生态种植势在必行：创建功能性的系统，而非程式化的生态
Ecological Planting Imperative: Functional Systems, Not Stylized Ecologies

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摘要

通过创建由植物构成的人工生态系统，景观设计项目得以缓解气候变化的严峻影响。尽管人们普遍认识到了生态学对于景观塑造的重要性，但景观设计专业人士却普遍缺乏构建稳定植物系统的知识和实践技能，因此迫切需要探索种植设计的新方法和新工具。本文概述了城市环境下高生物多样性植物系统的设计原理和方法，着重介绍了可提升物种丰富度、功能多样性和空间复杂性，有助于构造更具韧性的植物景观的设计方法。种植设计中选择那些对胁迫、干扰和竞争表现出相似适应性状的物种，以及构建由多样化植物形态构成的多层次组合，将有助于建构具有兼容性、长期稳定的植物组合。为平衡多种植物组合带来的视觉复杂性，本文结合美国华盛顿特区Phyto设计工作室的案例与研究和实践经验，探讨了提升景观效果的种植设计策略。这些方法总结于作者探讨如何创建人工植物群落的著作——《后荒野世界的种植设计》一书。

关键词

生态种植；种植设计；植物群落；生物多样性；多样植物系统；种植策略体系

ABSTRACT

The ability of landscape architectural projects to mitigate the worst effects of climate change will depend upon designed ecological systems. These systems will be built with plants. Despite the recognition of ecology as an essential driver of landscapes, the professionals of landscape architecture too often lack the knowledge and practical skills to create robust vegetative systems. New approaches and tools are required. This article outlines principles and methods for designing biodiverse plant systems for urban sites. Planting methods that increase species richness, functional diversity, and spatial complexity are emphasized as a way of developing more resilient plantings. Selecting species with similar evolutionary adaptions to stress, disturbance, and competition—as well as creating multi-layered compositions of diverse plant morphologies—allows designers to create compatible, long-lived plant mixes. To balance the increased visual complexity of diverse plant mixes, the article explores design techniques to make plantings more appealing to the public. The strategies explored here are based on the projects, experience, and research of Phyto Studio, a Washington, D.C. based studio. The methods build on work described in the author's book, *Planting in a Post-Wild World*, an exploration of how to create designed plant communities.

KEYWORDS

Ecological Planting; Planting Design; Plant Community; Biodiversity; Diverse Plant Systems; Planting Strategy Systems

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1 基于生态学的种植设计需求

景观设计领域能否为应对气候变化作出贡献，取决于人工生态系统成功与否。这类生态系统由诸多元素构成，包括土地、水、石头、构筑物、管网等；但在生态层面而言，植物或为其中最重要的元素。植物群落整体上作为一个动态系统，对于陆地生态系统的功能发挥举足轻重：植物可驱动碳、氧循环，辅助成土，调节水循环，并滋养万物。尽管人们普遍认识到了生态学对于景观塑造的重要性，但景观设计专业人士却普遍缺乏构建稳定植物群落的知识和技能。传统的种植方法仍然在行业中占主导地位，以致人工设计的环境难以具备自然环境的复杂性和功能性，因而亟需探索植物设计的新方法与新工具。本文结合美国华盛顿特区Phyto设计工作室的研究和实践经验，对城市环境下的多样化城市植物群落设计原理与方法进行了阐述。

通过种植设计来改善景观生态功能潜力巨大。生态思维的谨慎运用可以为应对更宏大的环境问题（如干旱、洪水、水土流失和物种入侵）提供创新型解决方案。此外，生态思维的运用还可以帮助解决持续存在的城市问题，如抑制杂草、避免植被管理中对化学品的过度依赖，以及高效利用维护资源。

为了提升景观设计项目的生态健康水平，设计师需要重新理解种植设计的功能性，而非形式上的美学特性——这并非否认美学在种植设计中的重要性；实际上，令公众意识到植物景观的有序乃至赏心悦目，才是自然种植设计成功的关键。然而，植物物种的筛选、布置与管理不能仅仅出于形式考虑；种植设计应依据当代生态科学和恢复生态学的生态学原理进行。

