

2016

Novel Urban Ecosystems: Concepts, Definitions and a Strategy to Support Urban Sustainability and Resilience

Jack F. Ahern

University of Massachusetts Amherst, jfa@larp.umass.edu

Follow this and additional works at: https://scholarworks.umass.edu/larp_faculty_pubs



Part of the [Landscape Architecture Commons](#)

Recommended Citation

Ahern, Jack F., "Novel Urban Ecosystems: Concepts, Definitions and a Strategy to Support Urban Sustainability and Resilience" (2016). *Landscape Architecture Frontiers*. 66.

Retrieved from https://scholarworks.umass.edu/larp_faculty_pubs/66

This Article is brought to you for free and open access by the Landscape Architecture & Regional Planning at ScholarWorks@UMass Amherst. It has been accepted for inclusion in Landscape Architecture & Regional Planning Faculty Publication Series by an authorized administrator of ScholarWorks@UMass Amherst. For more information, please contact scholarworks@library.umass.edu.

人类世城市生态系统： 其概念、定义和支持城市可持续性和弹性的策略

NOVEL URBAN ECOSYSTEMS: CONCEPTS, DEFINITIONS AND A STRATEGY TO SUPPORT URBAN SUSTAINABILITY AND RESILIENCE

收稿时间 RECEIVED DATE: 2016-01-18 中图分类号 / TU986 文献标识码 / A	
杰克·埃亨 美国马萨诸塞州阿姆赫斯特大学景观设计与区域规划教授	Jack AHERN Professor of Landscape Architecture and Regional Planning of University of Massachusetts Amherst, USA
译 田乐 王璐琦 TRANSLATED BY Tina TIAN Luqi WANG	

摘要

21世纪是一个充满着前所未有的根本性变化和新轨迹的时代——理想气候变化、全球经济、人口迁移和人口增长。当今的世界以城市为主导，而且这一趋势将一直持续到本世纪中叶，据预计，届时约70%的全球人口将生活在城市。世界已经进入了一个全新的地质时代——人类世，人类的影响和创造已被认定为一种地质力。在这个“属于城市的世纪”中，为了使世界拥有可持续性和弹性，城市是解决方案的关键所在——而且，人类世城市生态系统将发挥至关重要的作用。本文提出了21世纪“人类世”城市自然的新的概念、定义和类型，并以此为基础，提出了一种人类世城市生态系统策略，以为城市可持续性和弹性的实现提供必要的生态系统服务。这一人类世自然策略是在景观和城市生态的基础之上提出的，该策略需要结合城市景观设计学实践，在“设计好的实验”中进行系统性协作。这些设计好的实验对于人类世城市生态系统的必要性体现在：1）对创新性设计的绩效进行监测，以提供必要的生态系统服务；2）降低不可避免的生态系统危害；3）建立公众对于人类世城市生态系统新类型和新模式的理解和支持。

关键词

人类世城市生态系统；城市弹性；城市景观；生态系统服务；景观绩效；适应性设计

ABSTRACT

The 21st century is already known for unprecedented and fundamental changes and new trajectories — think climate change, global economics, migration and population growth. The world is now predominantly urban and will become increasingly so until mid-century when global population is expected to stabilize at around 70% urban. The world has entered a new geological era, the Anthropocene, in which the impacts and artifacts of humans are recognized as a geologic force. In this “Century of the City,” for the world to be sustainable and resilient, cities must be an essential part of the solution — and novel urban ecosystems will play a fundamental role. A new conception, definition, and typology of 21st century “novel” urban nature is proposed here as the basis for a novel urban ecosystem strategy to provide essential ecosystem services to support urban sustainability and resilience. This proposed novel nature strategy is informed by landscape and urban ecology and collaborates systematically in “designed experiments” with urban landscape architecture practice. Designed experiments on novel urban ecosystem are necessary to: 1) monitor the performance of innovative designs to provide essential ecosystem services; 2) to mitigate the inescapable ecosystem disservices; and 3) to build public understanding and support for new types and new models of novel urban ecosystems.

KEY WORDS

Novel Urban Ecosystems; Urban Resilience; Urban Landscapes; Ecosystem Services; Landscape Performance; Adaptive Design

引言

现在仍处于21世纪的初期，世界面临着一个不确定的且愈发具有挑战性的未来。2050年，全球人口预计将增至100亿，比现在的人口数量高出43%^[1]。这部分人口增长将发生在世界上的城市和城市化的地区中——这在人类历史上实属首次——而且在随之而来的城市增长中，最显著的人口增加将发生在发展中国家^[2]。我们现在开始明白我们当前——及未来——的城市存在的复杂性和后果^[3]。由人类引起的变化是在空间上可视的，在地球大气层中可衡量的，并可以从全球气候变化、海平面上升、生物多样性减少，以及水和空气质量、人类健康和生活的整体质量的变化上察觉到的。

不可否认，世界处于一个崭新而未知的领域——人类世时代。在这个时代中，人类的影响和创造已经在全球尺度上形成了和先前其他地质时期同样的地质力。在此背景下，认为“自然”和“城市”是分离且对立的公众认知已不能再有针对性地——更不要提有效地——满足当前和未来的挑战。艾玛·马里斯等人^[4]认为，人类世并不意味着环境主义的失败，而恰恰是一个行动召唤和一个从那些改变了世界城市面貌的“欣欣向荣的”人类世城市生态系统和景观中学习的挑战——这也是一个充满更多机遇的、“前瞻性的自然”。

我们知道，未来将需要新的观念、新的范式和新的城市自然结构——包括城市自然的外观、空间维度、功能和复杂性，以及其最终反映出的人类价值观和愿望。新的全球城市人口问题将导致人类重新思考对自然最根本的定义和认知。人类世之前的世界已经远逝。“我们只能勇往直前，必须找到继续发展的最佳道路”^[5]。

在人类世中，随着城市人口的预期增长以及伴随着那些陆续出生的数十亿人口的生活需求，“城市自然”要直接或间接地为这100亿人口提供衣、食、住、行，并承担激发启迪、焕发活力和其他作用。为了应对这一挑战，我们需要一种新的对城市自然的认知。“在自然中寻求平衡”的浪漫想法已不再现实、适当，甚至已一无是处。“人类

Introduction

Now, still early in the 21st Century, the world faces an uncertain and increasingly challenging future. The global population is projected to increase to 10 billion people by the year 2050, a 43% increase from today’s population^[1]. For the first time in human history, most of this population increase will occur in the world’s cities and urban regions — and the greatest increases in population, and in attendant urban growth, will occur in the developing world^[2]. We are now beginning to understand the consequences and complexities of our present, and future, urban existence^[3]. The changes that humans have caused are visible from space, measurable in the planet’s atmosphere, and palpable to all via the world’s changing climate, rising sea levels, biodiversity loss, and changes to water and air quality, human health and the overall quality of life.

