Biodiversity in the Built Environment
and The Index of Biodiversity Potential
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Cover Images: (Front) Echinacea pallida; Stapleton Central Park + Greenways, Denver, CO; US Census Bureau, Washington DC; National Museum of the American Indian, Washington, DC — (Back) Back Cover Images: Sand Dune, Perth, Australia; US Census Bureau, Washington DC; Kunshan Ma An Shan Road Landscape Design, Kunshan, China; Jinji Lake Waterfront Redevelopment + Landscape Master Plan, Suzhou, China; The Children’s Hospital at Fitzsimons, Aurora, CO
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Executive Summary

This report presents a new, quantitative approach to community biodiversity planning that utilizes a measurement protocol we have coined the “Index of Biodiversity Potential” (IBP). This approach is proving to be a powerful addition to sustainability efforts in community master planning and municipal planning contexts, especially when there is a need to demonstrate a measurable impact or improvement to site ecology. The IBP can help projects create high performance landscape master plan and design solutions customized for the projects unique ecological and development context. It can also act as a guideline for biodiversity friendly design strategies within broader planning efforts such as climate adaptation plans or municipal biodiversity policies. This report also discusses several leading edge built case studies that have helped shape a new biodiversity paradigm in sustainable community development.

Many leading edge sustainable communities are exploring strategies for embracing native biodiversity within the built environment. These biodiversity strategies go beyond traditional regulatory drivers that emphasize “avoidance” of protected species and embrace a new paradigm in comprehensive, integrated ecological design strategies that strive to:

- **enhance** overall biodiversity and ecosystem services through new approaches to ecological design in the built environment resulting in regenerative, footprint-positive landscapes;
- **learn** from biodiversity and ecosystems to help design communities to function more like their supporting ecosystems (often called “biomimicry”); and,
- **celebrate** native biodiversity as part of community identity and values through landscape design with native plants.

These strategies support high functioning urban ecosystems that balance the built and natural environments in urban, suburban, or exurban contexts. Projects challenged with development in areas that include sensitive ecological resources will find the IBP and our other ecosystem services planning approaches especially beneficial in helping projects build the case and take credit for a wide variety of steps taken to achieve environmentally friendly development.

National Museum of the American Indian, Washington, DC
Index of Biodiversity Potential

The Index of Biodiversity Potential (IBP) is a land planning and design tool that was developed by AECOM to help land owners, communities, and municipalities systematically plan for biodiversity in their landscapes. The IBP has been applied primarily in built environments including community master planning efforts in Singapore and Portland, OR, USA. Many elements of the approach have also been applied in more than one dozen other large-scale, high-profile international planning efforts led by AECOM in urban, suburban, and exurban contexts. The IBP helps projects craft a biodiversity strategy in a way that demonstrates quantifiable benefits of leading edge, sustainable landscape strategies.

The IBP provides a framework for developing landscape and community master plans, comparing potential biodiversity performance of alternative land plan scenarios, and creating biodiversity-oriented landscape design guidelines. The IBP relies on quantitative measurement of attributes of actual and/or planned landscapes within two overarching categories:

- Pattern attributes: shape, size, connectivity, and total area of habitat
- Structural attributes: habitat types and variety of habitat types

IPB scores from 1 to 5 are possible for landscape areas based on scoring criteria that are defined by the planning team for each project context. Scoring criteria and thresholds are defined based on several “keystone” attributes of local ecosystems and infrastructure such as native vegetation canopy structure; edge effect relationships for indicator species; native ecosystem “structural drivers” (processes); or widths of connectivity “barriers” such as roads or sidewalks. Plan IBP scores are evaluated using a combination of Excel-based calculations and GIS and/or by-hand measurements.

The first step in the IBP process involves “site calibration” to determine priority areas for preservation, to frame goals for biodiversity enhancement, and to customize IBP scoring criteria. Many projects seek to create a plan that achieves improved biodiversity value relative to the existing condition, a historic natural condition, or a business as usual development scenario “benchmark”. The second step involves developing alternative design and/or program scenarios and measuring IBP performance against the benchmarks. The final step includes assessing cost/benefit relationships, selecting an optimal program scenario, and creating biodiversity design guidelines and implementation plans.

At the design level, the IBP can help create and implement high performance landscape master plans and ecological enhancement strategies. At the policy level, the IBP can facilitate the creation of design guidelines for individual parcels to support a desired level of biodiversity performance across an entire community or planning area. The IBP can also be used to compare performance of different projects across municipalities or regions.

One of the greatest benefits of the IBP is that it allows many opportunities for creating customized calibration and solutions for specific contexts considering the wide variety of conservation priorities, ecosystem structure and pattern, and project economics while providing a meaningful comparison of potential biodiversity benefits. The IBP approach is especially beneficial in urban, suburban, or exurban contexts where sensitive or degraded environmental conditions call for innovative, ecologically oriented development concepts.
Rapidly accelerating habitat loss, habitat fragmentation, and climate change adaptation are combining to drive a major paradigm shift in conservation strategies across the globe. Changes to ecosystems, especially changes to biota, hydrology, temperature, and storm patterns, are some of the primary direct impacts that many communities will face. New climate change adaptation strategies are beginning to address these changes to ecosystems and land use. Within this paradigm is the idea of improving the broader “land use matrix” to facilitate biodiversity and ecosystem services in order to accommodate these changes. Smarter community and regional land use design strategies that maintain and restore more robust habitat connectivity in both rural and urban areas are often identified as strategies for sustaining biodiversity at the regional level. Mitigation of the urban heat island effect, increasing vegetation to sequester carbon, and water-sensitive urban design are all rapidly gaining importance as measures to adapt to climate change.

In response, we have developed biodiversity planning tools such as the IBP, ecosystem mapping protocols, and new ecological infrastructure strategies to help “future proof” communities for climate change and other emerging environmental challenges. This report emphasizes the IBP, but also touches upon these other ecosystem services that combine to present our whole-systems approach to ecological design, sustainability, and ecological performance assessment.
Introduction:
Biodiversity in the Built Environment

Many leading edge sustainable communities are exploring strategies for embracing native biodiversity within the built environment. While traditional regulatory drivers may focus on minimizing impacts to protected species and sensitive ecosystems, new approaches, typically driven by sustainability goals, seek more comprehensive strategies.

These strategies support high-functioning urban ecosystems with diverse interplay between built and natural environments, even in the most urban contexts. Many of the latest high-profile sustainable development concepts, including the Gardens By the Bay in Singapore, Prairie Crossing in Illinois, and the 2012 London Olympics, have all developed unique identities and the highest performing sustainability concepts by rigorously addressing ecology and biodiversity in design.

