Cities and the Environment (CATE)

Volume 13
Issue 1 *The Science and Practice of Managing Forests in Cities*

Article 38

3-2024

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Recommended Citation

von Behren, Christa (2024) "Developing a Protocol for Assessing Natural Area Function in Portland, Oregon," *Cities and the Environment (CATE)*: Vol. 13: Iss. 1, Article 38.
DOI: 10.15365/cate.2020.130138
Available at: https://digitalcommons.lmu.edu/cate/vol13/iss1/38

Developing a Protocol for Assessing Natural Area Function in Portland, Oregon

The Revegetation Program at the City of Portland Bureau of Environmental Services aims to use active adaptive management to steward natural areas in our portfolio, but we have lacked an adequate monitoring protocol to effectively implement this approach. We spent three years developing and testing a functional assessment protocol to assess progress toward management goals and to infer performance of different ecological functions. We completed our first data collection during the field season of 2022.

Keywords

urban forested natural areas, practitioner notes, urban forests, urban ecology, assessment, Portland OR

CONTEXT

The Bureau of Environmental Services (BES) manages sewer and stormwater for the City of Portland. Protection and enhancement of natural areas is one strategy BES uses to regulate stormwater quantity and meet water quality goals. The Revegetation Program (Reveg) stewards natural areas on both public and private property in riparian zones, wetlands, and some upland areas to meet bureau objectives. Beyond stormwater management, there are multiple goals that drive management actions on natural area sites, including habitat for different animal species, vegetation resilience in the face of climate change and urban pressures, community wellbeing, and equitable delivery of services to all Portlanders. We aim to use an active adaptive management approach to preserve and enhance ecosystem functions in a time of rapid climate change and increasing development pressures. While assessment and monitoring are crucial to this approach, we have lacked a protocol that can adequately evaluate progress toward multiple goals and performance of different functions on natural areas across habitat types.

GOAL

Our goal was to develop an assessment protocol for our natural area sites that would:

- Evaluate metrics that can provide meaningful information about various ecosystem functions;
- Allow for change to be detected in those metrics over a period of about five years;
- Be sufficiently rapid to realistically fit into busy work schedules;
- Be sufficiently repeatable to allow for consistency across different data recorders and over time;
- Work across habitat types;
- Produce results that can be used for reporting progress to stakeholders.

APPROACH

We worked backward from broad natural area goals to select metrics that contribute in a definable way to those goals. Our main goals were water quality protection, animal habitat, vegetation resilience, and environmental health, human safety, and public relations. For each goal we determined functions that could be linked to vegetation and environmental metrics. We call these functions subgoals (Table 1).

Next, we determined metrics that would provide meaningful information about subgoal functions. We reviewed existing assessment protocols and conducted literature searches on vegetation and environmental characteristics that affect these functions. After deciding what characteristics to measure we had to decide how to measure them (visual estimation, phone apps, densiometers, stem counts, etc.), balancing our desire for detail with the need for the protocol to be rapid. We had to choose from different metrics that give slightly different information about subgoals. For example, to learn about stream shading we could measure overall canopy cover, canopy cover on the south side of a water body, and size of canopy gaps, or use GIS shade models. We also had to decide how much data to collect for each management unit (habitat type within a natural area).

BES Reveg staff spent the 2020 and 2021 field seasons testing and revising the protocol. We evaluated different metrics for ease of measurement, repeatability, and time required. Once we decided which metrics to include, we had to determine the appropriate level of precision for each metric. For estimating percent cover, we considered Daubenmire classes but decided that it would be too difficult to see change over time with this method. For example, an increase in a cover type from 10 to 25% may be ecologically significant, but the Daubenmire class would remain unchanged. While a small increment, such as recording to the nearest 5% cover, would show ecologically significant changes, the level of error in estimation and variation among ecologists would make this increment inaccurate and imprecise.

TABLE 1: Management goals, subgoals, and related assessment metrics.
Each management goal was broken into two or more subgoals that are functional in nature. Metrics to assess subgoals were determined. Individual metrics can relate to multiple subgoals.

GOAL: WATER QUALITY	
Subgoal	**Metrics**
Rainwater interception	Canopy cover: total, evergreen/deciduous, height class
	Percentage trees with vine cover and extent of cover
	Woody stem density in different size classes
	Graminoid, forb, fern, woody, vine, litter, and bare ground cover (<1m)
	Downed wood, snags, and brush pile density
Water retention	Canopy cover: total, evergreen/deciduous, height class
	Woody stem density in different size classes
	Graminoid, forb, fern, woody, vine, litter, and bare ground cover (<1m)
	Downed wood, snags, and brush pile density
Shading water bodies	Canopy cover: total, evergreen/deciduous, height class
Erosion control	Canopy cover: total, evergreen/deciduous, height class
	Woody stem density in different size classes
	Graminoid, forb, fern, woody, vine, litter, and bare ground cover (<1m)
	Downed wood, snags, and brush pile density
	Tree/shrub/herbaceous species richness

