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新时代的花园城市
Garden Cities in the New Millenia

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摘要：在城市发展中，通过接触都市自然环境而产生的城市生物多样性和人类福祉的协同生态系统效益常被忽视，未来 30 年，随着全球都市趋向密集，这些效益将变得至关重要。回顾园林史可以发现，历史上的园林理想化地重现大自然，提供食物、审美享受、社交、休憩与幸福感。花园和庄园用于激发和恢复使用者的心理能力，而城市公园则将花园对身心的舒缓功效扩展到社会经济地位低的底层人群。数十年来，研究人员证实了接触自然能为人带来多项益处，并且对儿童和社会经济地位低的人群效果尤为突出。除非扭转趋势，否则在未来几十年里，城市密集化只会让花园和城市绿地流失问题更加严重；与之并行的，还有与人类福祉息息相关的生物多样性及生态系统文化服务的丧失。据估计，目前在世界范围内生物多样性的丧失速度比正常水平高出 1 000 倍。这一点之所以重要，是因为生物多样性的丧失关系到生态系统服务的衰减。然而已有城市发展的经验表明，城市绿地的流失并非不可避免。比如新加坡就在增加人口总量和密度的同时增加了公共绿地面积，另外还有一些高密度城市新添了绿色屋顶、绿墙和绿色建筑。像底特律这样的城市也用新的公共绿地扭转都市衰退。回顾更具生物多样性、更受欢迎且有高复原力的景观属性，并总结可纳入城市规划的规范性原则，以打造生物多样性与人类福祉兼备的新型花园城市。
关键词：生物多样性；生态系统服务；城市绿地；城市密集化；花园城市

Abstract: This paper posits that the synergistic ecosystem benefits of urban biodiversity and human wellbeing through contact with urban nature are often overlooked in urban development and that they will become critically important as cities, around the planet, densify in the next three decades. A review of the history of gardens reveals that gardens have historically been idealized representations of the natural world that have provided food, aesthetic enjoyment, socialization, respite and wellbeing. Gardens and estates were intended to stimulate and to restore the mental capacities of their users and city parks were intended as a means of extending the healing effects of gardens to the lowest socio-economic members of society. In recent decades, researchers have confirmed the multiple mental and physical benefits that accrue from contact with nature and the especially beneficial results for children and people of lower socio-economic status. Unless current trends are reversed, urban densification, in the coming decades, will lead to loss of both gardens and urban green space and a concurrent loss of biodiversity and the cultural ecosystem services that support human well-being. Worldwide, loss of biodiversity is now estimated to be up to 1,000 times greater than normal levels. This is important because loss of biodiversity is linked to loss of ecosystem services. However, some cities have demonstrated urban development and loss of urban green space are not inevitable. Cities like Singapore have increased public green space while increasing population and density. Other dense cities have added more green-roofs, walls and buildings. Cities like Detroit are replacing urban blight with new public green spaces. The paper reviews the attributes of more biodiverse, more preferred and more restorative landscapes and closes with a number of normative principles that may be incorporated in urban planning to make New Garden Cities that support both biodiversity and human wellbeing.
Keywords: biodiversity; ecosystem services; urban green space; urban densification; garden city

0 引言

生态系统服务是指人们从生态系统功能中获得的产品、服务和利益[1-3]。气候调节、防洪和授粉等众多服务是人类生存所必需的[4]。除了这类有形的生态系统服务，与大自然接触还能带来改善认知功能、减压、身心健康等非物质益处，恢复性特性也可被列入生态系统文化服务清单[5-7]。

自有历史记载开始，园林就被设计成既能够提供食物等物质生态系统服务，又能提供社交、娱乐和精神体验等非物质生态系统服务。今天，新的知识让我们能够通过景观设计增加生态系统服务的数量并提高其质量[7]。

尽管城市花园创造了许多生态系统服务，但笔者重点讨论两个彼此协同、至关重要，却常被城市规划者和城市设计师忽视的生态系统效益，即城市地区的生物多样性和人的身心健康。

1 园林简史

1.1 历史

在现代语中，“花园”一词被用来描述与住宅相邻的空间，这个空间里包含观赏类植物，可能还有可食用植物，其目的都是支持户外活动并且与公共领域构建出分离感。此外，在今天，疗愈花园也很常见，很多疗愈花园隶属于医疗机构。这些花园为人类身心健康提供保障[8]。在这些方面，现代花园与疗愈花园以及人类祖先创造的园林并无区别。

公元前 3000 年，埃及官员的宅邸花园深藏在墙宇间，墙能保护他们免受野生动物、掠夺者和沙漠狂风的侵袭。早期的花园是实用性的，种有蔬菜、果树和葡萄藤[9]。随后发展出装饰性水景和类型繁多的花卉，实用性的古埃及花园逐渐演进成提供安全和食物，改善微气候，具有审美体验、社交和精神寄托的多功能花园。

公元前 4000 年的古埃及花园和波斯花园都有围墙、大量水元素和树木植栽[10]。亚历山大大帝（公元前 356—公元前 323）于公元前 331 年征服波斯帝国，8 年后在他去世前，已经把波斯花园从东边的亚得里亚海和古埃及国传到了西边的喜马拉雅山[11]。正是这个帝国，在公元前 7 世纪被穆斯林阿拉伯人重新征服时，发展出伊斯兰花园。穆斯林吸收了查赫巴格花园的形式（或波斯四方花园的形式，即十字形水道在花园中心汇合，把花园分为 4 个象限），同时赋予伊斯兰花园《可兰经》中天堂的象征意味。公元前 7 世纪—公元 16 世纪，伊斯兰花园在伊比利亚半岛、西西里岛、北非，以及横跨中东至印度都有迹可查。如同早期的古埃及花园、波斯花园一样，伊斯兰花园既是尘世享乐的天堂，也象征着来世的天堂花园[11]。

之后古罗马花园的设计受到这些早期封闭式花园的影响。古罗马的私人花园有墙、对称、有花坛，庭院中的亭子围绕着中央的灌溉池或渠道[12]。

罗马人首次记录下自然恢复力。从罗马政治家小普林尼（即盖尤斯·普林尼·采西利尤斯·塞孔都斯，61—112）书信的引言可见，他有多么珍惜自己因接触大自然而获得的精神健康和灵感。他写道：

> 你想知道我夏天在托斯卡纳别墅的日子是怎么过的……大约十点或十一点左右……根据天气的变化，我要么到露台上，要么到有顶棚的门廊上，在那我或沉思，或口述……从那里我登上自己的战车……发现这种场景的变化保持并活跃了我的注意力。
>
> （第 9 书，36 行）
>
> 哦，庄严的大海、孤寂的海岸，最好也最隐秘的适合沉思的舞台，你们激励了我多少博大的思想！
>
> （第 1 书，9 行）
>
> ——盖尤斯·普林尼·采西利尤斯·塞孔都斯（普林尼二世）①

到了中世纪（公元前 500—公元 1500 年），基督教修道院建造出封闭式的花园，让人想起伊斯兰花园的形式[13]。修道院的墙壁和被称为回廊的拱廊包围着花园，从回廊可以一眼望见花园[14]。小路把花园划分成几块，就像伊斯兰花园，小路象征着伊甸园的 4 条河，在花园中心的水井或喷泉处交汇。回廊花园通常与修道院的诊疗室相邻，用作治疗病患的场所。圣伯纳德（1090—1153）这样描述他在法国克莱尔沃修道院的花园庭院和那里的治疗效果：

> 围墙里有各种各样的树木，它们结满果实，形成一座名副其实的树林，紧挨着那些病人的病房，缓解他们的病痛，同时也是一个可心的休息场所，给那些在宽阔人行道上的漫步者以及受酷暑之苦的人们一丝慰藉……可爱的绿色草本植物和树木滋养着双眼……巨大的喜悦在他面前悬挂和生长……当空气带着明亮的宁静微笑，大地带着果实呼吸，而病人带着眼睛、耳朵和鼻孔，品尝着颜色、歌曲和香水的喜悦。
>
> ——圣伯纳德[14]

这段话所表达的观点是：大自然中的美值得珍视，它能带来幸福，在整个人类历史上向来如此[15-16]。在古罗马和中世纪的欧洲，花园被认为是和平、疗伤和灵感来源的场所。还必须指出的是，普通人一般无法进入那些富人和教会修建的花园。这类花园，无论是小园子还是大庄园，许多都被墙围起来，以便让花园和里面的居民与外界隔开。它们既具有实用性，又是自然美的理想化表现，用于提供食物、审美享受、社交、休憩和幸福感。

1.2 浪漫主义的理想化景观

18 世纪的浪漫主义哲学家，如让–雅克卢梭（1712—1778）和亚历山大·波普（1688—1744）支持这样的观点：与自然的接触表明了人类本质上的善良，有助于个人的宁静和幸福[17-18]。他们的作品启发了北欧和英国的上层阶级去创造奢华的乡村庄园。在浪漫主义的影响下，这些非正式的庄园场地，或所谓的公园，旨在通过唤起人们对自然美景的情感反应来提升人类的思想和福祉。