作者认为，人工植物群落的生态功能取决于其所提供的生态系统服务。天然存在的植物群落具有众多已被广泛证实的生态系统服务[1]，这些服务对于土壤微生物的生长繁殖、养分循环、无脊椎动物和其他动物的生命支持，以及大气环境中的碳封存、雨水渗透和存储、废物处理和旱涝灾害的缓解至关重要[2]。可以提升植物群落的生态系统服务的特征包括物种丰富度（物种总数）、功能多样性（不同物种在群落中发挥的功能作用）和空间复杂度（物种的空间分布与栖息方式）。简而言之，物种多样性的提升可优化植物群落的功能服务[3]——即使在某一群落中两个物种可能发挥着相似的功能，但由于环境条件的变化，它们在不同

1 The Need for Ecologically Informed Planting Design

If the profession of landscape architecture is to have a meaningful impact on climate change, it will depend upon the success of designed ecosystems. These systems will be composed of many elements: earth, water, stone, structures, and pipes; but perhaps the most consequential element to their ecology is plants. Plants working together as dynamic systems have an outsized role in the function of terrestrial ecosystems. They drive the carbon and oxygen cycles, build soil, regulate hydrologic cycles, and feed the world. Despite the recognition of ecology as an essential driver of landscapes, the professionals of landscape architecture too often lack the knowledge and skills to create robust vegetative systems. Conventional planting approaches still dominate the profession, resulting in designed environments that lack the complexity and functionality of their natural counterparts. New approaches and tools for the design of plants are needed. This article outlines the principles and methods for designing diverse plant systems for urban sites. The strategies explored here are based on the projects, experience, and research of Phyto Studio, a Washington, D.C. based studio.

The potential for improving a landscape's ecological function through planting design is immense. A more rigorous application of ecological thinking can create innovations, mitigating bigger environmental issues such as drought, flooding, erosion control, and invasive species. It can also help address persistent urban issues like weed control, overreliance on chemical inputs to manage vegetation, and insufficient maintenance resources.

To achieve a greater level of ecological health in landscape architectural projects, a renewed focus on planting's functionality, as opposed to its formal aesthetic qualities, is required. This is not to say the aesthetics of plantings do not matter; in fact, the need for the public to perceive a naturalistic planting as ordered and even beautiful is critical to its success. However, formalistic concerns cannot drive their selection, arrangement, and management. Instead, ecological principles derived from contemporary ecological sciences and restoration ecology must be the primary drivers of planting design.

Ecological function, in this article, is defined by how well a designed plant community provides ecosystem services. Naturally occurring plant communities provide a wide range of well-documented ecosystem services[1] that are essential for soil microbiology, nutrient cycling, support of invertebrates and other fauna, sequestration of atmospheric carbon, stormwater infiltration and storage, detoxification of wastes, and mitigation of floods and droughts[2]. There are several characteristics which can increase the ecosystem services of a planting. Species richness (the total number of species), functional diversity (the functional roles that different species play in a planting), and spatial complexity (where and how species inhabit) are some of the main drivers of ecosystem services. Simply put, increased diversity increases the functional services of the planting[3]. Even when two species appear to perform the same function within a community, one may outperform another in different years as environmental conditions change[4]. This kind of

发展阶段的表现也会出现优劣差异[4]。植物群落中的这种功能性交叠使其能够更好地应对气候变化的影响。

2 超越单一物种集群：当前景观设计中种植设计手法评述

一项针对中国、北美和欧洲景观设计获奖项目的非正式调查显示，当前的种植方法主要通过模式化的植物配置来表达设计思想。当然也有一些特例，但上述项目大多更加注重植物群落的视觉构成，而非构建动态的群落功能或生态特性。

这并非一个全新的议题。单一物种种植“组团”或“集群”是形式主义设计传统的一种典型特征，融合了植物材料运用的大多数经验智慧。虽然具体模式随时间而改变，但植物在单一物种集群或组团中的排布方式并没有发生变化。自安德烈・勒诺特或意大利文艺复兴时期的欧洲古典园林以来，植物就已被排布成各种图案以表现规整、对称的几何形状——即便是在其他自然主义运动中，如英国的如画式造园运动（或美国弗雷德里克・劳・奥姆斯特德的园林作品），尽管植物集群的形状是自然且不规则的，但植物材料仍以单一物种群体的形式排布。