The Singapore Index for Cities Biodiversity, for example, is an initiative that seeks to assess overall biodiversity at the city scale by tracking a variety of indicators, from types of habitat present, to levels of environmental education. The Living Building Challenge is set to raise the bar above LEED by creating a rating system that aims to create ecologically footprint positive development strategies. The focus of this report, The IBP, is a planning tool developed by AECOM for designing and comparing performance of alternative community biodiversity strategies, and quantifying potential biodiversity benefits of community master plans or municipal strategies.

New performance analysis techniques and design ideas are being drawn from numerous recent scientific breakthroughs in the fields of climate change ecology, landscape ecology, ecosystem ecology, conservation biology, and ecological design. These breakthroughs are fostering fresh perspectives and innovation in ecological community design and urban biodiversity planning. This is in many ways as an exciting evolution of Ian McHarg’s original concept of “design with nature” within the emerging paradigm of integrated comprehensive sustainable design and climate change adaptation. Within these
comprehensive sustainability projects, biodiversity strategies are providing exciting co-benefits in the realms of biomimicry (architecture and built systems that mimic local ecosystem structure, patterns and processes); carbon sequestration (habitats can sequester carbon and provide valuable carbon offsets); water quality improvements; or diverse socio-cultural benefits. These approaches are proving especially relevant in urban areas that seek to maintain a connection with nature while experiencing rapidly increasing densities. They are also important in exurban areas where traditional forms of urban growth are increasingly in conflict with increasingly sensitive landscapes. The ancient ecosystems and iconic native species present in many exurban growth areas can become celebrated features that provide the foundation for new forms or sustainable development truly connected with place.

Within the IBP approach, we typically plan for biodiversity in terms of native biodiversity, although non-native biodiversity may also provide benefits in many situations. Simply trying to maximize the number of species alone is too general and does not consider key supporting functions such as population dynamics or supporting ecosystem processes. Therefore, some key supporting functions to consider in planning for sustainable levels of biodiversity include seed dispersal, habitat connectivity, the impacts of adjacent landscapes, predator/pray relationships, migration, potential habitat sinks, and natural processes like seasonal flooding, or species life-cycle/landscape interactions.

Targeting a biodiversity profile that mimics that of native ecosystems is often included in the IBP, although each project can be calibrated according to specific goals. Within communities and landscapes, goals may also include maintaining or improving the
Benefits of Ecosystem Services

In addition to biodiversity, key ecosystem services benefits often measured in ecological communities planning include:

**Urban heat island reduction:** development designed to consider tree canopy, wetlands, wind and sun patterns, and other ecosystem features and their relationship with creating a favorable site climate and reduced greenhouse gas emissions.

**Carbon sequestration:** soils and vegetation can sequester carbon, providing valuable carbon offsets. We often try to create an urban forest and landscape strategy that sequesters an amount of carbon equal to the historic natural carbon stock of a site. Sequestering carbon through the restoration of native ecosystems is optimal.

**Water quality:** ground water recharge, flood control, rainwater capture and re-use, erosion control, and wetland protection are all popular ecosystem services measures.

**Local food production:** creating landscapes that produce food, especially on any prime agricultural soils is a valuable opportunity.

**Recreation, education, and aesthetics:** creating landscapes that engage people with nature have wide ranging benefits including improved mental well being, health, improved conservation behavior, enhanced learning ability, and many others.

Because ecosystem services design measures often only include changes to landscape plant palettes or altering landscape patterns and forms, often at only minimal additional cost, the only barrier to capturing these opportunities is the knowledge of the design team. Therefore, we advocate that every project work with an ecologist-designer to identify opportunities and to guide a process of ecological design exploration including science-based ecological assessment. The assessment goes beyond typical regulatory “constraints driven” environmental objectives, and strives to view ecology through an “opportunities” lens. This approach has proven successful in numerous projects in recent years and is helping to reshape a new generation of sustainable and ecological land use projects.
The Index of Biodiversity Potential

How can communities be created to maximize the benefits and sustainability of biodiversity? At the master plan level, in both urban and rural contexts, design strategies can be crafted systematically to facilitate ecologically rich landscapes that are potentially suitable for high levels of native biodiversity. A well designed landscape master plan supports biodiversity by providing ecosystem characteristics for both flora and fauna that:

- facilitate species movement, migration, dispersal, succession, and establishment within and through the site;
- provide habitat for cover, foraging, and other life history characteristics including key species interactions;
- provide natural patterns and processes that species are adapted to including seasonal flooding, forest structure, habitat adjacencies, shading and light; or
- reduce threats to wildlife survival including road crossings, invasive species, inappropriate land uses adjacent to habitat, and light pollution.

These landscapes may eventually closely resemble native ecosystems of the region, or may be contemporary architectural landscapes that emphasize native plants to provide both a high value to biodiversity and a unique aesthetic for a project.

Applying the IBP requires assessment of the ecological role that a planning area plays within the broader region, especially considering habitat connectivity, regional rarity of ecosystems, and access to nature.
The Index of Biodiversity Potential (IBP) was developed to **assess the potential for community landscape scenarios to support native biodiversity**. Because this is a planning tool and projects are not built at the time of assessment, the measurement is based on potential rather than actual biodiversity present, with the exception of a baseline measurement of existing site conditions. The IBP considers two primary characteristics of habitat, which are assumed to be the key indicators of overall biodiversity potential:

- **Structural (vertical) attributes**: habitat types, plant community/ecosystem structure, and landform
- **Pattern (horizontal) attributes**: pattern of habitats including the total amount of habitat and the shape, size, and connectivity of habitat areas

The IBP is not designed to emphasize maximizing total species richness, rather, it places value on how close a landscape resembles a native ecosystem that could theoretically be present on a site; how well species can move through and within a site; and how accessible site biodiversity is to residents and visitors.

IPB scores of 1 (low biodiversity potential) to 5 (highest biodiversity potential) are possible for landscape areas based on performance against scoring criteria that are defined for the project area by the planning team. Once scoring criteria have been established, and the site existing condition benchmark has been measured, to score a project area, scores for each individual area of proposed landscape across a site are tallied and a comprehensive project IBP score is generated. Since IBP scoring criteria are based on specific, defined pattern and structural attributes, and are calibrated based on existing and target native ecosystems for a project area, the approach can effectively compare biodiversity potential between plan scenarios. At the community planning level, the IBP helps to determine the total amount and appropriate design of habitat to include on individual parcels to achieve a desired level of performance across an entire community. At the design scale, the IBP can help prioritize specific plant species, landscape patterns or the structural characteristics needed to achieve habitat objectives.