1.3 城市公园

欧洲、英国和北美城市公园的发展也受到浪漫主义的影响。新的公园被提倡作为改善公民健康、福祉和城市风貌特色的一种手段[19]。弗雷德里克·劳·奥姆斯特德表示，公园“为消除都市罪恶提供了条件”，并有助于使游客的思想“远离先前导致精神紧张或精神疲劳的实体，更有利于沉静地思考”[20]。

奥姆斯特德在这份报告中表达了从浪漫

1 底特律的拉斐特绿地社区花园建立在历史建筑的原址上
Lafayette Greens Community Garden in Detroit was built on the site of a historic building

主义者那里继承的观点，即人类通过接触城市公园里的自然而获得积极的精神效益。在他看来，花在公园里的时间，使市民能够恢复他们的心智[21]，不仅如此，接触城市公园还能将花园的疗愈效果扩展到那些社会经济地位低的底层人群，他们原本可能因为没有私人花园，而无法获取这些疗效[22]。

很明显，奥姆斯特德和浪漫主义哲学家们正确地认识到了与自然接触的好处。在过去的几十年里，研究人员发现了与大自然接触所带来的多种精神和身体上的好处。这些措施包括：减少压力、降低犯罪率和家庭暴力发生率、显著降低各种疾病发病率、改善情绪和提高心智能力、增加仁爱，还能改善注意力缺陷多动障碍[6, 23]。此外，研究人员还报告说，儿童时期接触大自然有助于促进健康发展、改善幸福感并提高对自然美的欣赏[24]。在与自然的接触中，社会经济地位较低的人和儿童可以获得更大的益处[23, 25]。

2 城市增长与密度效应

在世界范围内，越来越多的人搬到城市里。据估计，到 2050 年，全球城市人口占全球总人口的比例将从目前的 55% 提高到 68%，全球城市人口将增加 25 亿。到 2030 年，超过 1 000 万人口的城市数量将从目前的 33 个增加到 43 个②。随着城市密度的增加，私人花园的数量和面积将减少，取而代之的是公共开放空间（public open space, POS）的增加[26]。

按照目前的趋势来看，在未来几十年内，城市人口的急剧增加将导致花园和其他绿地的减少，随之而来的是城市地区生物多样性的减少，以及越来越多的城市居民的身心健康的下降。然而，这并非不可避免。

人口密度超过 7 500 人 /km^2 的新加坡，自称“花园中的城市”，以绿色建筑和不断增加的绿地而闻名[27]。1986—2007 年间，新加坡人口增长的同时，其绿地率也从 36% 增长到 47%[28]。像新加坡和香港这样的人口密集的城市，地面绿地空间有限，导致出现了更多的绿色建筑和绿墙[29]。像底特律这样经历了严重衰落的城市，城市复兴能在之前的建筑工地上发展出新的城市绿地（urban green space, UGS，图 1③）[30-31]。

2.1 生物多样性和生态系统服务

直到最近几年，风景园林专业才开始将生态系统服务纳入景观设计中。例如，美国风景园林师协会的场地可持续性设计行动计划（SITES）④和美国风景园林基金会（LAF）⑤的景观绩效系列都旨在促进将生态系统服务纳入景观设计中。这种景观被称为绩效景观或多功能景观。常见的与公共绿地相关的生态系统服务研究，包括碳储存、风暴和洪水防护、缓解城市热岛效应和维护土壤健康[28]。

“biodiversity”一词是“biological diversity”的缩写，简言之是地球上所有生物的多样性[32]。它包括所有有机体、物种和生态系统的遗传多样性。生物多样性对我们很重要，因为它支持着地球上所有生物的生命，包括人类。生物多样性尽管不是一种生态系统服务，但在提供生态系统服务方面具有重要作用，因此将其纳入了大多数生态系统服务评估中，而生态系统服务是生物群或生物与其环境相互作用的结果[33]。

已有研究在生物多样性与支持和调节生态系统服务之间建立了明确的联系[34]。例如，生物生产力或特定地区产生的净生物量是一种支持性的生态系统服务，与生物多样性密切相关[35]。在地方一级，生物多样性的下降可能意味着鱼类或虾等食物种类的减少，同时丧失的还有碳封存能力或自然抗洪能力。例如，在生态健康的森林中，生物生产力与降水的截留和渗透是相关的。如果该森林因自然或人为力量退化，其生物生产力将下降，同时其拦截、储存雨水的能力也将下降，从而降低防洪生态系统服务[33]。正如这个例子所说明的，生物多样性的丧失往往与一个或多个生态系统服务功能的降低有关。

2.2 城市增长和生物多样性丧失

即使科学家和城市规划者也普遍存在一种误解，即在城市规划和发展中，维持生物多样性并不合理，因为城市地区的生物多样性较低。然而研究表明，人们通常定居在生物多样性高的地区，许多城市仍然保留着高水平的生物多样性[36-38]，城市绿地对于支持区域生物多样性至关重要[39-40]。科学家们报告说，城市扩张降低了当地的生物多样性[41]，并预测除非当前趋势发生变化，否则 2012—2030 年期间因城市扩张将再破坏 120 万 km^2 的绿地。这种土地覆被变化将导致栖息地丧失、生物量和碳储量减少，威胁全球生物多样性[42]。

衡量生物多样性的一个常用指标是物种丰度或某一特定地区不同物种的数量。因此，物种的灭绝是生物多样性总体丧失的有力指标。据估计，由于人类活动，如空气和水污染，城市化、农业扩张和采矿、伐木造成的栖息地破坏，物种正在以自然状态下 1 000 倍的速度加速灭绝，许多可能作为新药开发或维持农业稳定性的物种正在消失，而它们从未被记录在案[43]。这被称为地球历史上第六次大灭绝。大型哺乳动物的灭绝已被广泛报道，但对生态系统功能至关重要的昆虫的灭绝速度是哺乳动物的 8 倍[44]，而其中传粉昆虫的减少也许是最令人担忧的。地球上 85% 以上的植物由昆虫和其他动物授粉，全球 75% 的主要粮食作物需要授粉[45]。与农田一样，自然区域现在也处于授粉不足的状态，降低了植物繁殖率，威胁了本地植物的生物多样性[46]。一项全球生物多样性丧失

调查报告称，有 30% 的鸟类、哺乳动物和爬行动物以及 15% 的两栖动物数量在下降；这项报告警告，在地球的生命维持系统受到不可挽回的损害之前，人类还有 20~30 年的时间采取行动 [47]。另一项研究报告表明，目前 21% 的鸟类物种正面临灭绝的危险，如果当前的趋势不逆转，全球生态系统服务很可能丧失 [48]。

在我们的集体意识中，这种问题与气候变化不可相比，但它可能是个更加严峻的问题。原因有两个：1）总有一天，当人类不再排放温室气体，气候将会缓慢趋于稳定，但物种灭绝却无可挽回 [32]；2）由于生物多样性与生态系统服务有关，就人类在地球上的生存问题而言，生物多样性的丧失很有可能比气候变化的影响要更大。我们无法知道何时生物多样性的下降将会导致生态系统的崩溃或生态系统服务的丧失。因此，维护生物多样性符合人类自身利益 [4]。

2.3 城市增长与绿地

纽约、东京、孟买、墨西哥城和温哥华等许多大都市地区的发展会受到地理条件和（或）规划政策的制约（图 2）。这意味着，随着人口的增加，这些城市应该将密集化作为首要发展战略，而不是向周围农村地区扩张，因为城市化不仅增加了城市的碳足迹范围，还会减少生物多样性和生态系统服务 [42]。紧凑型城市被认为是城市扩张的替代方案，具体策略包括高效的公共交通、普及自行车的使用，以及鼓励步行 [49]。

随着城市密度的增加，现有的低密度街区将被高密度的开发项目所填充。多户住宅将取代独栋住宅。包含私人花园的住宅类型将超出许多业主的财力负担范围，甚至不符合他们的期望，提供这类住宅将导致城市扩张，而不是密集化。当这种情况发生时，城市居民将得不到私人花园的恢复性效益。

虽然在历史上人类发展减少了生物多样性，但在许多地方，花园和果园对区域生物多样性产生了相当大的积极影响 [50]。在现代城市中，在城市郊区创造的各种公共和私人景观，承担了生态演替阶段的早期景观载体，为许多鸟类提供栖息地。研究人员报告说，虽然城市核心区的鸟类物种数量非常低，但郊区花园和公园的鸟类和蝴蝶的种类和个体数量显著增加 [51-53]。