The world is undeniably in new and uncharted territory, the era of the Anthropocene — in which the impacts and artifacts of humans have become global in scale, and comparable in its significance to the geologic forces that defined prior eras. In this context, the conventional wisdom that separates and opposes “nature” and “cities” is no longer accurate and certainly not productive to meet current and future challenges. Emma Marris et al.^[4] argue that the Anthropocene does not represent the failure of environmentalism, but rather a call-to-action, and a challenge to learn from the “exuberant” and novel urban ecosystems and landscapes that characterize the world’s cities — and to develop a more opportunistic and “forward-looking nature.”

We know that the future will demand new conceptions, new paradigms and new structures for urban nature — including its appearance, its spatial dimensions, its functions and complexity, and ultimately its reflection of human values and aspirations. The new global urban demography will cause humanity to rethink its most fundamental concepts and conceptions of nature. There is no going back to the pre-Anthropocene world. “We can only go forward and have to find the best way of making progress.”^[5]

In the Anthropocene with its expected growth in urban population, and the attendant needs of those yet unborn billions of humans, “urban nature” will be called on, directly and indirectly, to feed, clothe, shelter, buffer, inspire, rejuvenate, and otherwise sustain a population of 10 billion humans. To meet this challenge, a new conception of urban nature is needed. Romantic notions of “the balance of nature” are no longer realistic, appropriate or even useful. The term

世城市生态系统”一词已越来越多地用来反映城市自然的整体性，并为城市规划、设计和管理提供信息和指导，以满足人类世时代的人类需求^{[4][6][7]}。但这并不简单地等同于认为目前公众对自然的认知是不切实的；公众认知是更广泛的、全面的、内涵丰富的对自然的新的认知的一部分，这种新的认知能够更具针对性地解决现在这个全新城市世界的自然现实状况。

人类世城市生态系统的类型

作为生态学中的新兴生态系统，人类世生态系统是由人类行为、环境变化与外来物种的引入而引发形成的新的物种组合^[6]。虽然很多关于人类世生态系统的研究主要集中于非城市生态系统领域——例如森林和农业景观——但人类世生态系统的概念正越来越多地运用在城市领域^{[4][8][9]}。城市生态系统和城市景观是全新的——不仅是新出现的，而且还是前所未有的。因此，按照定义，人类世城市生态系统具有“不可类比性”，其正在越来越多地成为探究其起源、生态轨迹的研究课题，为制定新的管理目标和方法提供了机遇^[7]。

生态学是一门相对年轻的、注重理论发展的科学。生态系统是生态学中的一个基本概念和单位：“生物体与其所处的非生物环境是密不可分、相互联系和相互影响的。生态的系统或生态系统是指包含既定区域内的所有生物体的任何单位，其与所处环境相互作用产生的能量流动能够清晰界定该系统内的营养结构、生物多样性和物质循环”^[10]。这个开创性的定义侧重于生物及非生物之间的相互作用——这是生态学的本质。尤金·奥杜姆的著作反映出了生态学作为“生态系统生态学”的研究范围和研究方向，其关注于那些非人类主宰型景观。随后，景观生态学将奥杜姆的生态系统概念拓展至景观范畴，并将关注点转向人类主宰型景观的景观格局及其对景观过程的影响^[11]。城市生态学将生态系统和景观生态学的空间性和功能性应用于城市研究中——其中的一个基本研究方向是生态学理论和知识的运用，以解决包括城市景观和地区在内的人类主宰型景观的问题^{[3][8][12]}。人类世城市生态系统理论建立在这些开创性及其后续的理论基础之上，其宏大的、协同性的内涵旨在通过科学知识的应用及对生成景观的功能性和绩效所进行的系统性评估，推进科学知识发展^[13]。

联合国将生态系统服务的概念定义为一种建立共同语言和术语的

“novel urban ecosystems” is increasingly engaged to represent the totality of urban nature and to inform and guide planning, design and management of cities to meet human needs in the Anthropocene^{[4][6][7]}. This is not to say, simplistically, that conventional notions of nature are not viable, but rather that they be a part of a new, broader, holistic and inclusive conception of nature that more accurately accounts for the reality of nature in the new urban world.

A Typology of Novel Urban Ecosystems

Novel ecosystems, known in ecology as emerging ecosystems, are new combinations of species that arise through human action, environmental change, and the introduction of species from other regions^[6]. While much of the novel ecosystems research has focused on non-urban ecosystems, such as forests and agricultural landscapes, increasingly the concept is being applied in cities^{[4][8][9]}. Urban ecosystems and urban landscapes are novel — in the sense of being new and different from what was known before. By definition, therefore, novel urban ecosystems have “no-analog” and are increasingly the subject of research to understand their origins, ecological trajectories and opportunities for developing new management goals and approaches^[7].