In addition to comparison of alternative scenarios for an individual community or project area, the IBP can also be used to compare different projects or act as a guideline for projects across municipalities or regions. However, an essential lesson from ecology is that every site is different and any attempt at an index to compare performance across projects rather than across scenarios for the same project area must factor in these differences. Therefore, we have developed the index in a way that allows opportunities for calibration for specific contexts at a variety of scales considering conservation priorities, native ecosystem structure and pattern, and urban planning conventions.

**The IBP Process**

**Step 1) Site Calibration**

A key goal of many projects is to create a plan that achieves improved biodiversity value from the baseline existing condition. This baseline IBP score, other benchmarks including the historic native ecosystem condition, or a business as usual scenario are typically used as benchmarks by which achievement of performance goals are measured. Therefore, one “key performance indicator” of projects tends to be:

**Key Performance Indicator:**
- Percent change in the overall IBP for onsite habitats compared to the historic natural (pre-settlement), existing site, or business as usual master plan condition.

The first step in calibrating the IBP and establishing biodiversity performance targets includes a relative biodiversity valuation.
process for the existing condition (i.e. measurement of the baseline IBP score) to determine priority areas for preservation, to frame goals for biodiversity enhancement, and to measure project improvement.

The existing condition analysis involves performing an inventory of all areas of the site and scoring each area based on defined scoring criteria for each of the following attributes:

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Description</th>
<th>Importance Weighting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Naturalness</td>
<td>Natural habitats (i.e. low impact by man) are more highly valued. Generally, habitats less disturbed/modified will be rated higher.</td>
<td>a%</td>
</tr>
<tr>
<td>Patch Size</td>
<td>In general, large areas of habitat(s) are more valuable than smaller ones, all else being equal.</td>
<td>b%</td>
</tr>
<tr>
<td>Pattern</td>
<td>On-site connectivity, buffers, connectivity with off-site corridors influence habitat value.</td>
<td>c%</td>
</tr>
<tr>
<td>Species Diversity/Richness</td>
<td>The more diverse species assemblages and communities of a site, the higher the conservation value.</td>
<td>d%</td>
</tr>
<tr>
<td>Rarity/Endemism</td>
<td>Rarity can apply to habitats as well as species. The presence of one or more rare habitats or species will give a site higher value.</td>
<td>e%</td>
</tr>
<tr>
<td>Recreatability</td>
<td>Habitats which are difficult to re-create naturally or artificially are valued higher.</td>
<td>f%</td>
</tr>
<tr>
<td>Summary Score</td>
<td>Taking into account the criteria listed above, each habitat area is assigned an IBP score from low to high (1-5).</td>
<td>100%</td>
</tr>
</tbody>
</table>

**IBP Case Study:**

**Jurong Lake District, Singapore**

The Jurong Lake District in Singapore was the first project where the IBP was fully developed and applied. It was part of an AECOM led comprehensive sustainability planning effort for the District. The 300+ ha site included a small amount of existing wetland and secondary forest habitats and was envisioned by the client to be a global exemplar for sustainable development. The IBP process supported development of the overall master plan and park scenarios, a biodiversity target of a 25% improvement from the existing condition, and parcel level IBP design guidelines for landscapes to be designed by future developers. The recommendations also supported the idea of a broader biodiversity network within Singapore, with Jurong Lake acting as a key urban biodiversity hotspot.

The recommendations included structural guidelines including target habitat types, plant lists, and contemporary architectural applications of biodiversity enhancements including habitat on green roofs, an elevated “eco-grid” that connects a very urban part of the project, and a major urban park with very high levels of multiple ecosystem services. Next steps may include the broader application of the IBP framework to other projects in the Country and toward the further development of the Singapore Index of Cities’ Biodiversity.
The baseline IBP score for a site provides a general indication of its existing relative naturalness and value to biodiversity. Generally, urban sites with little or no valuable habitat will have IBP scores of between 0 and 1, whereas a perfectly natural site in a wilderness location could achieve a score of 5. While the assessment of the existing condition is somewhat subjective, and dependent on how the planning team defines scoring criteria, once a standardized protocol for scoring is developed for a site, municipality or region, the IBP process can effectively compare the relative performance of projects and scenarios within the planning area against the baseline, existing condition IBP benchmark.

**Step 2) IBP Scoring of Plan Alternatives**

Once the IBP score is measured for the existing site condition, plan alternatives are created and impacts to each existing condition IBP score area are measured. Next, alternative strategies are developed and the IBP is measured based on assumptions for new landscape areas in each scenario. Measuring IBP values for proposed landscape scenarios requires programming and measurement in the following areas:

- **Total amount of land designed as habitat**
- **Structure of preserved and proposed habitats** including plant species and general planting recommendations for a range of landscape typologies with different habitat values. It also includes targets for variety of habitat types. These habitat types may include restoration of native ecosystems; architectural types using native plants and design attributes that enhance habitat

<table>
<thead>
<tr>
<th>Pattern Attribute</th>
<th>Specifications</th>
<th>Benefits</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Habitat Shape</strong></td>
<td>Patches are roughly &lt;2x as long as wide (Specifically, patch width at narrowest point is no less than the square root of ½ the width at the widest point.) Corridors are &gt;2x as long as wide</td>
<td>Patch Shape: Patches have less edge, providing more interior habitat conditions. Interior conditions provide habitat most closely resembling native ecosystem conditions. Patches that are more closely shaped like circles or squares (less edge to area) where both edge and interior conditions can support a wider variety of species. Corridors provide movement and migration of species between patches. Since corridors are longer than they are wide, they provide a higher ratio of edge conditions compared to interior conditions, which supports more edge species. However, as corridors become wider they may exhibit greater interior conditions and the ecological characteristics of a patch. Wider corridors provide greater movement ability for both edge and interior oriented species.</td>
</tr>
<tr>
<td><strong>Habitat Size</strong></td>
<td>Patches and corridors should be as large as possible</td>
<td>Larger habitat areas generally provide more species richness and more favourable ecological conditions than smaller habitat areas. Larger patches provide area for important natural processes such as succession, disturbance, dispersal, cover, and also provide conditions necessary for “interior” species that require larger areas of contiguous habitat. Larger patches allow adequate space for large trees and forests to exhibit more natural forest structure, microclimatic and light characteristics.</td>
</tr>
<tr>
<td><strong>Habitat Separation</strong></td>
<td>Habitat areas should be located as close to other habitat areas as possible</td>
<td>Habitats that are closer to other habitats increase benefits for both habitats. IBP scoring rules were developed to account for habitat spacing thresholds. Generally, these thresholds were based on assumed widths of sidewalks, roads, and other features that will likely bisect habitat areas. Visual continuity, species mobility characteristics, dispersal strategies, and adjacent land use character are also closely tied with habitat separation performance.</td>
</tr>
<tr>
<td><strong>Habitat Structure</strong></td>
<td>Habitats should be designed to mimic native ecosystems (pattern and structure)</td>
<td>Biodiversity strategies typically emphasize native biodiversity. Structural design to mimic native ecosystem structure and their natural processes will improve habitat for native species. Since the above measures, plant species selection, and management for natural processes and functions such as shade levels, flooding, or soil types can be controlled in the design and planning phase; these are the best indicators of eventual biodiversity. Therefore, the IBP measures the potential value of habitat for biodiversity, not overall biodiversity itself. Targets for variety of habitat types are also included.</td>
</tr>
</tbody>
</table>

