原理，梳理选址、选型、施工和运维的一体化设计流程，提出“日照-容量-荷载”的适配化选址评估框架、“能源-生态-经济”的精准化选型评估框架、“多方联动-工序衔接-质效共管”的多维协同化施工框架和“物联感知-智能决策-人机协同”的智能化运维闭环流程。最后结合国内外技术和政策现状，提出技术有机转化、建设规范统一、政策时空兼顾等中国光绿复合屋面的推广应用建议。

Abstract

In response to the challenges posed by global warming and the escalating energy crisis, roof greening and distributed photovoltaics are widely used in urban built environments, leading to contradictions in the green utilization of limited roof resources. The Photovoltaic-Green Roof has emerged as an innovative solution in this context, yet research and application of this technology in China remain limited. This study summarizes the development history and technical principles of the Photovoltaic-Green Roof and outlines an integrated design process covering site selection, system selection, construction, and operation and maintenance, and proposes a site selection evaluation framework based on solar radiation, photovoltaic capacity, and roof load; a precise type selection assessment system integrating energy-saving, ecological, and economic benefits; a collaborative construction framework based on multi-stakeholder collaboration, process integration, and quality and efficiency management; and an intelligent operation and maintenance closed-loop process combining Internet of Things perception, algorithmic decision-making, and human-machine collaboration. Finally, based on the current state of domestic and international technologies and policies, this study proposes recommendations for promoting and applying Photovoltaic-Green Roofs in China, including the organic transformation of technologies, the unification of construction standards, and policies that account for both temporal and spatial factors.

文章亮点

1) 系统化梳理光绿复合屋面的选址、选型、施工、运维一体化设计流程，为复合型屋面的全生命周期设计提供指导。2) 基于国内的气候与政策条件提供技术的本土化转化路径。3) 从技术、规范、政策的视角梳理光绿复合屋面在国内的发展阻力，为促进光绿复合屋面在国内的推广应用提供参考。

关键词

光绿复合屋面；屋面绿化；屋面光伏；技术体系；一体化设计；节能

Keywords

Photovoltaic-Green Roof; Roof greening; Roof photovoltaic; Technical system; Integrated design; Energy saving

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