Ecology is a relatively young science that has advanced on the strength of theory. The ecosystem is a fundamental concept and unit in ecology: “Living organisms and their non-living environment are inseparably interrelated and interact each other. Any unit that includes all of the organisms in a given area interacting with the environment so that a flow of energy leads to clearly defined trophic structure, biotic diversity, and material cycles within the system is an ecological system or ecosystem”^[10]. This seminal definition focuses on biotic-abiotic interactions as the essence of ecology. Eugene Odum’s work reflected the scope and interests of ecology as “ecosystem ecology,” developed in landscapes that were not human-dominated. Landscape ecology subsequently extended Odum’s ecosystem concept to the landscape scale with a focus on landscape pattern and its effect(s) on landscape process(es) in human-dominated landscapes^[11]. Urban ecology extends the spatial and functional perspectives of ecosystem and landscape ecology to cities — with a fundamental interest in the application of ecological theory and knowledge to address human-dominated landscapes, including urban landscapes and regions^{[3][8][12]}. Novel urban ecosystem theory builds on each of these seminal / sequential theories with the ambitious

1. 基于生物多样性/物种组成和人类干预/管理类型及强度的人类世城市生态系统分类。这4种人类世景观/生态系统的边界互有重叠，并通过说明加以界定，但在不同的具体背景环境下，这些边界往往可能呈现出梯度变化。

1. A typology for classifying novel urban ecosystems based on biodiversity / species composition and the type and intensity of human intervention /management. The boundaries of the four types of novel landscapes / ecosystems overlap and are illustrated as definitive, while in any particular context they are likely to be expressed as transitional gradients.

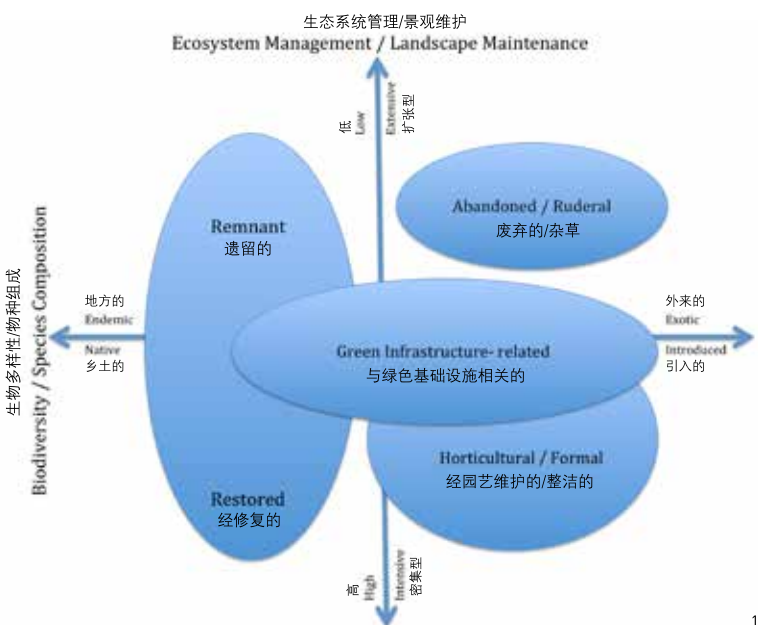
方式，通过生态系统服务，可持续性——连同可持续性目标——能够被有效地界定和测量。“新千年生态系统评估计划”将生态系统服务划分为4类，它们总体反映了人类对自然的全部所求与所得：支持服务、供给服务、调节服务、文化服务^[14]。自该计划由联合国推行以来，生态系统服务的概念已成为景观和城市规划与设计的重要工具^[15]。

生态系统服务和生态系统危害是指那些对人类福祉有益或有害的功能结构和文化层面^[16]。很显然，对人类世城市生态系统的利（服务）弊（危害）的理解对于城市与可持续性和弹性设计而言至关重要。有益的生态系统服务往往仅停留在人们的潜意识中，或被认为是理所应当的；而人们则可能会更加直接地感受到生态系统的危害——例如异味、过敏原，或污染物。

在本文中，我对人类世城市生态系统提出了一种“务实的”定义：城市中存在或出现的、由于刻意或间接的人类管理行为（包括无作为/废弃）导致及形成的生态系统；具有在生物物种引入及入侵影响下形成的独特的物种组成和结构；经由生物间的相互作用以及所处的非生物城市环境的变化，其能够产生一系列生态系统服务/危害。

这一定义可以涵盖人类世城市生态系统所包含的4种类型：遗留的/经恢复的生态系统、废弃的/杂草生态系统、经园艺维护的/整洁的生态系统，以及与绿色基础设施相关的生态系统。这种分类是以城市生物多样性、物种组成、人类干预和管理的程度和类型为基础的（图1）。表1详细阐述了这4种类型的定义、示例、可提供的主要生态系统服务，以及设计和管理方面的考虑。

人类世城市生态系统（NUE）的这一分类门别类地为我们展现了不同的NUE在生物多样性、管理程度，以及对于城市景观设计和管理的初步考虑等方面的差异。当我们从这些方面来解读NUE时——包括



and synergistic agenda of advancing scientific knowledge through its application and a structured evaluation of the resulting landscape functionality and performance^[13].

The United Nations defined the concept of ecosystem services as a means to establish a common language and terminology by which sustainability, and sustainability goals, can be effectively defined and measured. The Millennium Ecosystem Assessment defined four categories of ecosystem services that collectively represent the entirety of what humans need and receive from nature: Supporting, Provisioning, Regulating and Cultural Services^[14]. Since its introduction by the UN, the ecosystem services concept has become an important tool in landscape and urban planning and design^[15].

Ecosystem services and ecosystem disservices are those functions structures and aspects of culture that can be either beneficial or detrimental for human well-being^[16]. An understanding of the beneficial (services) and the negative (disservices) aspects of novel urban ecosystems is obviously fundamental to urban and design for sustainability and resilience. Beneficial ecosystem services are often experienced sub-consciously or taken for granted, while ecosystem disservices may be more directly experienced as odors, allergens, or pollutants.

Here, I offer a “working” definition of novel urban ecosystems as: Ecosystems that persist or arise in cities, resulting from — and structured by — intentional or indirect human management actions (including inaction / abandonment); with unique species composition and structure influenced by biotic introductions and invasions; and that provide a suite of ecosystem services / disservices resulting from interactions of the biota with the altered abiotic urban environment.