The above categories of habitat attributes represent the major themes assessed in the IBP. Metrics have been developed for each based on various planning contexts and they can also be calibrated based on individual site or regional conditions.
Ecosystem Mapping:
How do we determine which ecosystem attributes and species to encourage, and how the landscape pattern can best support biodiversity and ecosystem function? We often target native ecosystems adapted to the site as benchmarks for desired ecological performance of built environments. Oftentimes these ecosystems do not currently exist on a site, but were once present in the site’s historic natural state. In the United States, this is often called the “pre-European settlement” condition. (However, climate change is beginning to drive new thinking as to which ecosystems should be targeted for areas that may experience new climates in the near future.)

We often begin with a multi-scale understanding of the landscape through a process of ecosystem mapping. Ecosystems are often defined as “volumetric units of land and air plus organic contents extended spatially over the earth’s surface for a certain time.” Information available digitally, including aerial photography, topography, hydrology, vegetation, climatic or land cover data, can be combined with ground truthing, to create basic ecosystem maps for any site. These maps serve as a valuable tool to help understand the ecology and biodiversity of a site and organize ecological design opportunities. Ecosystem mapping is often performed at multiple spatial scales, from regional to local, in order to understand the nested hierarchy of processes and patterns operating across the site.

Regional/City Scale - To understand the existing ecosystem and biodiversity context at the regional scale, including priority species or communities, regional ecosystem, vegetation or species richness maps, and an examination of the landscape ecological relationships, including an assessment of the habitat patch/corridor mosaic, is essential.

Site Scale - Designed ecosystems and habitat within communities can take many forms. The structures may closely resemble native ecosystems established through ecological restoration or they may be more architecturally designed native plant landscapes that meet both aesthetic and biodiversity goals. Individual sites should work together within a broader community ecosystem strategy.

Beyond - Ecosystems and native biodiversity can also provide educational, recreational, and aesthetic benefits, and can be an important element to foster conservation behavior. This may be especially important in urban areas, where opportunities to experience nature are increasingly limited.

Ecosystem maps help to identify these opportunities and shape initial urban form ideas for a site. Our goal is often to prioritize, preserve, and enhance a network of ecological corridors, patches, or stepping stones through a community or landscape that fits within a broader regional ecosystem mosaic.
biodiversity value. Establishing target habitat types requires input from local experts and stakeholders in order to capture key regional or local priorities.

- **Pattern of preserved and proposed habitats** including connectivity of habitat “patches” (sometimes called “cores”) and “corridors,” and spatial criteria for size, shape, and spacing of habitat areas. Because few standards exist for size, shape and configuration of habitat areas within urban contexts, we define performance metrics based on an assumed “keystone” structural or process attributes of local ecosystems or infrastructure elements including: native forest canopy width and height; edge effects for key indicator species; a natural process such as dispersal mechanisms or flood regimes; or typical widths of habitat connectivity “barriers” including roads or sidewalks. Many of the metrics are based on the widely accepted principles of landscape ecology and conservation biology presented in *Landscape Ecology Principles in Landscape Architecture and Land-Use Planning* (Dramstad et al. 1996).

The IBP primarily uses two sets of performance metrics for typical community planning projects, one for **Major Open Space areas** and another for **Developed Area Landscapes**. Two sets are used because habitat functions, community benefits, and landscape approaches between these types of areas can be functionally quite different. Major Open Space areas tend to provide larger more contiguous habitats and higher functioning ecosystems, providing a more significant

### Contributing Factors to Biodiversity Loss

**Thousand Oaks Civic Arts Plaza, Thousand Oaks, CA**

Climate change and habitat loss are now two of the most significant threats to biodiversity. As many reports and scientific papers have shown, the loss, degradation and alteration of habitat are the primary factors responsible for the rapid decline in numbers of native biota and landscapes worldwide. Well entrenched trends in urban growth, industrial agriculture and forestry practices, and increases in land intensive infrastructure continues to threaten biodiversity across the globe. These activities directly impact species and bisect remaining habitat into lower performing fragments.

#### Climate Change

While it is critical for the world to become more committed to and effective at limiting climate change, some climate change is now inevitable. Even with mitigation measures in place, there is an immediate need to plan and implement adaptation measures to deal with existing and projected changes in climate. As some ecosystems and species are especially vulnerable to climate change, there is an immediate need to reconsider conservation priorities and strategies.

Climate change is increasingly driving biodiversity loss, affecting both individual species and their ecosystems. When climate conditions change, species respond according to climate tolerances and may adapt in place, or they may disperse into new suitable locations if landscape connectivity allows. It is difficult to predict the overall result of changes in the biodiversity, therefore many leading experts are promoting new precautionary conservation strategies designed for uncertainty.