按植物物种分组是一种实用的植物群落建构方式。这种排布方法使植物配置模式更加清晰可辨，并传达出一种有别于野生植物群落的秩序感与人工管理理念。从生态角度来看，这种方法的问题在于单一物种组团的排他性使用。单一物种组团种植有如下缺点：首先，相同物种的种植会产生相同的形态、特性和生长习性，这意味着这些植物不能有效地覆盖地表，即使是密集集群，植物之间或植物基部也经常出现间隙。此外，在植物休眠期间，植物之间也会产生间隙。这些空间或时间上的空隙给了杂草和外来物种侵入的机会。在阳光照射下，植物之间暴露的土壤中微生物的功能会被削弱，将碳释放到大气中，并降低土壤的渗水能力。这一问题的常见解决方法是厚铺护根覆盖物或使用芽前除草剂（在北美地区十分常见），但这些方法都会加剧环境问题。其次，单一物种组团的过度运用导致大型项目中的生物多样性极低。在传统的植物间隔下，植株密度为3 ~ 6株/m^2，而生态种植手法可将植株密度提升至9 ~ 15株/m^2。

3 种植设计新理念：构建多样的植物系统

一种新的种植理念是用由彼此兼容的植物物种构成的多种植物组合来代替单一物种种群（图1）。植物组合可以实现单一物种种植的美学效果——如果某组植物的高度相同且远观质地一致，那么它就可以表现

functional redundancy within a planting enables it to better withstand the impacts of climate change.

2 Beyond Monocultural Massing: A Critique of Current Landscape Architectural Planting Approaches

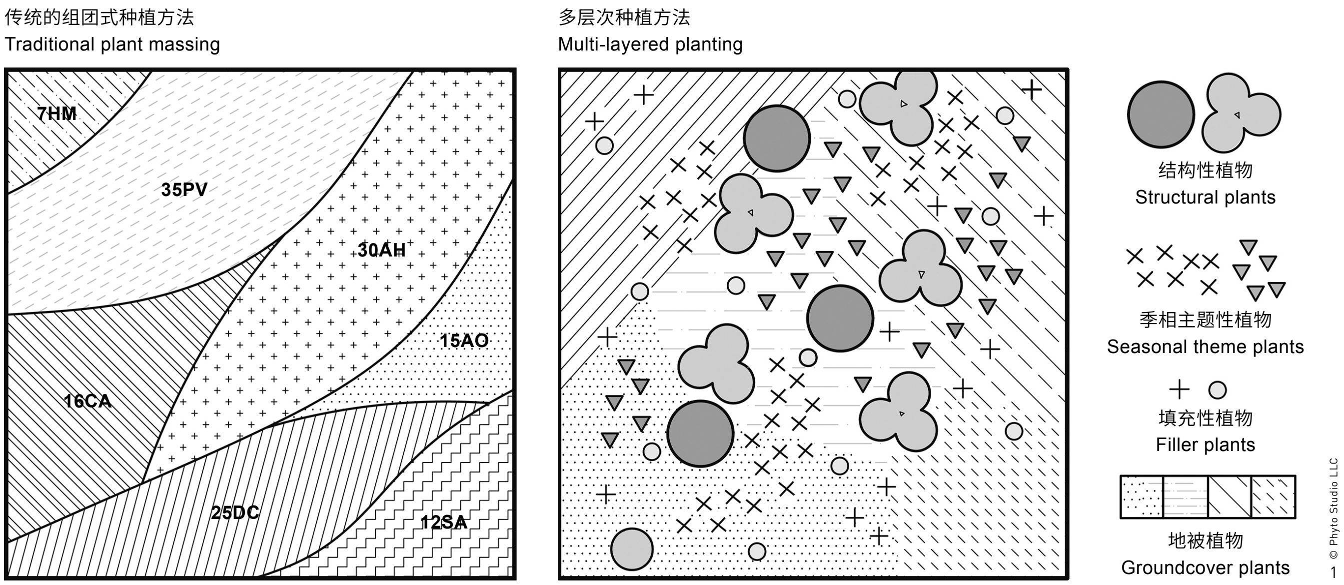
A casual survey of award-winning landscape architectural projects in China, North America, and Europe reveals that planting approaches primarily focus on arranging plants in patterns to express design ideas. There are notable exceptions, of course, but in most of these projects, a planting's visual and compositional qualities are prioritized—as opposed to functional or ecological dynamics.

This is not new. The use of monocultural “blocks” or “masses”—the defining feature of formalistic design tradition—has united most of the history of planting design. While the patterns have changed over time, the arrangement of plants in monocultural groups or blocks has not. Since the classical European gardens of André Le Nôtre or the Italian Renaissance, plants have been arranged in patterns to express formal, symmetrical geometries—Even during more naturalistic movements like the British picturesque (or the American counterpart in Frederick Law Olmsted's work), while the shapes of plant masses were natural and amorphous, plants were nonetheless arranged in monocultural groups.