更大、更拥挤、更高密度的城市将剥夺大多数居民拥有私人花园以及花园附带的各种生态系统服务。若要想提供这类好处给未来的城市居民，就必须开发新的公共绿色基础设施，以保护身心健康，而不仅限于城市私人花园和传统公园的服务范畴。

然而，评估生态系统服务和绿色基础设施等概念的生物、生态或技术功能的研究很多，但评价福祉和健康相关的研究很少 [54]。同样，大多数城市绿色基础设施提案都是单一目的的，没有自觉地纳入生物多样性或公共卫生，例如《温哥华市雨城战略》[55]。如果未来的城市要支持人类福祉和区域生物多样性，就需要在这一点做出改变。

除非未来密集的特大城市本身能成为生物多样性丰富的疗愈花园，否则将对人类福祉产生广泛的负面影响。相反，如果将这两个问题纳入城市规划和发展的考虑范围内，未来城市就可以起到保护生物多样性并提供生态系统服务的作用，可以增加人类福祉。

3 作为花园的城市

城市绿地（UGS）将如何弥补密集化城市中私人花园（减少）带来的损失？公共开放空间（POS）包括公共领域内的公园、操场、自然区域、市政花园、市民广场和学校场地 [28]。UGS 包含了城市中的所有植被区域，如私人花园、公园、高尔夫球场和行道树区域 [56]。与 POS 的重要区别在于，UGS 可以提供生物多样性、与之相关的生态系统服务以及与自然接触的健康和福祉。因此，为了实现城市地区的健康和生物多样性，应关注 UGS 而不是 POS。这意味着要综合考量公共和私人开放空间。研究人员报告说，在富裕的街区，绿地可达性通常更高 [57]。为了使 UGS 效益公平，其分布将需要与大都市地区的城市密度相关。

3.1 生物多样性与心理恢复

重要的是要了解生物多样性和与自然的接触的精神恢复是协同关系。研究人员对生物多样性与恢复之间的关系进行研究，结果表明：生物多样性丰富的环境更具恢复性（图 3~5）[58-60]。这与所谓的亲生物假说所认为的人天生就倾向于亲近自然相符 [61]。其他研究者的报告指出，自然环境中增加生物恢复指标，并不会让生物多样性增加 [62]。景观中鸟类物种多样性是总体生物多样性的有力指标 [63-64]。因此，提高鸟类的生物多样性可以增加总体生物多样性，同时也和人类亲生物本能紧密相关，是恢复性景观的标志。

就自然的恢复特性而言，恢复能力和偏好密切相关。人们普遍更喜欢偏自然感的环境，可以通过预测精神恢复能力的景观元素预测人的偏好，反之亦然 [65-66]。神秘性的本

Current condition 当前绿化 2-1

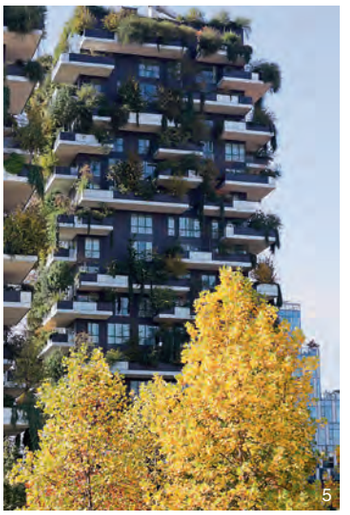
Post densification 密集化后的效果 2-2

2

2-1 加拿大温哥华正在密集化街区的绿地状况
The current green space in a neighbourhood that is undergoing densification in Vancouver BC, Canada.

2-2 密集化后的效果。灰色显示的是所有因重建而消失的私人花园
Post densification. It shows in grey all the private gardens that will be lost to redevelopment



3 英属哥伦比亚省维多利亚市多功能雨水公园。一个不仅仅能净化都市径流的小型的自然社区公园
Two views of a multipurpose rain garden park in Victoria BC. Instead of just cleansing urban runoff before it enters the ocean, a small naturalistic neighbourhood park has been created

4 韩国首尔的清溪川景观改造，是城市主动开创大型城市绿地的范例。这里曾是一条高架高速公路，现在是一条活跃的娱乐休闲步道，支持生物多样性和身心健康
Cheong Gye Cheon Canal Street in Seoul, South Korea, is an example of finding new opportunities for urban green space. This site of a former elevated freeway is now an active recreation corridor that supports both biodiversity and wellbeing

5 博埃里工作室设计的米兰博斯科垂直住宅楼栽植了 900 多棵树。在城市绿地受限的地方，这种亲生物设计有利于精神恢复
Bosco Verticale residential towers in Milan designed by Boeri Studio contains more than 900 trees. Where urban green space is limited this type of biophilic design provides restoration

表 1 花园特征类型及描述 [75]
Tab. 1 Character types of garden rooms and their descriptions[75]

花园特征类型 Garden rooms character types	每个类型的描述 Descriptors of each type
宁静的 Serene	和平、安静和关怀。风声、水声、鸟虫鸣声，没有垃圾、杂草和嘈杂的人群 Peace, silence and care. Sounds of wind, water and birds and insects, no rubbish, weeds or disturbing people
野生的 Wild	看起来像是自然野生状态。植物似乎是野生的，岩石和旧甬道上长满苔藓 Appears as wild nature. Plants seem self-sown, moss covered rocks and old paths
物种丰富的 Rich in species	能看到各种类型的动植物 A variety of animals and plants are seen
具有空间感的 Space	提供进入另一个世界获得宁静的空间；是一个连贯的整体，比如山毛榉树林 A room offering restful feeling of entering another world; a coherent whole such as a beech forest
公共的 The common	一个绿色开放的空间，能看到远景，有地方让人可以停驻 A green open space, allowing extended views and places to stay
游乐园 The pleasure garden	一个封闭而安全、与世隔绝的空间，在这里可以放松自我，也可以探索和玩耍 An enclosed, safe and secluded space, where you can relax and be yourself and also experiment and play
喜庆的 Festive	聚会场所或者节日庆祝和社交活动 A meeting place or festivity, and socialization
文化性 Culture	历史性的场地，在这里可以感受时间变化的魅力 A historical place offering fascination with the course of time

质——即深入其中才会发现更多，这也是预测景观偏好和精神恢复的因素 [66-68]。在“绿化”水平的研究中，研究者发现更绿色的环境中，获取的恢复性福利更可靠或更大 [69-70]。

一个人越是置身于风景之中，他的心理活动就会越活跃 [71]，研究表明，高参与程度能够带来强精神恢复能力 [72]。一般来说，增加接触自然环境的时间和频率会促成高恢复水平 [73-74]，因此城市居民在当地 UGS 上花费的时间越多，对 UGS 使用频率越高，他们得到的恢复效果就越显著。

瑞典阿尔纳普市景观规划健康与娱乐研究所的研究人员认为，花园必须是有四壁和天花板的室外空间，主导元素必须是植物，它们还要能带来生命感，让人感受到季节周期性的变化，从而传达平和、感官刺激和美感。此外，研究者表示，疗愈花园要能激活所有感官，不仅有视觉，还有嗅觉、味觉和触觉，疗愈花园随着时间的推移呈现出一系列特征，它给人以整体感，在这里，人与外界分离，具有安全感 [75]。

这些研究人员还逐渐意识到，特征繁多的公园比只有单一特征的公园能吸引更多人，而且某些类型的特征通常比其他类型更吸引人，这又一次证明生物多样性与偏好 / 恢复之间的协同作用。研究表明，随着生物栖息地多样性的增加，即某一地点不同类型栖息地的数量增加，生物多样性也会增加 [53]。研究人员将花园特征分为 8 种类型（表 1）。

他们发现，宁静、具有空间感和物种丰富的花园吸引的访客更多，而公共花园和游乐园则吸引了压力较小、希望观看他人的访客。此外，他们还报告说，呈现前一组特征（宁静、空间感、物种丰富）需要自然区域，有许多不同种类的植物和高大的树木。

3.2 策略

许多研究人员和设计师已经为生物多样性更丰富的城市区域或更具恢复性的城市环境提出了建议，感兴趣的读者可以自行查看这些建议，因为它们超出了本文的范围 [23, 28, 76-77]。从他们的建议和笔者的调查中，可以得出一些原则。虽然这些研究并不全面，但它们具有广泛的适用性，并以实证研究为基础。1）区域网络：将行动与规模联系起来。许多城市地区是生物多样性的热点地区。为此，应该规划和实施一个区域生态网络。这将保护并关