#### Landscape Ecology

Landscape ecology is the study of patterns and processes in the landscape. Intact, well-connected ecosystems are believed to be more likely to be resilient to climate change and other threats, and planning for biodiversity restoration and conservation aimed at reducing ecosystem damage and fragmentation will also help to limit its impacts. It will be increasingly necessary to enable the movement of species to new geographical locations through landscape ecology approaches to conservation design. Radical ideas such as assisting the migration of species to newly suitable environments may also need to be considered. The risks and likelihood of unexpected consequences must also be taken into account.
<table>
<thead>
<tr>
<th>Developed Area Landscape: X = “keystone” ecosystem measurement (calibrated at 6 m based on assumed average native forest tree canopy radius); Y = keystone spacing measurement (calibrated at 10 m based on assumed average street width)</th>
<th>Score</th>
<th>Score</th>
<th>Score</th>
<th>Score</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Pattern:</strong> Habitat patch area (patches are roughly less than 2x as long as wide)</td>
<td>any size</td>
<td>&lt;(2x)^2 sq meters</td>
<td>&lt;(3x)^2 sq meters</td>
<td>&gt;x^2 sq meters</td>
<td>No scores of 5 allowed in developed area landscapes</td>
</tr>
<tr>
<td><strong>AND</strong></td>
<td><strong>AND</strong></td>
<td><strong>AND</strong></td>
<td><strong>AND</strong></td>
<td><strong>AND</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Pattern:</strong> Patch separation</td>
<td>any separation</td>
<td>All patches &lt;x^2 sq meters and &gt;Y meters from another patch of an IBP score &gt;1 or; If patch is between x^2 and (2x)^2 sq meters and &gt;2Y meters from another patch of an IBP score &gt;1</td>
<td>If patch is &lt;x^2 sq meters and &lt;Y meters from another patch with IBP score &gt;2, or; If patch is between x^2 and (2x)^2 sq meters and Y-2Y meters from another patch with IBP score &gt;2, or; If patch is (2x)^2 sq meters to (3x)^2 sq meters and patch separation &gt;2Y meters from another patch with an IBP score &gt;1</td>
<td>If patch is between x^2 and (2x)^2 sq meters &lt;Y meters from another patch with IBP score &gt;3, or; If patch is (2x)^2 sq meters to (3x)^3 sq meters and patch separation &lt;2Y meters from another patch of any IBP score</td>
<td>No scores of 5 allowed in developed area landscapes</td>
</tr>
<tr>
<td><strong>AND</strong></td>
<td><strong>AND</strong></td>
<td><strong>AND</strong></td>
<td><strong>AND</strong></td>
<td><strong>AND</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Structure:</strong> Types of habitat allowed to achieve score (plant lists, landscape structural guidelines developed for each type by the planning team)</td>
<td>Non-native landscape: levels 1 or 2</td>
<td>Native restoration OR Native architectural landscape: level 1, 2, or 3 OR Non-native landscape: level 1</td>
<td>Native restoration OR Native architectural landscape: level 1 or 2</td>
<td>Native restoration; OR Native architectural landscape: level 1</td>
<td>No scores of 5 allowed in developed area landscapes</td>
</tr>
<tr>
<td><strong>AND</strong></td>
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<td><strong>AND</strong></td>
<td><strong>AND</strong></td>
<td><strong>AND</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Structure:</strong> Balance of habitat types</td>
<td>deviation from target % type mix native architectural landscape deviation from target % type mix native restoration</td>
<td><strong>AND</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

This sheet represents a sample of the scoring rules used in the IPB for habitat PATCHES in developed areas. “Keystone” measurement variables (X and Y), score thresholds for each IBP score level, and target habitat types are calibrated by the planning team based on local ecological and urban context. Scenario measurement and scoring is assessed using a combination of GIS and Excel-based tools. Other scoring rule categories used in the IBP include habitat CORRIDORS in developed area landscapes, and rules for PATCHES and CORRIDORS in larger community and regional open space.
contribution to regional biodiversity. In Developed Area Landscape, where habitats may be smaller, more fragmented, and more architectural in character, scoring metrics are adjusted accordingly. Some value may also be added for smaller habitats in developed areas that may be of higher socio-cultural value because of improved awareness of nature can result in improvements in conservation behavior. Two other sets of metrics have also been developed for Elevate Greenery (habitat on green roofs) Regional Open Space Networks, which may also be applicable in certain situations.

For large development projects or municipal plans, IBP score targets can be developed for each parcel of the project, land use type, or different districts or land use zones. Depending on the scope of the project, this may or may not include detailed parcel design to achieve habitat score targets. If design will occur in later development phases, or if the project will develop a municipal biodiversity policy, the parcel or district-level IBP targets and detailed IBP scoring rules can be used as design guidelines or codes.

At the planning level, IBP scores are determined by using a combination of basic GIS analysis and Excel-based calculations. For measurement of detailed designs, hand measurement may be most convenient for smaller projects, and a GIS-based pattern assessment tool (currently under development) can streamline the measurement of larger project areas. The diagram above and on the following pages describe some of the IBP scoring rules and implications.
Conceptual section diagrams of landscape types and IBP scores for open space and developed areas (Singapore case study)
Potential calibration of IBP scoring for corridor and patch size and spacing thresholds (Singapore Case Study)
For native habitat "restoration" areas, long term habitat targets may take decades to achieve through careful planting design and ongoing management. A phased approach to establishment of native ecosystems may be proposed, as in the case of primary forest establishment through a 70-year “successional” phasing strategy for a project in Singapore (above). This may seem like a long time to wait; however, such a long-term vision is necessary to maximize biodiversity and provide a dynamic, evolving, environmental legacy with enduring value.
In 2008, Portland Metro (Portland, OR, USA) held the “Integrating Habitats” design competition. Participants created habitat design strategies for a number of typical land uses across the City. The AECOM team examined a typical city block and developed the strategy on the following page. IBP measurements were performed to evaluate performance between the existing condition (below) and final concept (next page).
The AECOM entry, “Growing Together,” took the People’s Choice award and second place overall. The IBP assessment indicated more than a 100% improvement in biodiversity potential from the existing condition. Despite more than doubling the human population density. A key lesson of this case study is that biodiversity enhancement and density increases can be accomplished simultaneously. Integrating habitats into urban areas may become more important as the world’s population becomes more urban and overall cultural connections with nature widen.
**IBP Scoring Caveats**

As described, the IBP may provide the best indication of a difference in biodiversity potential between alternative scenarios for the same site. Comparing scores of different projects on different sites, especially across different regions (i.e. a project in Singapore vs. a project in Canada) is possible, but may require additional calibration steps and supporting research. The IBP could be very effective for comparing projects within, or as a guideline for broad scale biodiversity planning within a city or region if a regional calibration process was performed with key stakeholders, leading to a replicable IBP assessment methodology for projects within the area. This calibration would include standardized network sizing thresholds, priority areas, target habitat types, preservation targets, etc.

**IBP Continued Development**

We are excited to promote wider application of the IBP as a tool for prioritizing and comparing project biodiversity performance. No universal rating system currently exists for assessing the performance of biodiversity strategies for communities, and to our knowledge, no other projects have attempted to quantitatively assess biodiversity strategies at this level. Therefore, this work is unprecedented in many ways. Currently, many of the metrics, thresholds, and assumed performance benefits are not supported by focused scientific studies, but instead are based on sound scientific principles (primarily in the disciplines of landscape ecology and conservation biology); relevant supporting science, when possible; our experience on other projects and project analogs done by others; and consideration of native ecosystems as previously discussed. The last section of this document discusses some key case studies that helped to inform the development of the IBP.