Arranging plants in groups of the same species is a useful compositional tool. This method of arrangement makes patterns more legible and conveys a sense of intentionality and care that distinguishes it from wild vegetation. From an ecological perspective, the problem is the exclusive use of monocultural blocks. Monocultural blocks have several disadvantages. First, the plantings of same species have the same shape, behavior, and temporal sequence. That means they rarely cover ground effectively—Even in a dense grouping, there are often gaps created between or below the plants. Gaps are also created during dormancy. These gaps in space or time are where weeds and invasive species establish. The exposure of open soil between plants to sunlight degrades soil microbiology, releases carbon into the atmosphere, and reduces the soil's ability to infiltrate water. Deep bark mulches or pre-emergent herbicides (prevalent in North America) are often used to deal with this issue—each of which results in negative environmental consequences. Second, the reliance on monocultural blocks results in large-scale projects with minimum biodiversity. Traditional plant spacing gets 3 to 6 plants per square meter, whereas more ecological approaches can get anywhere from 9 to 15 plants in the same space.

3 An Alternative: Diverse Plant Systems

An alternative is to replace monocultural groupings with diverse mixes of compatible species (Fig. 1). Aesthetically, a group of plants can function like a monoculture. If the height of the mix is the same, and its texture from a distance appears consistent, it can convey the same sense of pattern and legibility as a single



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1. 图中显示了传统的组团式种植（左）与多层次种植（右）之间的区别。

1. Diagrams show the difference between traditional plant massing (left) and the kind of multi-layered planting (right).

出与单一物种种植相同的视觉效果。同时，多样化的植物组合也具有独特的美学优势（如多个花期、季相变化丰富、与硬质景观相衬的繁茂植物效果），其中以草本植物为主的组合最为突出。这一方法的关键在于理解如何构建稳定的植物群落。

其核心理念是以植物群落为单位进行种植设计。天然存在的植物群落是不同种群的集合，它们都可适应特定的场地环境条件。数千年来的共同演化使植物与环境及植物物种彼此都高度适配，这些野生植物群落经常为景观设计师带来灵感。而新理念的不同之处在于，不仅要将野生植物群落作为物种选择的参考来源（一种相对常规的做法），还要将它们视为功能性系统的模板。

这一区别非常关键。如果设计师仅将野生植物群落作为选用植物的参考来源而忽略了它们作为一个整体的功能性构成，那么设计出的植物群落将需要人工养护来维持。种植设计的目标是增加物种多样性，同时为不同物种间的稳定共存提供条件。当一个群落中的植物在空间和时间上占据不同的生态位时，就会产生稳定性。例如，耐荫的草本植物会在较冷的季节中生长并覆盖地面；而在夏季，这些物种中的大多数处于休眠状态，其上方为植株较高且喜阳的植物。这种生态位的差异化可提升生态系统服务，并维持植物组合的长期稳定。稳定性本身并不能使植物群落更具功能性。实际上，无论是稳定的植物群落还是不停变化的植物群落，都可以提供生态系统服务，但稳定性能够有效减少对人工景观的维护。不同的物种必须彼此兼容——每个物种就像拼图一样相互嵌合，

species grouping. Diverse mixes of plants—particularly herbaceous dominated ones—offer unique aesthetic advantages such as multiple flowering events, dynamic seasonal changes, and a lush counterpoint to hardscape. Understanding how to assemble plants into stable communities is the key.

The central idea is planting as a community. Naturally occurring plant communities are assemblages of different populations, all adapted to tolerate specific environmental conditions. Thousands of years of co-evolution results in plants with a high degree of fitness both to its environment and between each other. These wild plant communities are often claimed by landscape architects as inspiration. The difference is not just using plant communities as an inspiration for species selection (a more conventional approach), but instead using them as templates for functional systems.