联该地区稀有和代表性的生物多样性。UGS 可以支持区域生物多样性，因而不应只在有条件的情况下增加 UGS，而应将其作为维持栖息地类型多样性的整体区域战略的一部分 [22, 78]。这一策略将产生一系列不同规模和类型的 UGS，使人们能够进入更荒野的地区，增加人们体验到的景观类型，适应不同的 UGS 使用者，并增加人类福祉 [59]。2）小贴士（cues to care）：许多生物多样的景观未必符合文化习俗。可以实施一系列“小贴士”，以表明景观是特别规划的，并且是有管理的。这将有助于提高公众接受度 [75, 79]。3）使 UGS 成为一系列有区别但关联的空间 [75, 80]。4）从政策到设计：不要只依赖宽泛的政策。特别是在规模较小的空间下，需要特定的设计指令。例如，在邻近地区，为鸟类和昆虫，特别是传粉昆虫及其栖息地的恢复提供一系列景观特征。这些不同的栖息地将增加生物多样性，还将提供多种景观体验 [22, 53]。5）亲近自然：让自然近在咫尺，无处不在。通常不可能新建大型 UGS，但在医院、监狱、家庭和工作场所的景观中栽植行道树或其他植物是可能的，它们将是提供恢复效益的重要贡献者 [81-84]。6）公共及私人区域的融合：打破公私区域之间的壁垒，为了公共利益而塑造私人的绿地 [85]。考虑 UGS 在公共和私人区域能协同发挥作用。建立多元化的私人花园“互通网”，促进野生动物和传粉物种的交流。7）整个城市要公平地分配绿地 [57]。8）更多的绿地。提高城市开放空间、城市绿地的比例。许多城市对开放空间有很高的要求，但未能确保开放空间是绿色的，并可供公众使用。在大型住宅开发项目中，将私人绿地的一部分开放给公众 [7]。9）在城市中为小型区域赋予功能性和自然性 [27]。10）打造城市森林：种植大树以及垂直方向层次丰富的森林有利于生物多样性 [86]。11）将本地和非本地植物混合种植，能让鸟类和授粉物种受益。UGS 的种植应多样化，并混合适合当地的非本地和本地植物。植物种类多样性将支持传粉物种 [22, 87-88]。12）人们越深入地参与自然，从中收获的健康效益就越大 [22]。城市绿地的规划、设计和实施，要能够鼓励人们积极参与管理，就像他们以前管理私人花园那样。这可能意味着一系列的变化，例如住宅开发中会有更密集的屋顶花园，集合住宅的业主开始关心公共景观，更多的社区花园遍布整个城市，学校的孩子们参与鸟巢箱计划。13）使所有新的绿色基础设施支持多种生态系统服务。雨水花园和生物沼泽可以是亲近自然的方式，让城市有更好的生态修复能力，还能净化雨水。14）将 UGS 集中在人群密集的地方，比如机场、医院、学校、工作场所和通勤走廊 [23]。

注释：

① 引自 http://www.vroma.org/~hwalker/Pliny/PlinyNumbers.html。

② 引自 https://www.un.org/development/desa/en/news/population/2018-revision-of-world-urbanization-prospects.html。

③ 密歇根州底特律市在失去大企业和税源后于 2013 年宣布破产，许多城市核心区都被遗弃。如今，许多街区正在复苏，部分曾经的建筑工地变成了城市绿地。肯尼思·韦卡尔景观设计公司设计的拉斐特绿地社区花园获得美国风景园林师协会大奖，项目位于原底特律市中心的拉斐特大楼所在地，该大楼于 2010 年被拆除。康博软件公司于 2014 年捐赠这个花园给非营利组织“底特律绿化”（The Greening of Detroit）。这个花园不仅用于社区食品生产，还支持社区聚会活动，适合作为儿童花园，可作为传粉物种的栖息地。

④ 引自 https://www.asla.org/sites/。

⑤ 引自 https://www.landscapeperformance.org。

参考文献 (References)：

[1] WIGGERING H, DALCHOW C, GLEMNITZ M, et al. Indicators for Multifunctional Land Use: Linking Socio-Economic Requirements with Landscape Potentials[J]. Ecological Indicators, 2006, 6(1): 238-249.

[2] TERMORSHUIZEN J W, OPDAM P. Landscape Services as a Bridge Between Landscape Ecology and Sustainable Development[J]. Landscape Ecology, 2009, 24(8): 1037-1052.

[3] SELMAN P. Sustainable Landscape Planning: The Reconnection Agenda[M]. London: Routledge, 2012.

[4] KREMEN C. Managing Ecosystem Services: What Do We Need to Know About Their Ecology?[J]. Ecology Letters, 2005, 8(5): 468-479.

[5] HASSAN R, SCHOLES R, ASH, N. Ecosystems and Human Well-Being: Current State and Trends (Volume 1)[M]. Washington, D.C.: Island Press, 2005.

[6] MAAS J, VERHEIJ R A, DE VRIES S, et al. Morbidity Is Related to a Green Living Environment[J]. Journal of Epidemiology and Community Health, 2009, 63(12): 967-973.

[7] MOONEY P. A Systematic Approach to Incorporating Multiple Ecosystem Services in Landscape Planning and Design[J]. Landscape Journal, 2014, 33(2): 141-171.

[8] MARCUS C C, BARNES M. Healing Gardens: Therapeutic Benefits and Design Recommendations (Vol. 4)[M]. New Jersey: John Wiley & Sons, 1999.

[9] GOODE P, LANCASTER M. Oxford Companion to Gardens[M]. Oxford: Oxford University Press, 1986.

[10] WILBER D N. Persian Gardens & Garden Pavilions[M]. Tokyo: Charles E. Tuttle Company, 1962.

[11] CARROLL M. Earthly Paradises: Ancient Gardens in History and Archaeology[M]. Los Angeles, CA: J. Paul Getty Museum, 2003.

[12] BOWE P. Gardens of the Roman World[M/OL]. Getty Publications. (2004)[2021-04-02]. http://www.getty.edu/publications/virtuallibrary/0892367407.html.

[13] JELLICOE G, JELLICOE S. The Landscape of Man: Shaping the Environment from Prehistory to The Present Day[M]. London: Thames and Hudson, 1987.

[14] GERLACH-SPRIGGS N, KAUFMAN R E, WARNER S B. Restorative Gardens: The Healing Landscape[M]. New Haven: Yale University Press, 1998.

[15] ULRICH R S. Biophilia, Biophobia, and Natural Landscapes[J]. The Biophilia Hypothesis, 1993(11): 73-137.

[16] WARD THOMPSON C. Linking Landscape and Health: The Recurring Theme[J]. Landscape and Urban Planning, 2011, 99(3): 187-195.

[17] CLARK H F. Eighteenth Century Elysiums: The Role of “Association” in the Landscape Movement[J]. Journal of the Warburg and Courtauld Institutes, 1943, 6: 165-189.

[18] NEUMEYER E M. The Landscape Garden as a Symbol in Rousseau, Goethe and Flaubert[J]. Journal of the History of Ideas, 1947, 8(2): 187-217.

[19] SCHUYLER D. The New Urban Landscape: The Redefinition of City Form in Nineteenth-Century America[M]. Baltimore: Johns Hopkins University Press, 1986.

[20] OLMSTED F L. Draft Report on Fairmount Park (1871)[Z]. Schuyler, 1986: 107.

[21] KAPLAN S. The Restorative Benefits of Nature: Toward an Integrative Framework[J]. Journal of Environmental Psychology, 1995, 15(3): 169-182.

[22] MOONEY P. Planting Design: Connecting People and Place[M]. London: Routledge, 2019.

[23] KUO F E. Parks and Other Green Environments: Essential Components of a Healthy Human Habitat[EB/OL]. National Recreation and Park Association. (2010)[2021-04-02]. https://www.nrpa.org/globalassets/research/mingkuo-research-paper.pdf.

[24] GILL T. The Benefits of Children’s Engagement with Nature: A Systematic Literature Review[J]. Children Youth and Environments, 2014, 24(2): 10-34.

[25] BOYD F, WHITE M P, BELL S L, et al. Who Doesn’t Visit Natural Environments for Recreation and Why: A Population Representative Analysis of Spatial, Individual and Temporal Factors Among Adults in England[J]. Landscape and Urban Planning, 2018, 175: 102-113.

[26] SIVAM A, KARUPPANNAN S, MOBBS M. How “Open” Are Open Spaces: Evaluating Transformation of Open Space at Residential Level in Adelaide: A Case Study[J]. Local Environment, 2012, 17(8): 815-836.

[27] BEATLEY T. Handbook of Biophilic City Planning & Design[M]. Washington, D.C.: Island Press, 2017.