This definition can be expanded to outline a typology of novel urban ecosystems that includes four types: Remnant / Restored, Abandoned / Ruderal, Horticultural / Formal, and Green Infrastructure-related. This typology is based on the level and type of urban biodiversity and species composition, and the extent of human intervention and management (Fig. 1). In Table 1, these four types are elaborated in terms of definition, examples, principal ecosystem services provided and design and management considerations.

The novel urban ecosystems (NUE) typology is offered as one way to understand, through classification, how NUEs differ in terms of biotic diversity, the level of management, and initial considerations for urban landscape design and management. When NUEs are understood in these terms,

表1: 人类纪时代的城市生态系统 / 景观类型 (定义、示例、主要生态系统/景观服务, 以及在设计和管理方面的考虑)
Table1: Typology of Novel Urban Ecosystems / Landscapes (Definition, Examples, Principal Ecosystem / Landscape Services, and Design and Management Considerations)

	遗留的 / 经恢复的原始生态系统 / 景观 Remnant / Restored Native	废弃的 / 杂草生态系统 / 景观 Abandoned / Ruderal	经园艺维护的 / 整洁的生态系统 / 景观 Horticultural / Formal	与绿色基础设施相关的生态系统 / 景观 Green Infrastructure-related
定义 Definition	由城镇化之前或早期阶段保留下来的不连续的斑块, 或由物种组成和植被结构的适度变化恢复的斑块。 Discrete patches remaining from pre or early stages of urbanization, or restored with moderate changes in species composition and vegetative structure.	自发的、无或轻度管理的、在植被结构和物种组成上变化度很高、动态性高。 Spontaneous, non- or minimally managed, highly variable in vegetative structure and species composition, highly dynamic.	有意地得到管理以为人类使用, 尤其具有美学、社交和休憩层面的价值。 Intentionally made and managed for human use(s), particularly for aesthetic, social and recreation values.	具有人工生态基地和表层的某些绿色基础设施中的生命组成部分。 The biotic component of some green infrastructure in combination with ecologically-engineered substrates and surfaces.
示例 Examples	城市森林斑块、沼泽、滨河走廊、经恢复的林地、湿地。 Urban forest patches, marshes, riparian corridors, restored woodlands, wetlands.	棕地、废弃/破败的土地、交通道路边缘、废渣地。 Brownfields, abandoned / derelict lands, transportation verges, crosscapes.	公园、公共和私人花园、墓地。 Parks, public and private gardens, cemeteries.	人工湿地、生态洼地、屋顶花园、带状水环境、许多绿色基础设施实践。 Created wetlands, bioswales, greenroofs, bluebelts, many green infrastructure practices.
主要生态系统服务 Principal Ecosystem Services	专设的栖息地、营养循环、气候缓冲、汀步、雨水下渗, 参照生态系统、研究和教育。 Specialist habitat, nutrient cycling, climatic buffer, stepping stones, stormwater infiltration, reference ecosystems, research and education.	全面/外来物种栖息地、某些营养循环、气候缓冲、雨水下渗。 Generalist / exotic species habitat, some nutrient cycling, climatic buffer, stormwater infiltration.	气候缓冲、休憩、社交活动场所、都市农业、适度的水文功能。 Climatic buffer, recreation, social venue, urban agriculture, moderate hydrological functions.	多样——主要基于水文、雨水管理、水质、营养吸收和缓解气候变化。 Variable — predominantly based on hydrology, stormwater management, water quality, nutrient sequestration and climate mitigation.
设计与管理方面的考虑 Design and Management Considerations	是否适应气候变化? 是否有可能被外来物种入侵? Adaptation to climate change? Potential invasion by exotic species?	动态性高——但是可被管理的——植被的组成和结构、可能成为入侵物种的来源、管理公众认知。 Highly dynamic — but manageable — vegetation composition and structure, potential source for invasive species, public perception management.	能源和劳动力密集、普遍较高的文化接受度、在可持续意识方面很难站得住脚。 Energy and labor intensive, generally high cultural acceptance, difficult to justify in a sustainability-conscious context.	可接受的风险/机会来测试新的概念和组合、监测和成本核算尤为重要。 Safe-to-fail risk/opportunity to test novel concepts and combinations, monitoring and cost accounting particularly important.

它们产生的生态系统服务/危害——我们便可以更加谨慎地将它们融入城市规划和设计之中, 以促进可持续性和弹性目标的实现 (表2)。图2-8中所呈现的项目是在全世界城市背景下挑选出的、能够对NUE类型进行说明的示例。

通过对NUE的类型和示例加以说明, 显示出不同的NUE在起源、外观、效用和所能提供的生态系统服务等方面所存在的差异。遗留的NUE承载着城市出现之前的生态系统的记忆, 其可以作为监测对气候等变化的反应的参照生态系统和生态恢复的模型。经园艺维护的/整洁的NUE最被人们所熟知, 也往往代表着人们对于“城市中的自然”的通俗理解。它们既提供了重要的文化生态系统服务, 但同时也可能因为管理成本和影响带来生态系统危害。与绿色基础设施相关的NUE体现了将城市基础设施与生态系统服务相结合的混合型新策略。废弃的/杂草NUE显示了生物群对城市压力、污染物和由经济或技术变化导致的废弃的生态反应^[17]。总的来说, 任何城市中的这些NUE都反映出了城市自然的多样化斑块——这颠覆了公众对于城市自然的惯常思维, 这种城市

including the ecosystem services / disservices they provide, they can be more deliberately integrated into urban planning and design in support of sustainability and resilience goals (Table 2). Projects shown as Figure 2 to Figure 8 are examples to illustrate the NUE typology in selected international urban contexts.