The distinction here is critical. If a designer merely uses a wild plant community as an inspiration for a plant list, but ignores their functional role as an assembly, the result will be a planting that requires labor and maintenance to persist. The goal is to increase diversity while providing the conditions for stability between different species. Stability is created when plants within a community inhabit different niches in space and time. For example, shade-tolerant herbaceous species actively cover the ground during cooler months. In summer many of these species go dormant while taller, sun tolerant species grow above them. This kind of niche differentiation increases ecosystem services while providing stable, long-term combinations. Stability, by itself, does not make a planting more functional. In fact, both stable and highly dynamic plant communities can provide ecosystem services. However, stability is important for reducing maintenance in designed landscapes. Species must be compatible with each other—each interlocking together like a puzzle, and their dynamic qualities should balance each other. For example, if one species

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2. 由Phyto设计工作室设计师克劳迪娅・韦斯特设计的生物截留雨水花园。图片展现了人工植物群落一年四季的动态混合变化，在整个生长季节都有地表覆盖、花期不断。
3. 用于植物选择的各种生态与美学筛选机制

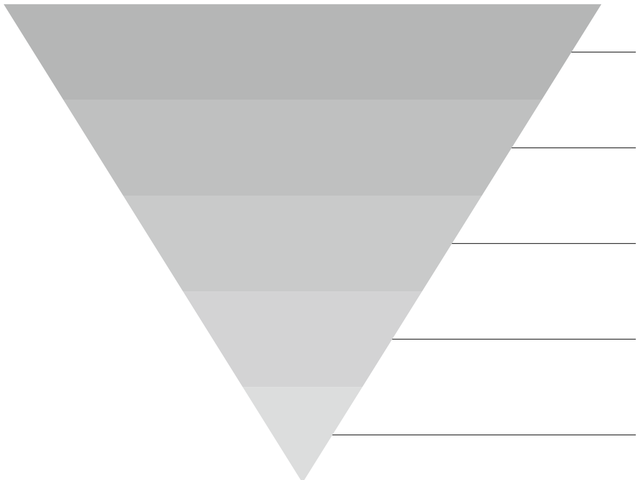
2. Bioretention planters designed by Claudia West of Phyto Studio. The images show how dynamic mixes change through the season, offering both ground cover and flowering events throughout the growing season.
3. Plant selection should be passed through various ecological and aesthetic filters.

它们的动态特性也应相互平衡。例如，若一个物种的花期是初夏，另一个的花期是仲夏，那么它们就是兼容互补的。

互补物种的选择需要跳脱出传统园艺的种植设计思路。最重要的是，所选物种必须对同样的环境压力具有耐受性，这就需要首先考虑场地中影响植物生长的外部因素。植物对各种压力（如光照、水分或养分不足）的耐受力将在很大程度上影响其在场地中的分布。英国生态学家约翰・菲利普・格莱姆提出的“植物生存策略”概念[5]（C—S—R理论）为设计者提供了有效参考。他认为植物在野外环境中面临三种限制因素：1）位于水分、光照和土壤肥力充足地区时，与其他物种间的激烈竞争（竞争者）；2）高压条件，如干旱、土壤肥力较低或极端温度（胁迫耐受者）；3）高度外部干扰（杂草型植物）。这一理论强调针对不同的城市环境条件需要创建不同的植物系统。干扰性较高和土壤湿度较大的城市绿色基础设施适合杂草型植物和竞争者植物生长，而土壤浅薄且高温的绿色屋顶则适宜引入胁迫耐受者植物。格莱姆还强调某些物种是不相容的，即便它们来自同一生物群系。例如，北美草原植物可能备受设计师青睐，但若将胁迫耐受者植物淡紫松果菊（*Echinacea pallida*）与竞争性植物美国薄荷（*Monarda didyma*）或紫苞泽兰（*Eutrochium purpureum*）混合种植于肥沃的土壤中，将导致淡紫

blooms in early summer, another will bloom in mid-summer. In this way, they are complementary.

Selecting complementary species requires thinking about planting in ways that are often ignored in traditional horticulture. Above all, species must tolerate the same environmental stresses. The key concept is to define a site by the external factors that limit plants' growth. A plant's tolerance to different kinds of stress—low light, water or nutrients—will to a large degree influence its distribution on site. British ecologist John Philip Grime's concepts of plant survival strategies[5] (C–S–R theory) are a useful shorthand for designers. He describes three limitations that plants face in the wild: 1) strong competition from other species found in sites with abundant moisture, sun, and soil fertility (Competitors or "C"); 2) highly stressful conditions like drought, limited fertility, or temperature extremes (Stress-tolerators or "S"); and 3) high levels of external disturbance (Ruderals or "R"). Grime's strategies highlight different systems that might be applied to different urban conditions. Urban green infrastructure with its high disturbance and moist soils favors ruderals and competitors, whereas a green roof with its shallow soils and high temperatures favors stress-tolerators. It also shows that some species—even those from the same biome—are incompatible. For example, North American prairie species might be the focus of a designer's plant list. Mixing a stress-tolerator like *Echinacea pallida* with a competitive *Monarda didyma* and *Eutrochium purpureum* together in rich soils,