[28] DAVERN M, FARRAR A, KENDAL D, et al. Quality Green Public Open Space Supporting Health, Wellbeing and Biodiversity: A Literature Review[R]. Victoria: National

Heart Foundation, University of Melbourne, 2016.
[29] TIAN Y, JIM C Y, TAO Y, et al. Landscape Ecological Assessment of Green Space Fragmentation in Hong Kong[J]. Urban Forestry and Urban Greening, 2011, 10(2): 79-86.
[30] New York Times. Anatomy of Detroit's Decline[EB/OL]. (2013-08-17)[2021-04-02]. https://archive.nytimes.com/www.nytimes.com/interactive/2013/08/17/us/detroit-decline.html.
[31] Greening of Detroit. Lafayette Greens[EB/OL]. (2014)[2021-04-02]. https://www.greeningofdetroit.com/greenspaces.
[32] CARRINGTON D. What Is Biodiversity and Why Does it Matter to Us? The Guardian[EB/OL]. (2018)[2021-04-02]. https://www.theguardian.com/news/2018/mar/12/what-is-biodiversity-and-why-does-it-matter-to-us.
[33] HAINES-YOUNG R, POTSCHIN M. Methodologies for Defining and Assessing Ecosystem Services[M]. Nottingham: Centre for Environmental Management, 2010.
[34] BALVANERA P, PFISTERER A B, BUCHMANN N, et al. Quantifying the Evidence for Biodiversity Effects on Ecosystem Functioning and Services[J]. Ecology Letters, 2006, 9(10): 1146-1156.
[35] COSTANZA R, FISHER B, MULDER K, et al. Biodiversity and Ecosystem Services: A Multi-scale Empirical Study of The Relationship Between Species Richness and Net Primary Production[J]. Ecological Economics, 2007, 61(2-3): 478-491.
[36] RICKETTS T, IMHOFF M. Biodiversity, Urban Areas, and Agriculture: Locating Priority Ecoregions for Conservation[J]. Conservation Ecology, 2003, 8(2): 1.
[37] LUCK G W. A Review of the Relationships Between Human Population Density and Biodiversity[J]. Biological Reviews, 2007, 82(4): 607-645.
[38] IVES C D, LENTINI P E, THRELFALL C G, et al. Cities are Hotspots for Threatened Species[J]. Global Ecology and Biogeography, 2016, 25(1): 117-126.
[39] ELMQVIST T, FRAGKIAS M, GOODNESS J, et al. Urbanization, Biodiversity and Ecosystem Services: Challenges and Opportunities: A Global Assessment[M]. Basingstoke: Springer Nature, 2013.
[40] SOANES K, SIEVERS M, CHEE Y E, et al. Correcting Common Misconceptions to Inspire Conservation Action in Urban Environments[J]. Conservation Biology, 2019, 33(2): 300-306.
[41] SOL D, GONZÁLEZ - LAGOS C, MOREIRA D, et al. Urbanisation Tolerance and the Loss of Avian Diversity[J]. Ecology Letters, 2014, 17(8): 942-950.
[42] SETO K C, GÜNERALP B, HUTYRA L R. Global Forecasts of Urban Expansion to 2030 and Direct Impacts on Biodiversity and Carbon Pools[J]. Proceedings of the National Academy of Sciences, 2012, 109(40): 16083-16088.
[43] ALDHOUS P. We Are Killing Species at 1000 Times the Natural Rate[EB/OL]. (2014-05-29)[2021-04-02]. https://www.newscientist.com/article/dn25645-we-are-killing-species-at-1000-times-the-natural-rate/.
[44] CARRINGTON D. Plummeting Insect Numbers Threaten the Collapse of Nature[EB/OL]. (2019)[2021-04-02]. https://www.theguardian.com/environment/2019/feb/10/plummeting-insect-numbers-threaten-collapse-of-nature.
[45] RHODES C J. Pollinator Decline: An Ecological Calamity in the Making?[J]. Science Progress, 2018, 101(2): 121-160.
[46] THOMANN M, IMBER, E, DEVAUX C, et al. Flowering Plants Under Global Pollinator Decline[J]. Trends in Plant Science, 2013, 18(7): 353-359.
[47] CEBALLOS G, EHRLICH P R, DIRZO R. Biological Annihilation Via the Ongoing Sixth Mass Extinction Signaled by Vertebrate Population Losses and Declines[J]. Proceedings of the National Academy of Sciences, 2017, 114(30): E6089-E6096.
[48] ŞEKERCIOĞLU Ç H, DAILY G C, EHRLICH P R. Ecosystem Consequences of Bird Declines[J]. Proceedings of the National Academy of Sciences, 2004, 101(52): 18042-18047.
[49] BURTON E. The Compact City: Just or Just Compact? A Preliminary Analysis[J]. Urban Studies, 2000, 37(11): 1969-2006.
[50] SPONSEL L E. Human Impact on Biodiversity: Overview[M]// LEVIN S A. Encyclopedia of Biodiversity (Vol. 4). Waltham, MA: Academic Press, 2014: 137.
[51] BLAIR R. Birds and Butterflies Along Urban Gradients in Two Ecoregions of the U.S[M]// LOCKWOOD J L, MCKINNEY M L. Biotic Homogenization. New York: Kluwer Academic/Plenum Publishers, 2001: 33-56.
[52] MELLES S, GLENN S, MARTIN K. Urban Bird Diversity and Landscape Complexity: Species–Environment Associations Along a Multiscale Habitat Gradient[J]. Conservation Ecology, 2003, 7(1): 5.
[53] MOONEY P F. The Effect of Human Disturbance on Site Habitat Diversity and Avifauna Community Composition in Suburban Conservation Areas[J]. WIT Transactions on Ecology and the Environment, 2011, 144: 13-26.
[54] SKÄRBÄCK E, BJÖRK J, STOLTZ J, et al. Green Perception for Well-Being in Dense Urban Areas: A Tool for Socioeconomic Integration[J]. Nordic Journal of Architectural Research, 2014, 26(2): 179-200.
[55] City of Vancouver. Rain City Strategy: A Green Rainwater Infrastructure and Rainwater Management Initiative[EB/OL]. (2019)[2021-04-02]. https://vancouver.ca/files/cov/rain-city-strategy.pdf.
[56] KABISCH N, HAASE D. Green Spaces of European Cities Revisited for 1990–2006[J]. Landscape and Urban Planning, 2013, 110: 113-122.
[57] WOLCH J R, BYRNE J, NEWELL J P. Urban Green Space, Public Health, and Environmental Justice: The Challenge of Making Cities 'Just Green Enough'[J]. Landscape and Urban Planning, 2014, 125: 234-244.
[58] FULLER R A, IRVINE K N, DEVINE-WRIGHT P, et al. Psychological Benefits of Greenspace Increase with Biodiversity[J]. Biology Letters, 2007, 3(4): 390-394.
[59] CARRUS G, SCOPELLITI M, LAFORTEZZA R, et al. Go Greener, Feel Better? The Positive Effects of Biodiversity on the Well-Being of Individuals Visiting Urban and Peri-Urban Green Areas[J]. Landscape and Urban Planning, 2015, 134: 221-228.
[60] MARSELLE M R, IRVINE K N, LORENZO-ARRIBAS A, et al. Does Perceived Restorativeness Mediate the Effects of Perceived Biodiversity and Perceived Naturalness on Emotional Well-Being Following Group Walks In Nature?[J]. Journal of Environmental Psychology, 2016, 46: 217-232.
[61] KELLERT R, WILSON E O. The Biophilia Hypothesis[M]. Washington, D.C.: Island Press, 1993.
[62] CHANG K G, SULLIVAN W C, LIN Y H, et al. The Effect of Biodiversity on Green Space Users' Wellbeing: An Empirical Investigation Using Physiological Evidence[J]. Sustainability, 2016, 8(10): 1049.
[63] BLAIR R B. Birds and Butterflies Along an Urban Gradient: Surrogate Taxa for Assessing Biodiversity?[J]. Ecological Applications, 1999, 9(1): 164-170.
[64] LARSEN F W, BLADT J, BALMFORD A, et al. Birds as Biodiversity Surrogates: Will Supplementing Birds with Other Taxa Improve Effectiveness?[J]. Journal of Applied Ecology, 2012, 49(2): 349-356.
[65] LAUMANN K, GÄRLING T, STORMARK K M. Rating Scale Measures of Restorative Components of Environments[J]. Journal of Environmental Psychology, 2001, 21(1): 31-44.
[66] HAN K T. An Exploration of Relationships Among the Responses to Natural Scenes: Scenic Beauty, Preference, and Restoration[J]. Environment and Behavior, 2010, 42(2): 243-270.
[67] GIFFORD R. Environmental Psychology: Principles and Practice[M]. Colville WA: Optimal Books, 2007.
[68] GIMBLETT H R, ITAMI R M, FITZGIBBON J E. Mystery in an Information Processing Model of Landscape Preference[J]. Landscape Journal, 1985, 4(2): 87-95.
[69] KUO F E, SULLIVAN W C. Environment and Crime in the Inner City: Does Vegetation Reduce Crime?[J]. Environment and Behavior, 2001, 33(3): 343-367.
[70] SUGIYAMA T, LESLIE E, GILES-CORTI B, et al. Associations of Neighbourhood Greenness with Physical and Mental Health: Do Walking, Social Coherence and Local Social Interaction Explain the Relationships?[J]. Journal of Epidemiology and Community Health, 2008, 62(5): e9.
[71] BELL S. Landscape: Pattern, Perception and Process[M]. London: Routledge, 2012.
[72] VAN DEN BERG A E, CUSTERS M H. Gardening Promotes Neuroendocrine and Affective Restoration from Stress[J]. Journal of Health Psychology, 2011, 16(1): 3-11.
[73] KAPLAN R, KAPLAN S. Preference, Restoration, and Meaningful Action in the Context of Nearby Nature[M]// BARLETT P F. Urban Place: Reconnecting with the Natural World. Cambridge, MA: MIT Press, 2005: 271-298.
[74] KORPELA K M, YLÉN M, TYRVÄINEN L, et al. Determinants of Restorative Experiences in Everyday Favorite Places[J]. Health and Place, 2008, 14(4): 636-652.
[75] STIGSDOTTER U A, GRAHN P. What Makes a Garden a Healing Garden?[J]. Journal of Therapeutic Horticulture, 2002, 13: 60-69.
[76] RYAN C O, BROWNING W D, CLANCY J O, et al. Biophilic Design Patterns: Emerging Nature-Based Parameters for Health and Well-Being in the Built Environment[J]. ArchNet-IJAR: International Journal of Architectural Research, 2014, 8(2): 62.
[77] FORMAN R T T. Basic Principles for Molding Land Mosaics[M]// NDUBISI F O. The Ecological Design and Planning Reader. Washington, D.C.: Island Press, 2014.
[78] CORNELIS J, HERMY M. Biodiversity Relationships in Urban and Suburban Parks in Flanders[J]. Landscape and Urban Planning, 2004, 69(4): 385-401.
[79] NASSAUER J I. Care and Stewardship: From Home to Planet[J]. Landscape and Urban Planning, 2011, 100(4):