As the NUE typologies and examples illustrate, NUEs vary in origin, appearance, utility and ecosystem services provided. Relict NUEs provide a memory of the pre-urban ecosystem, and may serve as reference ecosystems to monitor response to climate and other changes and to serve as models for ecological restoration. Horticultural / Formal NUEs are familiar and tend to represent the popular understanding of “nature in the city.” They provide important cultural ecosystem services but also involve ecosystem disservices related to their management costs and impacts. Green Infrastructure-related NUEs represent new, hybrid strategies to combine urban infrastructure with ecosystem services. Abandoned / Ruderal NUEs show the ecological response of urban biota to urban stresses, contaminants and abandonment related to economic or technological change^[17]. Collectively, the array of NUEs in any city represents a diverse

表2: 与人类纪时代的城市生态系统相关的部分生态系统服务和生态系统危害
Table2: Selected Ecosystem Services and Ecosystem Disservices associated with Novel Urban Ecosystem Typology

	遗留的 / 经恢复的原始生态系统 / 景观 Remnant / Native	废弃的 / 杂草生态系统 / 景观 Abandoned / Ruderal	经园艺维护的 / 整洁的生态系统 / 景观 Horticultural / Formal	与绿色基础设施相关的生态系统 / 景观 Green Infrastructure-Related
生态系统服务 Ecosystem Services				
野生动物栖息地 Wildlife habitat	***	**/***	*	*
雨水截留/渗透 Stormwater interception/infiltration	***	***	**	*/***
水质改善 Water quality improvement	***	***	*/**	**/***
空气质量改善 Air quality improvement	***	***	**	**/***
缓解气候变化 Climate mitigation	***	***	**	**
植物修复 Phytoremediation	*	***	—	**
碳吸收 Carbon sequestration	***	**/***	**	*/**
审美价值 Aesthetic value	**	*	***	*/**
休憩、社交 Recreation, social interaction	**	*	***	*
减轻孤独感、缓解压力 Sense of solitude, stress reduction	***	*/**	**	—
生态系统危害 Ecosystem Disservices				
替代当地特有植被 Displace endemic vegetation	—	**/***	**	*
外来入侵物种 Invasive species	—	***	—	*
害虫栖息地 Pest habitat	—	**/***	—	*
灌溉耗水 Water use for irrigation	—	—	***	—
管理能源耗用 Energy use for management	—	—	***	*
养分流失 Nutrient runoff	—	—	**	—
呼吸道过敏 Respiratory allergies	*	**/***	—	—
维修费用 Maintenance costs	—	—	***	**
感觉不安全 Perceived unsafe	*	***	—	—
认为没有吸引力 Considered unattractive	—	***	—	*

自然拥有提供重要生态系统服务和支撑城市可持续性和弹性能力的巨大潜能。下文关于NUE策略的内容将概述若干具体的问题和行动，以使我们更好地了解 and 融入NUE。

人类世生态系统策略

NUE作为一种思考城市环境的新的方式，和其所反映出的对城市自然现状的解读同等重要。该NUE策略提出的根本原因是21世纪的城市所面临的挑战需要新的解决方案。这些新的解决方案将依赖于文化、知识和社会的所有领域：政府管理、经济、科技、公共卫生、交通、能源、住房、民间机构。必要的解决方案还需要大自然的帮助——而且城市中的自然因其所处的城市的生态环境、气候条件、历史和发展状况的不同而各具特点。

城市中的自然——尤其是生物多样性——将在提供每个城市实现可持续和弹性所必需的生态系统服务方面发挥至关重要的作用。除了令我们的城市在诸多层面更加智能、更加高效外，另一个有助于实现这一前所未有的挑战的途径则是生物多样性^[7]。许多NUE在提供生态系统服务方面具有重要的但不可见的（隐性的）潜能。例如，科学家已发现有氧/厌氧环境中的细菌能够对其所处环境中的污染物进行新陈代谢。这些细菌可以被用来修复其他受污染的城市环境。艾蒿（*Artemisia vulgaris*）这种常见的城市植物物种通常被视为一种入侵性生物，但其已被证实拥有植物修复能力，可以用于棕地治理^[18]。艾蒿是一颗真正被人们视而不见的珍宝，它身上的益处仍有待开发。这是一个城市生态环境中的有趣案例，生物多样性“学习了”如何处理自然中没有、却在城市中处处可见的废料。在NUE中我们面临的挑战是要更好地理解这种城市生物多样性，及其可能提供的生态系统服务。

我们需要在不同的尺度上对NUE进行理解——从微观尺度到宏观的区域尺度。从更广泛的尺度上来说，连通性非常重要，因为许多生态系统服务依赖走廊才能形成跨尺度运行的网络。城市水文和动物迁徙就是很好的例子。如果这种连通性被削弱，那么跨尺度运行的功能也将受到损害。景观生态学研究了景观破碎化随着时间推移对物种的迁移、定生和生存情况的影响，并在栖息地连通性上发挥了重要作用



mosaic of urban nature, one that challenges conventional thinking about urban nature, and that holds great potential to provide important ecosystem services and to support urban sustainability and resilience capacity. The NUE strategy that follows outlines a number of specific issues and actions in support of greater understanding and engagement with NUEs.

A Novel Ecosystem Strategy

NUEs are as much a new way of thinking about the urban environment as they are about understanding the current reality of urban nature. The basic rationale for this NUE strategy is that the challenges that 21st century cities face demand new solutions. These new solutions will rely on all spheres of culture, knowledge and society including: governance, economy, technology, public health, transportation, energy, housing, civic institutions. The necessary solutions will also need nature's help — and nature in the city is different and unique to each city based on its ecology, climate, history and state of development.

Nature in cities, and biodiversity in particular, will play an essential role in providing the ecosystem services that every city relies on to be sustainable and resilient. In addition to making our cities smarter and more efficient in multiple ways, we need to employ biodiversity to assist this unprecedented challenge^[7]. Many NUEs have important but latent (hidden) potential to provide ecosystems services. For example, scientists have learned that bacteria found in toxic /

2. 遗留的/经恢复的人类世城市生态系统类型：在城市建设过程中，这片拥有多年历史的橡树林被保护了下来，并作为瑞典斯德哥尔摩市哈马比港口生态城开发项目的参照生态系统。
2. Relict / Restored Novel Urban Ecosystem type: An old-growth oak woodland was protected during construction and remains as a reference ecosystem in the Hammarby Sjöstad Eco-city development in Stockholm, Sweden.