3 © Phyto Studio LLC

松果菊的死亡。因此重要的一点是，不要将对压力具有不同适应性状的植物混合种植。

4 多层次地表覆盖

构建多样植物组合的关键在于通过植物分层，对地表进行密集覆盖。地表覆盖对建立功能性植物群落来说最为重要。除了个别极端条件地区或受干扰的地区外，大多数温带气候地区的土壤裸露情况是暂时性的，每个裸露的地方都是潜在的生态位。野外环境中的所有地表都覆盖着植物，这就为景观设计师提供了一个简单但尚未得到充分实践的设计原则：植物本身可以起到“护根物”的覆盖作用[6]。

为了有效覆盖地表，人工设计的植物组合具有不同的垂直层次，每一层在全年中扮演着不同的角色。人工植物群落的构建需要两个基本层：由地被植物组成的近地面的基底层，与由较高的直立植物组成的第二（上）层，这一层的植物通常占据视觉主导作用。

基底层是指由耐荫植物构成的低矮圆丘状组合。良好的基底层中，植物的传播方式各异，其中许多物种为无性繁殖，它们在水平方向上分布在较高植物——如草莓属（*Fragaria* spp.）、路边青属（*Geum* spp.）、淫羊藿属（*Epimedium* spp.）、筋骨草属（*Ajuga* spp.）、金千里光属（*Packera* spp.）、老鹳草属（*Geranium* spp.）、蝶须属（*Antennaria* spp.）和细辛属（*Asarum* spp.）——的基部周围。基底层物种也包括种子自播、成簇生长的植物，例如薹草属（*Carex* spp.）、重楼属（*Paris* spp.）、矾根属（*Heuchera* spp.）、报春花属（*Primula* spp.）和蓝禾属（*Sesleria* spp.）。可在春季形成短暂而绚丽景观效果的马裤花属（*Dicentra* spp.）、报春花属，以及水仙（*Narcissus* spp.）等隐芽植物，与可在冬季形成稳定景观效果的薹草属和矾根属等，即为一种可行的植物组合。

上层多采用传统景观设计中的常见植物，包括观赏草、直立阔叶草本植物和亚灌木。上层植物应成簇状、不分散且寿命长。就基底层

will result in the death of the *Echinacea*. It is important not to mix species with different evolutionary adaptations to stress.

4 Covering the Ground With Multiple Layers

The key to assembling diverse plant mixes is to densely cover the ground by layering plants. Covering ground is the most important concept of creating a functioning plant community. In most temperate climates, except for extreme or disturbed sites, bare soil is almost always a temporary condition. Every bare spot is an available niche, and in the wild, all niches are filled with plants. This fact prompts a simple, yet underutilized design principle for landscape architects: plants themselves can function as mulches[6].

To effectively cover the ground, plant mixes are designed at different vertical layers, each performing different roles throughout the year. Start with two basic layers: the base layer composed of low ground-covering species, and a second (upper) layer composed of tall, upright species that tend to be more visually dominant species.

The base layer describes a mix of low, hummocky plants which are shade tolerant. Good base layers are a combination of plants with different spreading behaviors. Many are clonal species that spread horizontally around the base of taller species (such as species in the genus of *Fragaria*, *Geum*, *Epimedium*, *Ajuga*, *Packera*, *Geranium*, *Antennaria*, and *Asarum*). Other base layer species may be clump-forming plants that more often spread by seed (*Carex*, *Paris*, *Heuchera*, *Primula*, *Sesleria*, etc.). Mixing species allows the designer to balance species that are showy in spring but ephemeral (*Dicentra*, *Primula*, and geophytes like *Narcissus*) with species that are stable and winter present (*Carex* and *Heuchera*).