321-323.
[80] KAPLAN R, KAPLAN S, RYAN R. With People in Mind: Design and Management of Everyday Nature[M]. Washington, D.C.: Island Press, 1998.
[81] MOORE E O. A Prison Environment's Effect on Health Care Service Demands[J]. Journal of Environmental Systems, 1981, 11: 17-34.
[82] ULRICH R S. View Through a Window May Influence Recovery from Surgery[J]. Science, 1984, 224(4647): 420-421.
[83] TALBOT J F, KAPLAN R. The Benefits of Nearby Nature for Elderly Apartment Residents[J]. The International Journal of Aging and Human Development, 1991, 33(2): 119-130.
[84] KAPLAN R. The Nature of the View from Home: Psychological Benefits[J]. Environment and Behavior, 2001, 33: 507-542.
[85] NISSEN S. Urban Transformation from Public and Private Space to Spaces of Hybrid Character[J]. Sociologickýčasopis/Czech Sociological Review, 2008, 44(6): 1129-1149.
[86] BLINKOVA O, SHUPOVA T. Bird Communities and Vegetation Composition in the Urban Forest Ecosystem: Correlations and Comparisons of Diversity Indices[J]. Ekologia, 2017, 36(4): 366-387.
[87] SALISBURY A, ARMITAGE J, BOSTOCK H, et al. Enhancing Gardens as Habitats for Flower-Visiting Aerial Insects (Pollinators): Should We Plant Native or Exotic Species?[J]. Journal of Applied Ecology, 2015, 52(5): 1156-1164.
[88] WRAY J C, ELLE E. Flowering Phenology and Nesting Resources Influence Pollinator Community Composition in a Fragmented Ecosystem[J]. Landscape Ecology, 2015, 30(2): 261-272.

图表来源：

图 1 引自 https://www.asla.org/2012awards/073.html； 图 2 由 Charlotte Chen、Marco Leung 和 Alwyn Rutherford 拍摄；图 3 由经默多克·德莱夫公司景观设计师许可使用；图 4 由 Ted McGrath 提供，在知识共享许可下使用；图 5 由 Ty 提供，在知识共享许可下使用。表 1 引自参考文献 [75]。

（编辑 / 刘玉霞）

Garden Cities in the New Millenia

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0 Introduction

Ecosystem services are the goods, services and benefits that people receive from the functions of ecosystems[1-3]. Many of these services like climate regulation, flood control and pollination are necessary for human survival[4]. In addition to these material ecosystem services, the non-material benefits of improved cognitive functioning, stress reduction, psychological and physical wellness that result from the restorative properties of contact with nature may be added to the list of cultural ecosystem services[5-7].

Since the dawn of recorded history, gardens have been designed to supply material ecosystem services like food and non-material ecosystems services like socialization, recreation and mental restoration. Today new knowledge allows us to increase the number and degree of ecosystem services that can be derived from designed landscapes[7].

Although there are many ecosystem services that accrue from the urban gardens, I will focus in this essay on two ecosystem benefits that are synergistic, critically important and that are often overlooked by city planners and urban designers: biodiversity in urban regions and human mental and physical wellbeing.

1 A Brief History of Gardens

1.1 History

In modern discourse, the term garden is used to describe a space adjacent to the residence that contains ornamental, and possibly food plants and that is intended to provide outdoor activity and separation from the public realm. In addition, it is now common to hear of healing gardens, many of which are attached to health care institutions. These are gardens that support mental and physical wellbeing[8]. In these respects, modern gardens do not differ from those or our ancestors.

In 3,000 BC, the home and garden of an Egyptian official were contained within a wall that provided protection from wild animals, marauders, the desert winds. Originally, the garden was utilitarian, growing vegetables, tree fruits and grape vines[9]. With the development of decorative water features and abundant flowers, the utilitarian ancient Egyptian garden evolved into a multi-purpose garden that offered safety, food, microclimate modification, aesthetic enjoyment, socialization and repose.

The ancient Egyptian garden and the Persian garden (c. 4,000 BC) were both walled gardens with extensive water features and trees[10]. Alexander the Great (356–323 BC) conquered the Persian Empire in 331 BC and by the time of his death eight years later, had transmitted the Persian garden from the Adriatic Sea and Egypt in the east to the Himalayas in the west[11]. It was this empire that, when re-conquered by Muslin Arabs the 7th century BC, developed the Islamic Garden. The Muslims absorbed the Chahar Bagh, or four-garden, form of the Persian garden i. e. , a garden divided into quadrants by cruciform water channels meeting in the center of the garden, but ascribed to it the meaning of the afterlife paradise described in the *Quran*. Between the 7th century BC and the 16th century AD, iterations of the Islamic garden were created in the Iberian Peninsula, Sicily, north Africa, and across the Middle East to India. Like the earlier ancient Egyptian and Persian gardens, the Islamic garden was both a worldly pleasure garden and a simulation of an afterlife paradise[11].

Later the design of ancient Roman gardens was influenced by these earlier enclosed gardens. In ancient Rome, a private garden was a walled, symmetrical, treed courtyard with flower beds, in

which pavilions were arranged around a central irrigation pool or channel[12].

The Romans were the first to leave a historical record of the restorative powers of nature. Quotes from the Letters of Roman statesman Pliny the Younger (c. 61 AD – c. 112 AD) illustrate how much he treasured the mental restoration and inspiration that he received from contact with nature. He wrote….

You desire to know in what manner I dispose of my day in summer time at my Tuscan villa. … About ten or eleven of the clock… according as the weather recommends, I betake myself either to the terrace, or the covered portico, and there I meditate and dictate… From thence I get into my chariot… and find this changing of the scene preserves and enlivens my attention. (Book nine, Letter 36)

Oh solemn sea and solitary shore, best and most retired scene for contemplation, with how many noble thoughts have you inspired me! (Book one, Letter 9)

—Gaius Plinius Secundus (Pliny II) ①

In in the Middle Ages (c. 500–1500 A. D.), Christian monasteries built enclosed gardens reminiscent of the form of Islamic garden[13]. The gardens were enclosed by the walls of the monastery and covered arcades known as cloisters that provided views into the garden[14]. Like the Islamic garden, these gardens were divided into by paths symbolizing the four rivers of Eden that intersected at a well or fountain in the center of the garden. Often, the cloister garden was adjacent to the monastery infirmary and was used as a place of healing. Saint Bernard (1090–1153) described the courtyard garden of his monastery at Clairvaux France and its healing benefits.

Within this enclosure, many and various trees, prolific with every sort of fruit, make a veritable grove, which lying next to the cells of those who are ill, lightens with no little solace the infirmities of the brethren, while it offers to those who are strolling about a spacious walk, and to those overcome with heat, a sweet place for repose… The lovely green of the herb and tree nourishes his eyes… their immense delights hanging and growing before him … while the air smiles with bright serenity, the earth breathes with fruitfulness and the invalid himself with eyes, ears and nostrils, drinks in the delights of colours, songs and perfumes.