3. 废弃的/杂草人类世城市生态系统类型：作为这种类型中的一个独特案例，位于德国柏林市的王子花园是一个改造项目，为社区创建了都市农业和包括照片中的“林中咖啡馆”（树种为外来入侵物种）在内的社交集会空间。
4. 废弃的/杂草人类世城市生态系统类型：纽约市的“今朝广场”。场地原为一个入侵物种蔓生的废弃地块，未来绿色设计工作室通过对外来/入侵物种进行选择性清除和策略性地保留，将之改造为了一个广受人们喜爱的啤酒花园。

3. Abandoned / Ruderal Novel Urban Ecosystem type: As a unique example, the Prinzessinnengarten in Berlin, Germany has been reclaimed and repurposed by the community for urban agriculture and social gathering spaces as in this café grove nested in a grove of exotic invasive species.
4. Abandoned/Ruderal Novel Urban Ecosystem type: “Nowadays” in New York City where Future Green Studio transformed an abandoned lot with dense growth of invasive vegetation into a popular beer garden through selective removal and strategic retention of the exotic / invasive vegetation.



anaerobic environments can have the capacity to metabolize the very contaminants they live in. And these bacteria can then be employed to remediate other contaminated urban environments. A common urban plant species, Mugwort (*Artemisia vulgaris*), commonly considered to be an invasive pest, has been discovered to have phytoremediation capacities that can be employed to remediate brownfields^[18]. Mugwort is truly a jewel hidden in plain sight — waiting for its virtues to be discovered. Here is an interesting example of urban ecology where biodiversity has “learned” to process waste materials that are not found in nature, but that exist in most cities. The challenge for NUEs is to better understand such urban biodiversity and the ecosystem services that it can deliver.

NUEs need to be understood at multiple scales — from the microscopic to the metro-region. At broader scales connectivity is important because many ecosystem services depend on corridors to form networks that operate at broader scales. Urban hydrology and animal movement are good examples. When connectivity is diminished, the functions that operate at broad scales are compromised. Landscape ecology



has researched the effects of landscape fragmentation on species movement, colonization and survival over time, and has established the essential role of habitat connectivity. Connectivity in hydrological networks not only supports hydrological functions, but also collateral functions including: species movement, human recreation, and buffering of nutrient flows. NUEs can be planned and managed to support or restore connectivity across cities.

Cities share common attributes, issues and concerns, yet ultimately each city is a unique manifestation of its geography, culture, climate, and history. Urban planning and design is therefore, by definition, always a location-specific activity. Designers celebrate the unique character of cities and this diversity is a source of identity and strength. This same local identity, however, limits the transferability of new ideas and innovations to other cities. While designers rely on precedents and best practices, we also need to consult the *genus loci* of every place to assure that our designs fit the place in an ecological, cultural, historical and aesthetic sense. The imperative to employ innovative practices, and also to design for a particular place presents a dilemma to designers. What kind(s) of site-specific research are needed to adapt innovations from other locations to a local application? The economics and time expectations of most urban design projects rarely allow the opportunity for extensive research. The result tends to reinforce the status quo, or the reliance on established, familiar, and somewhat proven solutions. This results in a culture of design conservatism and a lack of innovation.

An answer to this dilemma is the concept of adaptive design, also known as learning-by-doing, design experiments and research-by-design. Under these concepts designs can be developed as experiments, testing the best available knowledge in fine-scale pilot projects where the risk of failure is understood and accepted, as is the possibility to succeed, and to innovate. Adaptive designs are understood to be hypotheses rather than proven solutions. Adaptive designs, of course, should be conceived responsibly with the best available knowledge, but with uncertainty specifically acknowledged. Adaptive design thinking can be applied to specific novel ecosystem / landscape projects, for example, testing the bioremediation capacity of a created wetland to sequester excessive nutrients, or to monitor the biodiversity and habitat value of alternative urban tree planting schemes.

用。水文网络的连接性不仅可以支持水文功能，而且还将提供额外的功能，包括：物种迁移、人类休憩和营养流的缓冲等。NUE可以由规划和管理，对城市的连通性进行支持或修复。

虽然城市具有共性，并面对着普遍相同的问题，但每个城市不同的地理、文化、气候和历史条件造就了其独一无二的表现形式。因此，城市规划和设计，顾名思义，一直是一项具有地点独特性的工作。设计师喜欢突显城市的独特性，地域条件的多样性也成为了塑造城市形象和特点的源泉。然而，也正是这种地方差异性的限制，使我们无法将新的想法和创新设计运用到其他城市中。虽然设计者习惯于借鉴先例和最佳实践，但我们也需要了解每一个场地的场所特色，以确保我们的设计能够因地制宜地贴合当地生态、文化、历史和审美语境。既要运用创新性实践，也要设计因地制宜的方案，这一当务之急使得设计师陷入了两难。我们需要怎样的特定性场地研究，才能将借鉴于他地的创新性实践运用到本地？大多数城市设计项目的经济和时间预算，使得设计师很难有机会进行广泛的研究。其结果往往会强化现状，或应用那些已建成的、熟悉的、在一定程度上已在应用的解决方案。这导致了一种设计上的守旧主义、缺乏创新。

这一难题的答案是适应性设计（也被称为边干边学、设计实验和设计型研究）。根据这些概念，设计可以被开发为实验，在精细尺度的试验项目中对现有的最佳知识进行检测。这些项目可以理解并接受失败，但也存在成功和创新的可能性。适应性设计被视为研究假设，而非已证实的解决方案。当然，适应性设计应该认真负责地对现有最佳知识进行运用，但其也具有众所周知的不确定性。适应性设计思维可以应用到具体的人类世生态系统/景观项目中——例如，检测人工湿地的生物修复能力以隔离过多的营养物质——或监测替代性城市树木种植方案在生物多样性和栖息地方面的价值。

5. 经园艺维护的/整洁的人类世城市生态系统类型：位于荷兰阿姆斯特丹市的冯德尔公园是19世纪浪漫主义公园的经典案例。
6. 经园艺维护的/整洁的人类世城市生态系统类型：采用了单一树种的大胆种植设计形式的中国北京市奥林匹克森林公园。
5. Horticultural / Formal Novel Urban Ecosystem type: Vondel Park, Amsterdam, The Netherlands is a classic example of a Romantic 19th-Century park.
6. Horticultural / Formal Novel Urban Ecosystem type: The Olympic Forest Park in Beijing, China includes bold, mono-specific grove plantings.