The upper layer is composed of plants more traditionally associated with landscape architectural plantings, including ornamental grasses, upright forbs, and shrub-like mounding perennials. Upper layer plants should be clump-forming, non-

和上层的比例而言，基底层的物种多样性和生物量应该更高；上层植物应间隔更大、植株密度更低，随着时间的推移，上层植物不会导致基底层因少光而死亡，植物群落的稳定性会更高。花葶直立无叶的物种是良好的上层植物材料，如百子莲属（*Agapanthus* spp.）、葱属（*Allium* spp.）、独尾草属（*Eremurus* spp.）、夏风信子属（*Galtonia* spp.）、火把莲属（*Kniphofia* spp.）和丝兰属（*Yucca* spp.）。花朵长于直立茎顶端的夏季开花植物，如松果菊属（*Echinacea* spp.）、刺芹属（*Eryngium* spp.）、钓钟柳属（*Penstemon* spp.）、狼尾草属（*Pennisetum* spp.）和一枝黄花属（*Solidago* spp.）的许多物种均为理想的上层植物材料。

植物的生态特性——植物与环境及植物彼此间的相互作用——对物种选择至关重要，这意味着各种生态和设计层面的筛选机制尤为关键（图3）。一开始，可能会有众多植物材料进入设计师的视野，但设计师可通过层层考量，筛选出那些更具韧性的物种。这个筛选过程不同于传统的园艺方法，后者的选择更多出于美学考虑，包括花朵的色彩、高度或质感对比等。

5 利用设计框架使高生物多样性的植物组合更加特色鲜明

随着植物群落变得更加动态和自然化，公众也可能认为其景观效果与杂草无异，或毫无美感可言。随着人们对于美的社会共识不断扩大，生态美学有望逐步为公众所接纳。这意味着最终落在景观设计师肩上的“将生态功能转化为美学形式”的责任将更重。本文在此提出几项策略。

首要策略是在植物群落周围使用几何框架。“有序框架”（orderly frame）概念由琼·艾弗森·纳索尔[7]首先提出，在公众眼中，这代表着秩序感和人工管理。在Phyto设计工作室的实践中，相对于路缘、矮墙、铺路、草坪、树篱或其他结构元素，草本植物组合的边界感更加模糊、多变，设计师可以加强这种鲜明对比。

spreading, and long-lived. In terms of proportions of the two layers, the base layer should have more diversity of species and biomass. The upper layer species are spaced farther apart and at lower densities, creating more stability in the plantings over time as the taller species are less likely to shade out the ground layer. Good upper layer plants include emergent vegetation with leafless upper stems such as *Agapanthus*, *Allium*, *Eremurus*, *Galtonia*, *Kniphofia*, and *Yucca*. Summer flowering species whose flowers rise above their foliage are quite useful in this layer. Many species of *Echinacea*, *Eryngium*, *Penstemon*, *Pennisetum*, and *Solidago* may work well.

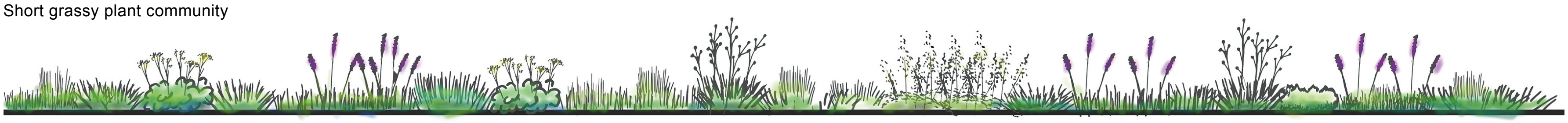
Plants' ecology—their interaction with their environment and each other—is critical to species selection. In developing plant lists, a systematic process that considers various ecological and design filters is important (Fig. 3). While a plant list may be initially broad, purging the list of species that do not pass each filter is important for developing the most resilient selections. This filtering process differs from traditional horticultural approaches that focus on aesthetic considerations like flower color, height, or textural contrast.

5 Using Design Frames to Make Biodiverse Plant Mixes Legible

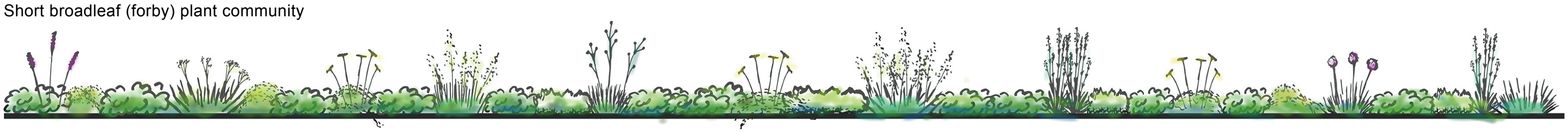
As planting becomes more dynamic and naturalistic, it may also be perceived by the public as messy or unattractive. As much as one may hope the social conventions for beauty would broaden to embrace a more ecological aesthetic, ultimately the burden rests on landscape architects to translate ecological function into an aesthetic form. Several strategies can be considered.