—Saint Bernard [14]

The ideas expressed in this quote, i.e., that the beauty found in nature is to be prized and that it bestows wellbeing have been consistent throughout human history[15-16]. In ancient Rome and mediaeval Europe gardens were understood to be places of peace, healing and inspiration. It must also be noted that these gardens, built by the wealthy and the church were generally unavailable to the common person. Many of these gardens, whether smaller gardens or estates, were enclosed by a wall that separated the garden and its inhabitants from the outside world. They were simultaneously utilitarian gardens and idealized representations of the beauty of the natural world and were intended to provide food, aesthetic enjoyment, socialization, respite and wellbeing.

1.2 The Romantic Landscape Ideal

In the 18th century, Romantic philosophers like Jean-Jacque Rousseau (1712–1778) and Alexander Pope (1688–1744) espoused the idea that contact with nature revealed the essential goodness of human beings and contributed to an individual's serenity and wellbeing[17-18]. Their writings inspired the upper classes of northern Europe and Great Britain to the create lavish country estates. Under the influence of Romanticism, these informal estate grounds, or parks as they were called, were intended to elevate human thought and wellbeing by evoking an emotional response to the beauties of nature.

1.3 City Parks

The development of urban parks in Europe, Britain and North America was also influenced by Romanticism. New parks were advocated as a means to improve the health, welfare and character of citizens[19]. Frederick Law Olmsted claimed that parks "provide for counteracting the special evils that result from the confinement of life in cities" and help to turn visitor's thoughts "away from the mental contemplation of objects associated with conditions which have produced previous strain or mental fatigue"[20].

In this statement, Olmsted is expressing the idea, inherited from the Romantics, that positive mental benefits accrue to human beings from contact with the nature found in urban parks. In his view, time spent in parks, enabled citizens to restore their mental capacities[21] and were a means of extending the healing effects of gardens to the lowest socio-economic members of society who otherwise could not attain them, because they did not have gardens[22].

It is now evident that Olmsted and the Romantic philosophers were correct in identifying the benefits of contact with nature. In the last several decades, researchers have identified multiple mental and physical benefits that accrue from contact with nature. These include, stress reduction, lower crime and domestic violence, significant reduction in all manner of illness and disease, improved mood, and cognition, increased benevolence and reduction in attention deficit hyperactivity disorder[6, 23]. In addition, researchers report that time spent in nature during childhood promotes, healthy development, improved wellbeing and greater value for the environment[24]. People of lower socio-economic status and children receive the greatest benefits from contact with nature[23, 25].

2 The Effects of Urban Growth and Densification

Worldwide, more and more people are moving to cities. It is estimated that by 2050, the percentage of global population living in cities will increase from the current 55 percent to 68 percent of the total global population, adding an additional 2. 5 billion people to cities worldwide. By 2030, the number of cities of over 10 million people will rise from the current number of 33 to 43 ②. As cities densify, the number and area of private gardens is reduced and is not replaced through an increase in public open space (POS)[26].

If current trends continue, the dramatic

increase of urban populations that will occur in the next few decades will result in a reduction of gardens and other green spaces with an attendant reduction in biodiversity of urban regions and a decrease in the mental and physical wellbeing of the increasingly large number of people living in cities. However, this is not inevitable.

Singapore, with a density of more than 7,500 inhabitants per square kilometre, refers to itself as The City in a Garden and is noted for its green buildings and adding green space[27]. Between 1986 and 2007, Singapore increased its green space from 36% to 47% while increasing its population[28]. In dense cities like Singapore and Hong Kong, limited opportunities for ground-level green space have led to more green roofs and building facades[29]. In cities like Detroit that have experienced severe urban decline, regrowth is leading to new urban green spaces (UGS) being developed on former building sites (Fig. 1 ③)[30-31].

2.1 Biodiversity and Ecosystem Services

Only within recent years has the profession of landscape architecture embraced the incorporation of ecosystem services in designed landscapes. For example, The American Society of Landscape Architects SITES initiative ④ and the American Landscape Architecture Foundation, Landscape Performance Series ⑤ are both intended to foster the inclusion of ecosystem services in designed landscapes. Such landscapes are referred to as performance landscapes or multi-functional landscapes. Commonly reported ecosystems services associated with POS include carbon storage, storm and flood protection, mitigation of the urban heat island effect, and the maintenance of healthy soils[28].

The term biodiversity is a contraction of biological diversity is most easily understood as the variety of all life on earth[32]. It includes all organisms, species and ecosystems in all their genetic diversity. It matters to us because it is the life and life support of all living creatures on earth, including *homo sapiens*. Although biodiversity, is not an ecosystem service, it is included in most ecosystem services assessments because of its importance in providing ecosystem services that are the result of interactions between biota or living organisms and their environment[33].

Research has established a clear linkage between biodiversity and supporting and regulating ecosystem services[34]. For example, bioproductivity or the net biomass produced in a given area is a supporting ecosystem service that is shown to be strongly related to biodiversity[35]. At a local level, a decline in biodiversity might mean a decline in food species like fish or shrimp, a reduction in carbon sequestration or a loss of flood protection. For example, in a healthy forest, bioproductivity and the interception and infiltration of precipitation are correlated. If that forest were to be degraded by natural or human forces, its bioproductivity would decline, together with its ability to intercept, store and distribute rainfall, resulting in a reduction of the ecosystem service of flood control[33]. As this example illustrates, a loss of the biodiversity will often be related to a reduction in one or more ecosystem services.

2.2 City Growth and Biodiversity Loss

It is a common misconception, even among scientists and urban planners, that maintenance of biodiversity in not a legitimate concern in urban planning and development since urban regions are low in biodiversity. However, research reveals that people have usually settled in areas of high biodiversity, that many cities still retain significant biodiversity[36-38]and that urban green spaces are important for supporting regional biodiversity[39-40]. Scientists report that urban expansion reduces local biodiversity[41] and predict that unless current trends change, urban expansion will destroy an additional 1.2 million square kilometres of greenfield sites between 2012 and 2030. This land cover change will result in habitat loss, reduction in biomass and carbon storage and threatens biodiversity at a global scale[42].

One commonly used measure of biodiversity is species richness or the number of different species in a particular area. For this reason, loss of species is a strong indicator of total biodiversity loss. It is estimated that due to human activities like pollution of air and water, habitat destruction caused by urbanization, agricultural expansion and mining and logging humans are now exterminating species at 1,000 times the natural rate and many species that might yield new medicines or agricultural stability are being lost without ever being recorded[43]. This has been termed the 6th great extinction in the history of planet earth. The losses of larger mammals are widely reported but insects which are essential to the functioning of ecosystems are declining eight times faster than animals[44]. Of the decline in insects, the decline in pollinators is perhaps most concerning. More than 85% of plants on earth are pollinated by insects and other animals and 75% of major global food crops need pollination [45]. As well as farmlands, natural areas are now under-pollinated reducing plant reproduction and threatening native plant biodiversity[46]. A global examination of biodiversity loss reported that 30% birds, mammals, and reptiles and 15% of amphibians were declining and warned that humanity has two to three decades to act before the life support system of the planet is irrevocable harmed[47]. Another study reported that 21% of all bird species are currently in danger of extinction and that if current trends are not reversed, global loss of ecosystem services is likely[48].

This situation is not in our collective consciousness to the same degree as climate change but it may be considered a greater problem. There are two reasons for this: at some point, humanity will eliminate greenhouse gas emissions and climate will slowly stabilize, however loss of a species is irrevocable[32]. Because biodiversity is related to ecosystem services, its decline may well have a greater effect on the ability of humans to inhabit the earth than climate change. We cannot know the point at which declining biodiversity will result in the collapse of an ecosystem or the loss of ecosystem services. It therefore in the self-interest of humanity to maintain biological diversity[4].

2.3 City Growth and Greenspace

The growth of many metropolitan regions such as New York, Tokyo, Mumbai, Mexico City and Vancouver, is constrained, either by geography or planning policies or a combination of the two

(Fig. 2). That means that rather than sprawling over the surrounding countryside, these cities will densify as their populations increase. Where densification, rather than sprawl in not necessitated by policy or geography, it should be the preferred growth strategy of choice, because urbanization that increases the area of the urban footprint also reduces biodiversity and ecosystem services[42]. The Compact City is advocated as an alternative to urban sprawl that will incorporate efficient public transport and promote cycling and walking[49].

As cities densify, existing low-density neighbourhoods will be infilled with higher-density developments. Multi-family developments will replace single-family detached housing. The kinds of homes that would allow private gardens will be beyond the means, or even the desires of many home owners, and providing them would result in urban sprawl rather than densification. When this occurs, the restorative benefits of the private gardens will be unavailable to the urban dweller.

While human development has historically reduced biodiversity, in many places gardens and orchards have had considerable positive effect on regional biodiversity[50]. In modern cities, a variety of public and private landscapes created, in city suburbs, act as a surrogate for early seral stage landscapes that provide habitat for many bird species. Researchers report that while the number of bird species in the urban core is very low, the number of birds and butterfly species and individuals increases significantly in suburban gardens and parks[51-53].