在制定人类世生态系统和景观适应性设计方案中，存在着哪些挑战和阻碍？对失败和责任的惧怕是人们拒绝运用适应性设计的常见理由。具有“可接受性失败”理念的设计实验可以解决这一难题^{[19][21]}。通过这种方式，设计被明确地界定为实验，其空间尺度将缩小，以将潜在的失败后果控制在可接受的范围内。“可接受性失败”的设计实验采用严格的科学监测和评估，当出现能够满足项目目标和期望的绩效表现时，设计师可以对相关信息加以学习。美国的可持续场地计划提供了一套实质性的措施对项目进行监测，以验证景观设计项目的效力和效果^[22]。

这种“可接受性失败”的理念代表了一种可以提升在与人类世城市生态系统和景观相关的可持续性和弹性景观实践方面的场地具体知识的重要策略机遇。基于科学严谨性、为公众所接受，并在生态和专业层面上都做到功能与美观兼顾的“可接受性失败”型人类世生态系统需要一种跨学科的工作方式，其中利益相关者、设计师、科学家和决策者在整个项目过程中协同合作——包括建成后的监测工作。将当地志愿者纳入“公民科学”计划将是一个可以使利益相关者参与进来、获得有价值的经验数据、提升公众对创新性人类世城市生态系统及景观的意识和支持的有效策略。

这种NUE策略包括几个关键概念。城市生物多样性并未过时，而仍是一种提供生态系统服务必不可少的资源和工具。NUE需要被在多尺度下进行解读、规划、设计和管理，以支持能够在这些尺度上产生作用的实质过程。在要求场地特性和时间紧迫的背景下边学边干，以及在意识到城市开发的积极潜能方面，适应性设计范式都是必要的。为了让所有这些概念得以慢慢为人们所接受、所实践、所支持，我们需要一个跨学科的合作模式，专业设计师、科学家、决策者和利益相关者都可能在其中不断共享信息、交流想法。



What are the challenges and barriers to practicing adaptive design for novel ecosystems and landscapes? The fear of failure and liability concerns is often cited as the reasons for not practicing adaptive design. A conceptual solution to this challenge is the idea of “safe-to-fail” design experiments^{[19]-[21]}. In this approach, designs are explicitly understood to be experimental, and scaled-down in spatial extent to limit the consequence of potential failure. Safe-to-fail design experiments depend on rigorous scientific monitoring and assessment to learn if the observed performance meets the projects goals and expectations. The Sustainable Sites program in the US provides a substantial suite of measures to monitor to validate the efficiency and effectiveness of landscape design projects^[22].

The “safe-to-fail” concept represents an important strategic opportunity to advance place-specific knowledge about sustainable and resilient landscape practices associated with novel urban ecosystems and landscapes. To be scientifically rigorous, publically acceptable, ecologically and professionally responsible and beautiful, safe to fail novel ecosystems demand a transdisciplinary working method where stakeholders, designers, scientists and decision makers collaborate throughout a project — including post-implementation monitoring. Including local volunteers in a “citizen science” program can be an effective strategy to engage stakeholders, to gain useful empirical data, and to raise public awareness and support for innovative novel urban ecosystems and landscapes.

This NUE strategy includes several key ideas. Urban biodiversity is not an anachronism, but rather an essential resource and tool to deliver ecosystem services. NUEs need to be understood, planned, designed and managed at multiple scales to support the essential processes that function at those same scales. An adaptive design paradigm is necessary to learn-by-doing in a place-specific, time efficient context and to realize the positive potential of urban development. For all of these ideas to be accepted, practiced and supported over time, a transdisciplinary mode of working is needed in which design professionals, scientists, decision makers and stakeholders share information and ideas continuously.



- 与绿色基础设施相关的人类世城市生态系统类型：这种类型中包括都市农场和屋顶花园，而纽约市的布鲁克林农场是一个二者兼备的案例；其可以提供一系列生态系统服务，包括食物生产、雨洪滞留、环境教育和社区集会等。
- 与绿色基础设施相关的人类世城市生态系统类型：美国俄勒冈州波特兰市的一个绿色停车场展示了绿色基础设施所拥有的生态系统服务潜能，包括雨洪截流/下渗、提供野生动物栖息地和缓解气候变化。

- Green infrastructure-related Novel Urban Ecosystem type: Green infrastructure-related Novel Urban Ecosystems include urban farms and green roofs. The Brooklyn Grange in New York combines both — yielding a number of ecosystem services including food production, stormwater retention, environmental education and community gathering.
- Green infrastructure-related Novel Urban Ecosystem type: A green parking lot in Portland, Oregon demonstrates the ecosystem service potential of green infrastructure, including stormwater interception / infiltration, wildlife habitat, and climate mitigation.

结论

这个属于城市的世纪为城市的可持续性及其弹性发展带来了前所未有的挑战。诸多类型的NUE将生存下来，或在未来的城镇化过程中形成。而矛盾的是，NUE中可能包含的生态知识却产生于遭受污染的环境之中——这些知识可能具备修复同样由城镇化过程造成的危害的能力。



Conclusions

The century of the city poses unprecedented challenges for urban sustainability and urban resilience. NUEs of many types will survive, or result from future urbanization. Paradoxically, NUEs may include ecological knowledge that evolves from and in polluted environments — knowledge that may contain the capacity to remediate the same toxins that generally accompany urbanization.

The world’s new urban demographic has profound implications and consequences for urban sustainability and resilience. Cities will be central to research on ecosystem services and disservices since 75% of the world’s population will be urban by 2050^[16]. The idea and promise of novel urban nature captures the important conclusion that has been drawn from the Century of the City — that the global challenge for sustainability and resilience will be won or lost in cities.