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TABLE 1, cont'd

GOAL: HABITAT FOR TARGET ANIMAL SPECIES	
Willow Flycatcher	Vegetation requirements for each species, loud noise frequency, human management issues
Western Painted Turtle	
Northern Red-Legged Frog	
Other amphibians	
Band-tailed pigeon	
Pileated Woodpecker	
White-breasted Nuthatch	
Yellow-breasted Chat	
Bats	
Insect pollinators	
GOAL: VEGETATION RESILIENCE	
Climate change	Canopy cover: total, evergreen/deciduous, height class
	Woody stem density in different size classes
	Graminoid, forb, fern, woody, vine, litter, and bare ground cover (<1m)
	Tree/shrub/herbaceous species richness
	Presence of earthworms
Emerald ash borer	Ash cover in different height classes
	Canopy cover: total, evergreen/deciduous, height class
GOAL: ENVIRONMENTAL HEALTH, SAFETY, AND PUBLIC RELATIONS	
Equity	Potential for using ITECK
	Cultural resources present
Fire	Canopy cover: total, evergreen/deciduous, height class
	Woody stem density in different size classes
	Graminoid, forb, fern, woody, vine, litter, and bare ground cover (<1m)
	Downed wood, snags, and brush pile density
	Human management issues
Urban heat island	Canopy cover: total, evergreen/deciduous, height class

KEY RESULTS

- Our final protocol contains 23 metrics at the level of the management unit. An additional 32 metrics are evaluated in one-to-three 1/100th–acre plots nested within management units. The number of plots is determined by management unit size. The plots are randomly placed and are not permanent.

- There are some included metrics that are unique to our assessment. When choosing metrics, we stayed focused on a mechanistic link to our goal functions. For this reason, we did not include questions about species origin. While dominant species are recorded, we do not estimate percent cover of native and non-native vegetation, as we could not determine a way that this characteristic affects our functional goals. We do include questions about climbing vines, all of which are typically non-native in our sites—though the native poison oak (*Toxicodendron diversilobum*) occurs occasionally—because of the structural effects

of these vegetation types. We could not find an adequate metric in other protocols for describing the coverage of these vines on trees, so we developed our own rating system. Because of the impact that earthworms can have on soil properties, we include presence/absence of earthworm evidence. Additionally, one of our program's goals is to provide opportunities for harvest of first foods and materials by indigenous Portlanders, as well as education and practice of indigenous stewardship methods. In our assessment protocol we have included questions on the suitability of different management units for these activities.

- Field season 2022 was our first year of data collection with the new functional assessment protocol. In the first two data collection seasons, we surveyed 49 management units across 18 natural area sites, totaling 148 acres. We have a goal of assessing all management units in our portfolio once every five years.

- Of the 49 assessed management units, 22 were forested, giving us a snapshot of our forested sites. Ten units were in upland mixed deciduous/coniferous forest, nine in wetland or riparian forest, and three in oak woodland. Total canopy cover averaged 63%, and across forest types canopy was dominated by deciduous species (Table 2). Data showed some structural differences across forest types, particularly between upland and riparian forests. These differences generally concur with our expectations for these forest types based on differences in disturbance and hydrological regimes. Upland mixed deciduous/coniferous forests had the highest mean overstory canopy cover and the lowest midstory cover. In contrast, riparian forests had the lowest overstory canopy cover and highest midstory cover. Most groundcover categories varied little across forest types, though graminoid cover was notably lower in mixed deciduous/coniferous upland forests than in the other forest types (Table 2). Tree and shrub species richness also varied little across forest types (Table 3).

TABLE 2: Mean cover of different vegetation categories across forest types.
Cover data were collected in 1/100th acre circular plots in 2022 and 2023 in 22 forested management units.

Cover Type (%)	Riparian	Upland	Oak Woodland	All Forest
Total canopy >1m	58	72	62	63
Overstory canopy >5m	49	69	49	55
Evergreen overstory canopy >5m	4	19	5	8
Deciduous overstory canopy >5m	48	50	47	49
Ash overstory canopy >5m	12	9	1	10
All midstory canopy 1-5m	46	32	35	41
Evergreen midstory canopy 1-5m	4	20	5	7
Deciduous midstory canopy 1-5m	44	22	28	35
Graminoid groundcover <1m	31	11	38	25
Forb groundcover <1m	22	21	17	21
Woody groundcover <1m	20	24	21	21
Fern groundcover <1m	4	8	17	6
Leaf litter <1m	15	18	11	16
Bare ground <1m	9	6	2	7

TABLE 3: Tree and shrub species richness across forest types.
The number of tree and shrub species making up at least 5% absolute or relative cover was recorded for each management unit surveyed.

Vegetation Type	Riparian	Upland	Oak Woodland	All Forest
Trees	4	5	6	5
Shrubs	6	7	6	6

OPEN QUESTIONS

- From our first two years of data collection, we learned that the ways in which some of our data are collected and stored make analysis difficult. We are using the ESRI Survey123 smartphone application to record data in the field. The benefits of this program are that it is relatively simple to set up and modify ourselves, it is easy to share data among practitioners, and it maps survey points in ArcGIS online. However, it can be difficult to extract data from the program in a useable format. We plan to consult with database experts at the City to determine whether this is the best program to use.

- Our current protocol does not include an assessment of landscape-level features, including edge properties, forest connectivity, or proximity to water or other natural features. A protocol to assess these features is in development and will be included in future years.

- BES, like many similar organizations, is moving toward an asset management framework for natural areas. As part of this process, Reveg is being asked to score the sites in our portfolio. For our own active adaptive management purposes, we have chosen to explicitly avoid assigning overall scores to natural areas or management units. As sites and project goals are so variable, we did not think we could come up with an overall site score in a way that would have any ecological meaning or utility for our management. However, to meet broader bureau goals, we will be using the functional assessment data to determine whether sites are meeting specified levels of service. We have not yet determined a process for this.

- It is not yet clear how well we will be able to see change over time in various metrics. While we have extensively field-tested the protocol and selected intervals for recording data that we believe will allow us to detect meaningful change over a five-year period, we cannot evaluate our success until we have done repeat collections at our sites in 2027.