Bigger, more congested, denser cities will deprive most of their residents of private gardens and the range of ecosystems services that those gardens provide. In order for these benefits to be provided to future urban dwellers, new public green infrastructure must be developed to provide mental and physical well-being and other ecosystem services over and above those that were previously provided by a city's private gardens and parks.

However, concepts like ecosystem services and green infrastructure are evaluated for their biological, ecological or technical functions, but are rarely related to well-being and health[54]. Similarly, most urban green infrastructure proposals are single purpose and do not consciously incorporate either biodiversity or public health. See for example, the *City of Vancouver Rain City Strategy*[55]. This needs to change if the city of the future is to support human wellbeing and regional biodiversity.

Unless the dense megacity of the future becomes a biodiverse healing garden in itself, the negative effects on human wellbeing will be extensive. Conversely, by considering these two issues in urban planning and development, future cities can protect biodiversity and ecosystem services and increase human wellbeing.

3 The City as Garden

How will UGS replace the loss of private gardens on denser cities? POS includes parks, playgrounds, natural areas, municipal gardens, civic squares and school grounds within the public realm[28]. UGS describes all vegetated areas in cities, including private gardens, parks, golf courses, and street trees[56]. This is an important distinction as biodiversity, the ecosystems services it is related to and the health and wellness benefits of contact with nature occur in all UGS but not all POS. For this reason, achieving wellness and biodiversity in urban regions should concentrate on total UGS rather than POS. This means considering public and private open space in concert. Researchers report that accessible green spaces are usually higher in affluent neighbourhoods[57]. For the benefits of UGS to be equitable, its distribution will need to relate to urban densities across the metropolitan region.

3.1 Biodiversity and Psychological Restoration

It is important to understand that biodiversity and the mental restoration that comes from contact with nature are synergistic. Researchers who have examined the relationship between biodiversity and restoration report that biodiverse settings are more restorative (Fig. 3-5)[58-60]. This is in keeping with what is known as the biophilia hypothesis, which argues that people are innately predisposed to affiliate with nature[61]. Other researcher's report that biological indicators of restoration increase in natural settings and that increasing biodiversity does not lower these effects[62]. Secondly, the presence of a diverse set of bird species in the landscape is a strong indicator of general biodiversity[63-64]. Thus, raising avian biodiversity increases general biodiversity and is indicative of a more biophilic, and restorative landscape.

In terms of the restorative qualities of nature, it has been found that restoration and preference are closely linked. More naturalistic settings are preferred and those elements of a landscape that predict restoration predict preference and vice versa[65-66]. The quality of mystery i.e., the suggestion that moving forward will reveal more is a predictor of both landscape preference and the restorative experience[66-68]. In studies where levels of "greenness" were distinguished, restorative benefits were found more reliably or were greater for greener environments[69-70].

The more involved a person is in the landscape, the greater will be their mental processing of that landscape[71]and studies indicate that this higher involvement yields greater mental restoration[72]. In general, increasing the duration and frequency of contact with natural settings results in higher levels of restoration[73-74] so that the more time urban dwellers spend in their local UGS and the more often they do so, the greater will be the restorative effect they receive.

Researchers at the Institution of Landscape Planning Health and Recreation in Alnarp Sweden posit that a garden must be an outdoor room with walls and ceilings, that plants must be the dominant element, and that if it does not bring the message of life, and cyclical change it will not convey the feelings of peace, sensual stimulation and beauty. Further, they tell us that a healing garden is one that activates all the senses, not only sight but smell, taste and touch and that healing garden it is experienced over time as a series of rooms of different characters that make a whole where one is separated from the outside and feels safe[75].

These same researchers came to realize that

parks that had many room characters attract more people than ones that had only one type of character and that certain types of characters were generally more attractive to people than others. (This is another example of the synergies between biodiversity and preference/restoration). Research shows that as habitat diversity i.e., the number of different types of habitat on a given site increase, biodiversity increases[53]. The researchers gave these eight types of room characters descriptive names (Tab. 1).

They found that the characters Serene, Space and Rich in Species appealed to many people and that The Common and The Pleasure Garden appeal to park visitors who are less stressed and wish to watch other people. Further, they reported that achieving these characters required natural areas, with many different kinds of plants and tall trees.

3.2 Strategies

Many researchers and designers have made recommendations for more biodiverse urban regions or more restorative urban environments and I encourage the interested reader to investigate these, as they are beyond the scope of this article[23, 28, 76-77]. From their recommendations, and my own investigations, a number of principles may be derived. While these are not comprehensive, they are widely applicable and based in empirical research. 1) Regional Network: Relate action to scale. Many urban regions are biodiversity hot spots. To preserve this a regional ecological network should be planned and implemented. This should protect and connect the rare and representative biodiversity of the region. UGS should be added not as opportunity allows, but as part of an overall regional strategy to maintain a diversity of habitat types as this will support regional biodiversity[22, 78]. This strategy will produce a range of sizes and types of UGS that will allow people access to wilder areas, increase the types of landscape that people experience, accommodate a diverse set of UGS users and will enhance human wellbeing[59]. 2) Cues to Care: Many biodiverse landscapes may not conform to cultural norms. A range of 'cues to care' can be implemented to show that the landscape is intentional and is managed. This will aid in public acceptance[75, 79]. 3) Make public green spaces a series of connected rooms of distinct but related character[75, 80]. 4) From Policy to Design: Do not rely on only broad policies. Specific design directives will be needed, especially at smaller scales. For example, at the neighbourhood and site scale, provide a range of landscape characters for restoration and habitats for birds and insects – especially pollinators. These different habitats will increase biodiversity and will also provide a mix of landscape experiences[22, 53]. 5) Nearby Nature: Make nature nearby and ubiquitous. It is often impossible to add large new UGS but adding street trees, or other plantings, to the views from hospitals, prisons, homes and work places is possible and will be important givers of restoration[81-84]. 6) Blend Public and Private: Break down the barriers between public and private making private open space for the public benefit[85]. Consider UGS as being the public and the private realm working together in concert. Make an interconnected network of diverse private gardens and incentivise wildlife and pollinator gardens. 7) Distribute green space equitably throughout the city[57]. 8) More Green Space. Make a higher percentage of urban open space, urban green space. Many cities have high open space requirements for fail to ensure that that space is green and publicly accessible. In large residential development developments, make some part of the private open space green space that is publicly accessible[7]. 9) Find small areas throughout the city and give them function and naturalness[27]. 10) Plant the Urban Forest: Planting large trees and forests that are vertically layered will increase biodiversity[86]. 11) Mix native and non-native plantings to benefit birds and pollinators. UGS plantings should be diverse and mix regionally appropriate non-native and native plants. This floristic diversity will support pollinators[22, 87-88]. 12) The more deeply people are engaged in nature the greater their wellness benefits[22]. Plan, design and implement UGS that encourage people to actively engaged in stewardship, just as they have previously done in private gardens. This might mean more intensive roof top gardens in residential developments, home owners in multi-family residences caring for the communal landscape, more community gardens spread throughout the city, or school children participating in nest box programs for cavity nesting birds. 13) Make all new green infrastructure support multiple ecosystem services. Rain gardens and bioswales can be a "near nature" strategy to make the city more restorative as well as cleansing stormwater. 14) Concentrate UGS where people are concentrated e. g. airports, hospitals, schools workplaces and commuter corridors[23].

Notes:

① Retrieved from http://www.vroma.org/~hwalker/Pliny/PlinyNumbers.html.

② Retrieved from https://www.un.org/development/desa/en/news/population/2018-revision-of-world-urbanization-prospects.html.

③ After the City of Detroit, Michigan lost its biggest employers and tax base it declared bankruptcy in 2013 and much of the urban core became derelict. Today, many neighbourhoods are seeing a resurgence with former some building sites become urban green spaces. The ASLA award winning Lafayette Greens Community Garden by Kenneth Weikal Landscape Architecture occupies the site of the Lafayette Building in downtown Detroit which was demolished in 2010. The garden was donated to The Greening of Detroit by Compuware in 2014. As well as community food production, the gardens support community gathering and events, a children's garden and pollinator habitat.

④ Retrieved from https://www.asla.org/sites/.

⑤ Retrieved from https://www.landscapeperformance.org.

Sources of Figures and Table:

Fig. 1 from https://www.asla.org/2012awards/073.html; Fig. 2 © Charlotte Chen, Marco Leung, and Alwyn Rutherford; Fig. 3: Design and photos used with permission Murdoch Degreeff Inc. Landscape Architects; Fig. 4: Image Ted McGrath, used under creative commons licence; Fig. 5: Image by Ty, used under creative commons licence. Tab . 1 from reference[75].

(Editor / LIU Yuxia)