“The challenge of the Anthropocene is to use human ingenuity to set things up so that the planet can accomplish its 21st-century task.”^[5]

世界上城市人口的新局面已经对城市可持续性和弹性产生了深远的影响。城市将成为研究生态系统服务和危害的核心，因为到2050年时，城市人口将占世界总人口的75%^[16]。人类世城市自然的观念和前景正是基于对这个“属于城市的世纪”的重要总结——全球面临的挑战是：城市中的可持续性和弹性要么实现，要么沦丧。

“人类世的挑战是利用人类智慧来创造，从而使地球能够完成其21世纪的任务。”^[5]

景观设计师拥有一个为应对这一全球性挑战贡献自身力量的前所未有的机遇。在人类世中，自然正在被重新定义——我们需要承认那些新出现的和永久性的城市现实，了解NUE如何为城市提供其所需的生态系统服务，并对生态系统危害进行管控，以使城市具有可持续性和弹性。设计师可通过与科学家和决策者的合作，通过“可接受性失败”的实验来践行适应性设计——并养成从监测和评估中学习（尤其需要获悉人类世自然的绩效表现）的职业习惯。

“我们改变了地球，作为生活在这颗星球上的一个物种，我们有责任用爱和智慧对其进行保护和管理。地球并非已破损不堪。她美丽依旧。如果我们共同携手呵护，她将更加美丽。”^[4]

Landscape architects have an unprecedented opportunity to contribute to this global challenge. In the Anthropocene, nature is being redefined — to acknowledge the new and permanent urban reality, and to understand how NUEs can deliver the ecosystem services that cities need, and manage the ecosystem disservices for cities to be sustainable and resilient. Designers can partner with scientists and decision makers to practice adaptive design, through “safe-to-fail design” experiments — and to make a professional habit of monitoring and assessment to learn, specifically how this novel nature performs.

“This is the Earth we have created, and we have a duty, as a species, to protect it and manage it with love and intelligence. It is not ruined. It is beautiful still, and can be even more beautiful, if we work together and care for it.”^[4]

REFERENCES

- Burdett, R. & Sudjic, D. (2008). *The Endless City: The Urban Age Project*. London: Phaidon Press.
- UN Habitat. (2006). *The State of the World’s Cities 2006/7: The Millennium Development Goals and Urban Sustainability*. New York: Routledge.
- Forman, R. T. T. (2014). *Urban Ecology: Science of Cities*. New York: Cambridge University Press.
- Marris, E., Kareiva, P., Mascaro, J. & Ellis, E. (2011, December 7). Hope in the Age of Man. *New York Times*.
- Sijmons, D. (2014). *IABR 2014-Urban by Nature*. Rotterdam: IABR.
- Hobbs, R. J., Arico, S., Aronsen, J., et al. (2006). *Novel Ecosystems: Theoretical and Management Aspects of the New Ecological World Order*. *Global Ecology & Biogeography*, 15(1), 1-7.
- Hobbs, R. J., Higgs, E. S. & Hall, C. (2013). *Novel Ecosystems: Intervening in the New Ecological World Order*. New Jersey: John Wiley & Sons.
- Ross, M. R. V., Bernhardt, E. S., Doyle, M. W. & Heffernan, J. B. (2015). Designer Ecosystems: Incorporating Design Approaches into Applied Ecology. *Annual Review of Environment & Resources*, 40(1), 419-443.
- Ahern, J. (2014). Cultivation of Novel Nature for Urban Resilience. *ECLAS Conference Porto 2014 — Landscape: A Place of Cultivation*, 45-57.
- Odum, E. & Barrett, G. W. (2004). *Fundamentals of Ecology* 5th Edition. Boston: CENGAGE Learning.
- Forman, R. T. T. & Godron, M. (1986). *Landscape Ecology*. Chichester: Wiley-Blackwell.
- McDonnell, M. J. & Hahs, A. K. (2013). *The Future of Urban Biodiversity Research: Moving beyond the ‘Low-Hanging Fruit’*. *Urban Ecosystems*, 16(3), 397-409.
- Ahern, J. (2012). *Urban Landscape Sustainability and Resilience: The Promise and Challenges of Integrating Landscape Ecology with Urban Planning*. *Landscape Ecology*, 28(6), 1203-1212.
- Millennium Ecosystem Assessment. (2005). *Millennium Ecosystem Assessment Synthesis Report*. Retrieved from <http://www.millenniumassessment.org/documents/document.34.aspx.pdf>
- Windhager, S., Steiner, F., Simmons, M. T. & Heymann, D. (2010). *Toward Ecosystem Services as a Basis for Design*. *Landscape Journal*, 29(2), 107-123.
- Döhren, P. V. & Haase, D. (2015). *Ecosystem Disservices Research: A Review of the State of the Art with a Focus on Cities*. *Ecological Indicators*, 52, 490-497.
- Tredici, P. D. (2010). *Spontaneous Urban Vegetation: Reflections of Change in a Globalizing World*. *Nature & Culture*, 5(3), 299-315.
- Kennon, N. & Kirkwood, N. (2015). *Phyto: Principles and Resources for Site Remediation and Landscape Design*. New York: Routledge.
- Ahern, J. (2011). *From Fail Safe to Safe-To-Fail: Sustainability and Resilience in the New Urban World*. *Landscape & Urban Planning*, 100(4), 341-343.
- Rottle, N. & Yocom, K. (2011). *Basics Landscape Architecture 02: Ecological Design*. Lausanne: AVA Publishing.
- Lister N. M. (2007). *Sustainable Large Parks: Ecological Design or Designer Ecology?* New York: Architectural Press.
- SITES. (2014, June 28). *Sustainable Sites Initiative Online*. Retrieved from <http://www.sustainablesites.org>
- Thompson, C. W. (2002). *Urban Open Space in the 21st Century*. *Landscape & Urban Planning*, 60(2), 59-72.