IBP Applicability: The IBP is currently most suited for comparing alternatives for a single site. Regional calibration could allow effective use at the city or regional scale to compare projects within or between regions.
Precedent Biodiversity Planning Approaches

Tools to measure and evaluate biodiversity within planning and design projects are critical for targeting and evaluating options to optimize performance. Incorporating biodiversity metrics into development is a complex process because of the structural interplay of landscapes and land uses and the complexity of the interactions with biodiversity. Developing conservation and implementation strategies for increasing biodiversity within the urban framework requires a great understanding of the landscape’s structural and functional needs of species, including the important spatial element of ecological networks and methods to combat the adverse affects of fragmentation.

AECOM’s research into the current availability of biodiversity planning tools within development contexts yielded few precedents. The majority of research conducted has been within the realm of landscape ecology and conservation biology, and has focused largely on conservation in areas void of development or on specific protected species, rather than for comprehensive biodiversity or ecosystem preservation. Urban biodiversity tools tend to provide qualitative, policy guidance rather than specific guidelines or metrics for assessing design performance. The Singapore Index of Cities’ Biodiversity is a tremendous example of how a policy level method can be developed for implementing strategies to achieve national targets by engaging regional and local authorities. The scaled approach (from national to local) is key to achieving measurable results.

For valuable examples of how comprehensive biodiversity performance may be considered and measured see:

- Natural Capital Project
- Matrix Matters: Biodiversity Research for Rural Landscape Mosaics
- UK Forestry Commission
- Biodiversity in Fragmented Landscapes
- Evaluating Biodiversity in Fragmented Landscapes: Applications of Landscape Ecology Tools
- ASLA Sustainable Sites Initiative
- Living Building Challenge
- Convention on Biological Diversity
- International Association for Landscape Ecology
- California Natural Communities Conservation Planning
- Landscape Ecology Principles in Landscape Architecture and Land Use Planning
- Portland Metro Nature in Neighborhoods

Singapore Index of Cities’ Biodiversity

The Singapore Index of Cities’ Biodiversity is a tremendous example of developing a comparative method for implementing strategies to achieve national targets by engaging regional and local authorities. The Index is focused primarily on the evaluation of existing ecological conditions and policy level activities within cities and towns; however, the approach can be used as a framework when planning for desired landscape conditions and habitat connectivity.

The Singapore Index of Cities’ Biodiversity was an important consideration in developing the IBP. However, we found that the Index was not suitable to quantify and compare biodiversity design scenarios on smaller project sites. Therefore, one of our goals in developing the IBP was to create an approach for biodiversity design oriented projects that may fit within a broader framework, including the Singapore Index.

For additional information see:

http://www.cbd.int/authorities/gettinginvolved/cbi.shtml
Case Studies

The following five case studies include some of the latest exemplary biodiversity programs. The unique planning and ecological contexts of each of these projects led to a wide variety of approaches to biodiversity planning. Each considers biodiversity across scales from regional to site and provides valuable lessons for planning, design, implementation, and ongoing management of biodiversity in the built environment. Additional detail for each case study is provided in the “biodiversity plan implementation spectrum” matrix located at the end of the section.
As part of the Olympic Park Master Plan, AECOM created a Biodiversity Action Plan (BAP) to ensure that biodiversity was included in all aspects of the plan for the Olympic Park. The BAP is an overarching policy document intended to guide biodiversity within the 230-hectare Olympic Park.

In 1992, the UK government established the UK Biodiversity Partnership Standing Committee, which supports the implementation of the UK Biodiversity Action Plan. BAPs are now required as part of the planning process. BAPs are conducted at national, regional, city, and borough levels. The Olympic Park BAP was not mandatory, but was a planning obligation designed to ensure that biodiversity was considered throughout the project by all participants.

The BAP was created during the master planning phase. The idea is that every aspect of the planning, construction, and design of the Olympic Park incorporate the directives in the BAP.

Released in October 2008, the main goals of the BAP are to: (1) “Establish targets and provide guidance on how to create habitats, encourage species and generally enhance biodiversity through the Olympics to Legacy Transformation phase in 2014.” (2) “Outline actions and set measurable targets for the establishment and conservation of selected habitats and species of conservation concern.” (3) “Provide the method and means for monitoring, measuring and reporting on the action plans.”

The BAP has two major sections: the Habitat Action Plan (HAP) and the Species Action Plan (SAP). The HAP proposes several habitat conditions, with the goal of creating at least 45 hectares of new habitat by 2014, including built environment (0.40 ha); parks, squares, and amenity space (1.67 ha); allotments (1.04 ha); brownfield habitats (5.05 ha); species-rich grassland (23.69 ha); trees and scrub (10 ha); wet woodland (0.90 ha); rivers (0.27 ha); reedbed (1.80 ha); and ponds (0.18 ha). The SAP outlines key protected species that need to be incorporated and considered within specific habitat(s) on site.

The relationship between the species and their ideal habitats helped determine the location and size of these habitats. The BAP outlines two phases to create the habitat areas: 1) Olympic phase: during the Olympics, the habitat acreage will be lower than the targeted 45 hectares because of the space need to accommodate guests, athletes and events. By 2012, the wetlands will be created, but most of the terrestrial habitats will not. 2) Legacy phase: after the Olympics, the remaining habitats will be created by 2014.

References:
UK BAP http://www.ukbap.org.uk
Lea Valley Regional Park BAP http://www.leevalleypark.org.uk/en/content/cms/about_us/environment/biodiversity_plan/biodiversity_plan.aspx
London BAP http://www.lbp.org.uk/londonap.html
Local BAPs http://www.ukbap.org.uk/GenPageText.aspx?id=57
Prairie Crossing Master Planned Community  
Chicago, Illinois, USA

From an interview with Mike Sands, Executive Director of the Liberty Prairie Foundation

Prairie Crossing was one of the first built green master planned communities in the United States. The project includes 395 dwelling units, a mixed use village center, a community center and foundation, an organic farm, and many other outstanding community amenities. It was built on former agricultural fields that contained very little native biodiversity. Historically—pre-European settlement—the 240 ha site contained native tallgrass prairie ecosystems and oak savanna. These ecosystems have become widely celebrated in the region and are increasingly being restored through efforts including the Chicago Wilderness Regional Biodiversity Recovery Plan. The Prairie Crossing master plan included preserving 60% of the land as permanent open space, 50% of which was restored to native tallgrass prairie and wetland ecosystems. Homes were also sold with lots containing 30% to 70% native prairie landscape.