The primary strategy is to use geometric frameworks around the planting. These "orderly frames"—a concept first articulated by Joan Iverson Nassauer[7]—signal to the public an intentionality and care. In Phyto Studio's practice, herbaceous plant mixes are often conceptualized as a liquid that is poured into a mold. Designers may use curbs, low walls, paving, turf, hedges, or other constructed elements that provide a sharp contrast.

低矮草类植物群落
Short grassy plant community



低矮阔叶植物群落
Short broadleaf (forby) plant community



4

另一个策略是限制植物组合的高度。与肩齐平的高度会让许多人感到威胁，而与膝盖齐高的植物组合，即使物种繁多也不会让人们感到眼花缭乱。低矮的植物群落常需要将土壤肥力维持在较低水平，高肥力的土壤往往会加强植物的竞争而导致群落的衰败；土壤表层15 ~ 20cm可使用砾石或粗砂，以降低土壤肥力并抑制杂草。

另一个策略是限制植物组合的视觉复杂性。由外观相似的物种组成的植物组合远观可形成相同的质感。例如，当低矮的草类组合中混有类草状的阔叶草本植物（通常为单子叶植物），其外观则与单一集群相似。相反，全部由阔叶草本植物组成的组合则可能表现为单一的叶片质感。植物组合中不同物种的反差程度决定了其视觉复杂性。

最后一个策略是设计出具有强烈开花效果的植物组合。一项由谢菲尔德大学开展的研究显示，在色彩丰富的植物群落中，当花朵面积不低于27%（临界阈值）时，观赏者的审美感知最佳[8]。多个花期是多样植物组合的优势。因此，拥有不同花期的兼容性物种的比例是其中关键的设计因素。这就要求采用足够多的开花效果强烈的单个物种，但也需要在组合中为其他花期较晚的物种留出充足空间。生命周期极短的阔叶草本植物，尤其是隐芽植物或报春花等早春开花的植物，即为适宜的植物材料。

本文中讨论的策略融合了园艺学与生态学原理。在植物群落的复杂性或功能性方面，人工设计的植物组合可能永远无法和真正的自然生态系统相媲美，但本文中提出的方法和策略或能够为景观设计师提供参考，促使他们通过种植设计来提升植物群落的多样性和功能性。当景观设计师掌握了植物的生态特性以后，便可提高设计品质，创造出常规种植无法具有的景观效果和生态绩效。**LAF**

Another strategy is to restrain the height of a mixed planting. A mix that is shoulder-height will feel intimidating to many people, whereas even a visually diverse mix at knee-height can feel calm and restrained. Shorter plantings often require low fertility soils to be sustained. Highly productive soils often produce competitive vegetation that flops. Using gravel or coarse sand in the top 15 ~ 20 centimeters can help reduce fertility and weed pressure.

Limiting the visual complexity of a mix is another strategy to consider. Mixes composed of similar looking species may all appear as one consistent texture from a distance. For example, a low grass matrix filled with grass-like forbs (typically monocots) will appear similar to a monocultural grouping. Or in contrast, a mix composed of all broadleaf forbs may appear as a single leafy texture. The degree of internal contrast between the species in a mix will determine its visual complexity.

A final strategy is to design mixes to have strong flowering events. In studies conducted by the University of Sheffield, colorful planting with flower-cover above a critical threshold (27%) was associated with the highest level of aesthetic preference[8]. Multi-flowering-season is an advantage of diverse mixes. To achieve this, proportion of compatible species that bloom during different weeks is a critical design factor. It is important to have enough of a single species to create a strong flowering event yet leave enough space in the mix for subsequent waves of flowers. Ephemeral forbs are particularly useful, especially geophytes or early season blooming plants like *Primula*.

The strategies discussed here represent a hybrid of horticulture and ecology. Designed mixes may never have the complexity or functionality of true wild ecosystems. However, these approaches can be valuable tools for landscape architects to embed more diversity and functionality in plantings. Armed with the knowledge of how plants behave ecologically, they can elevate their work, creating effects not possible with conventional planting. **LAF**

4. 图中所示两个植物组合的植株高度和质感相同，组合中的所有物种都具有相似的形态和质感（都是草类与阔叶植物的组合）。通过这种方式，既可以实现物种多样性，也可以避免造成眼花缭乱的视觉效果。

4. Two examples of plant mixes where both height and texture are restrained. All species within the mix have similar forms and textures (grassy vs. broadleaf). In this way, diversity is achieved without visual complexity.

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