There were no regulatory drivers that required restoration of the native biodiversity at Prairie Crossing, and the choice to restore these ecosystems was because it fit with the envisioned community identity. Consideration of landscape ecology and “biopermeability” (i.e., creating habitat connectivity and corridors for flora and fauna; creating large patches; and restoring native ecosystem structure and processes) were important factors in locating habitat areas and community design. One goal was to create connectivity with a 4,000 acre protected area to the east of the site and a proposed protected area to the west.

Replicating the pattern and structure of the presettlement ecosystem (native tallgrass prairie) was the benchmark/target for habitat areas and native plant landscapes. No specific measurements of native species are tracked; however, performance of the open space areas is measured in terms of the presence or lack of invasive species.

It was important that strategies and measures be understood by homeowners for them to support biodiversity management initiatives through their Home Owner Association (HOA) fees. The idea of managing native landscapes to control invasive species is well understood and received, and the HOA allocates a budget for consultants to develop habitat area work plans, set annual goals and targets, and organize volunteers. The homeowners and HOA are in charge of managing habitat areas over time, not the developer, so it is essential that design measures, management activities, and performance targets can be understood and implemented by the educated consumer.

Planning and Design Team: Applied Ecological Services (AES)
For more information see:
Chicago Wilderness Regional Biodiversity Planning Authority: http://www.chicagowildness.org
Chicago Wilderness Regional Biodiversity Recovery Plan, Biodiversity Climate Action Plan, etc: http://www.chicagowildness.org/resources.php
Prairie Crossing Homepage http://www.prairiecrossing.com
Tuxedo Reserve is a 1,200 acre AECOM masterplanned community located in Tuxedo, New York within the larger, ecologically rich Hudson River Valley. The many wetlands, forests, and vernal pools on the site have driven the methodology, which includes detailed impact studies on amphibian migration patterns, for masterplan layout. The concept of habitat connectivity and species richness was a major influence in defining the open space network with the community. The plan preserves 80% open space for habitat and recreation which ties together the diverse neighborhoods.

Tuxedo Reserve met or exceeded all of the necessary State and Federal baseline environmental standards and has integrated innovative techniques for managing ecological processes within the community development framework. Regional plans, including the Hudson River Estuary Wildlife and Habitat Conservation Framework and the Biodiversity Program for the Hudson River Estuary Watershed, were utilized to help Tuxedo Reserve fit within the larger conservation efforts of the region. At the site scale, landscape guidelines were adopted to ensure appropriate vegetative coverage and species selection on residential lots and in the public realm to create viable habitat and low maintenance requirements.

Biodiversity at Tuxedo Reserve was measured against the baseline, pre-development forest condition dominated by Appalachian Oak-Hickory and Northern Appalachian, and Hemlock-Pine-Northern Hardwood forest communities. Biodiversity metrics were focused on a rigorous salamander (the “keystone species” for the project) migration and population study. This study set a baseline for wetland and vernal pool richness that will be measured against throughout construction and post occupancy of the community.

A strong environmental ethic has been embedded within the creation of community planning documentation and the HOA. Management of the open space will be conducted by the HOA and will be volunteer driven through a citizen scientist program. The goal of this approach is to empower community members, foster understanding of natural processes, and promote a high level of caring for their local environment.

For more information see:
New York Natural Heritage Program:  http://www.acris.nynhp.org
Habitat Vulnerability Assessment in the Hudson Valley:  http://www.gap.uidaho.edu/bulletins/13/smith.htm
Dos Lagos is a 220 ha master planned community located in the Los Angeles Metro Region. With the Region’s combination of high development pressure and location within one of the 20 global biodiversity hotspots, Dos Lagos was subject to some of the most aggressive conservation regulations anywhere in the world. The Western Riverside Multi-Species Habitat Conservation Plan (MSHCP) was developed as a regional strategy for the preservation of 150 target species over 500,000 hectares. While the plan focuses on these specific species of concern, it simultaneously assists in mitigating future impacts to other species and protecting regional biodiversity as a whole. Dos Lagos falls within several priority “criteria cells” of the MSHCP and was required to include a rigorous preservation and restoration program. The project includes extensive preserved sensitive habitats. The project included the restoration of a major water course through a former gravel mining area on-site as mitigation for other anticipated impacts. Restoring habitat connectivity along this watercourse, as well as preserving habitat connectivity across the site, were important priorities for the MSHCP and the project.

Development with each MSHCP criteria cell was required to achieve a range of preservation depending on how well the project design preserved priority habitats. Native plants and preserved old growth oak trees were used within the new community on private parcels.

The MSHCP has strict measurement protocols for compliance, which are administered by the MSHCP governing agency. Developer compliance is monitored by the MSHCP governing agency even after project buildout. Because the MSHCP operates across such a large region with numerous projects, it has a well-established protocol for implementation that developers can follow. MSHCP compliance is a rigorous and costly process that requires many consultants, legally binding agreements, integrated ecological master planning and design, and ongoing management and monitoring by the community.

For more information see:
Western Riverside Multi-Species Habitat Conservation Plan: http://www.rcip.org/conservation.htm
Dos Lagos: http://doslagos.net
Biodiversity in the Built Environment

Edge management and vegetation transition are important considerations at the interface of the three vegetation zones. In particular, the edges between the native plant communities zone and the historic forest and landscape vegetation management zones require careful attention. The greater the zone edge of native plant communities relative to the zone area the more difficult it is to manage the zone. Also, it is important to be especially aware of design at the edge of habitats in focal areas—they must look cared for.

The Presidio is truly a dynamic living landscape, and management approaches are constantly being tested and adapted. The area, especially the historic forest, is of extremely high value to the San Francisco community and changes to convert some of the forest to habitat have required a long process of education and incremental change. A long-term monitoring program will allow evaluation of the success of native plant community enhancement and restoration projects. Procedures exist for collecting information include regular sampling, data analysis, periodic vegetation mapping, and the establishment of permanent transects and photopoints in native plant communities. The Presidio's exemplary biodiversity is a testament to their success at leveraging the site's ecological opportunities, careful management of the entire landscape for biodiversity (not just the natural areas), and balancing cultural and natural landscapes that receive broad appreciation by the residents and visitors to San Francisco.

For more information see:
Oasis in the City - Video Documentary: http://www.youtube.com/presidiosf
The following matrix provides an inventory of how each project addressed biodiversity planning across scales ranging from regional to site. The unique planning and ecological contexts of each of these projects led to a wide variety of approaches to biodiversity planning.

<table>
<thead>
<tr>
<th>Biodiversity Plan Implementation SPECTRUM</th>
<th>Jurong Lake District</th>
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<th>Tuxedo Reserve, New York</th>
<th>London Olympics</th>
<th>Prairie Crossing, Illinois</th>
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</thead>
<tbody>
<tr>
<td>Regional Biodiversity Policy</td>
<td>Endangered/ Legally Protected Species Policy</td>
<td>X Legal protections</td>
<td>Federal Endangered Species Act and Habitat Conservation Plans; California Endangered Species Act and Natural Community Conservation Planning Act; Federal and State Law (TBD if area plan, i.e., HCP, etc for the area exists)</td>
<td>Western Riverside Multi Species Habitat Conservation Plan (MSHCP) (plan for 20+ species)</td>
<td>X Federal and State Law</td>
<td>X Endangered Species Act</td>
</tr>
<tr>
<td>Regional Scale</td>
<td>Singapore Index of Cities' Biodiversity establishes a framework</td>
<td>X Not specifically addressed</td>
<td>Not specifically, but by default the MSHCP addresses a broad spectrum of biodiversity and ecosystem patterns and processes that are associated with the 20+ focus species</td>
<td></td>
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<tr>
<td>Regional Physical Habitat Plan in Place</td>
<td>NParks is working on a regional physical plan for biodiversity</td>
<td>X Golden Gate National Recreation Area General Management Plan (expected completion of update in 2011) - will not supersede the Presidio Vegetation Management Plan</td>
<td>MSHCP has regional network of priority &quot;cells&quot; with specific preservation requirements</td>
<td>Hudson River Estuary Wildlife and Habitat Conservation Framework</td>
<td>X UK Biodiversity Action Plan, London Biodiversity Action Plan, Local Biodiversity Action Plan</td>
<td>Chicago Wilderness: Biodiversity Recovery Plan, Annual Progress Reports</td>
</tr>
<tr>
<td>Regional Enhancement Plan</td>
<td>NParks is working on a regional physical plan for biodiversity</td>
<td>X Golden Gate National Recreation Area General Management Plan (expected completion of update in 2011)</td>
<td>Regional restoration programs exist, unsure of details</td>
<td>Biodiversity Program for the Hudson River Estuary Watershed</td>
<td>X Regional restoration priorities emphasize restoring habitat connectivity and priority habitats/ species</td>
<td>Chicago Wilderness: Biodiversity Recovery Plan, Annual Progress Reports</td>
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<tr>
<td>Community Master Biodiversity Program/ Performance Targets Developed</td>
<td>Preservation plan</td>
<td>SSIM process included preservation strategy and set targets for preservation</td>
<td></td>
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<td></td>
<td>The site had no native ecosystems at the time of purchase.</td>
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<td></td>
<td>Enhancement plan</td>
<td>Enhancement to provide a 25% increase in “biodiversity potential” from pre-project condition</td>
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<tr>
<td></td>
<td>Preservation areas</td>
<td>Preservation areas identified</td>
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<td></td>
<td>New habitat creation strategy</td>
<td>Specific amounts of landscape to be designed for use as native plant landscaping/restoration have been identified for each parcel across the community</td>
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<td></td>
<td>Community-scale habitat network strategy</td>
<td>Landscape ecology and connectivity quantitatively measured to inform locational guidelines for habitat enhancement areas</td>
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**Community Scale**

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**Presidio of San Francisco**

- Vegetation Management Plan
- Presidio Trust Management Plan
- Must comply with MSHCP guidelines for the site.
- Negotiated with Department of Fish and Game.

**Dos Lagos, Riverside County, CA**

- Vegetation Management Plan - does not manage the concept of biodiversity
- Mitigation was required by Fish and Game due to impacts.
- Landscape Guidelines were created to restore and enhance public area and on-lot habitat

**Tuxedo Reserve, New York**

- Vegetation Management Plan, Presidio Trust Management Plan
- Landscape Guidelines were created to restore and enhance public area and on-lot habitat

**London Olympics**

- London Olympics Biodiversity Action Plan (BAP)
- Areas beneficial for habitat connectivity with adjacent neighboring (off-site) habitat areas were preserved for future enhancement

**Prairie Crossing, Illinois**

- 60% of land preserved in open space, 50% of which was restored as native ecosystems. Historic (pre-European Settlement) tallgrass prairie and native wetlands were the target ecosystems. 30%-70% of private landscapes were also designed as native prairie.
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<tr>
<td><strong>Preservation guidelines</strong></td>
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<tr>
<td>pending</td>
<td>Parcels with preservation requirements have been identified</td>
<td>Vegetation Management Plan - Preservation guidelines provided for specific plant species or fauna habitat</td>
<td>Preservation strategy is community scale, individual parcels have no restrictions</td>
<td>Specific preservation areas designated for priority species</td>
<td>Protected areas identified</td>
<td>NA No preservation areas exist on private parcels</td>
</tr>
<tr>
<td><strong>Enhancement guidelines</strong></td>
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</tr>
<tr>
<td>pending</td>
<td>All sites in the project required to include relevant level of native plant landscaping for biodiversity</td>
<td>Vegetation Management Plan - Enhancement guidelines provided for specific plant species or fauna habitat</td>
<td>Enhancement only occurring in major open space area along the river and in preservation area.</td>
<td>All sites in the project required to include relevant level of native plant landscaping for biodiversity</td>
<td>Legally binding, specific guidelines for biodiversity enhancement on parcels</td>
<td>X</td>
</tr>
<tr>
<td><strong>Integration with community habitat network strategy</strong></td>
<td>pending</td>
<td>Sites that provide better connectivity awarded the opportunity to provide less land area as habitat if they choose</td>
<td>Community scale measures only</td>
<td>Community scale measures only</td>
<td>X</td>
<td>Yes, connectivity encouraged</td>
</tr>
<tr>
<td><strong>Detailed Landscape plans for parks, open space and developed areas</strong></td>
<td>pending</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td><strong>Biodiversity in plant species selection</strong></td>
<td>pending</td>
<td>Native plan landscapes that meet biodiversity criteria area required to meet community targets</td>
<td>The Presidio Native Plant Nursery - supplies plant material needed for native plant community restoration, as well as historic forest restoration</td>
<td>Encouraged but not mandatory, except in mitigation areas in open space</td>
<td>No specific species selection for the open space only on-lot and right of way landscapes</td>
<td>Specific targeted species/habitats identified and required per parcel</td>
</tr>
<tr>
<td></td>
<td>X</td>
<td>X</td>
<td>X</td>
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