Natural Resource Inventory Update

vegetation mapping project

City of Portland Bureau of
Planning & Sustainability
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project description

The vegetation mapping project originated in 2004 as the Bureau of Planning & Sustainability was developing a new automated GIS model to inventory landscape features that contribute to riparian and upland natural resource values and functions. The inventory will update Portland's existing significant natural resource inventories and their related programs (e.g., environmental overlay zoning, Willamette Greenway, etc.)

Initially the GIS model was developed and tested using the regional vegetation map layer digitized by Metro from 2000 aerial photos. During the model testing phase it became apparent that this regional data was not sufficient to support Portland's inventory. A more detailed, precise, and comprehensive map of vegetation was necessary for analysis at the local scale.

The key goals of the vegetation mapping project include:

› refine the location of vegetation "patches" — the patch *geometry* — of areas previously mapped by Metro;

› incorporate vegetation maps generated by other agencies — such as Portland Parks and Recreation and the Portland Bureau of Environmental Services — and refine and improve that information where necessary;

› map vegetation patches meeting Portland's criteria for inclusion in the natural resource inventory — a ½ acre minimum patch size versus the 1 to 2 acre patch size used by Metro for the regional dataset;

› map all vegetation within a ¼ mile of a surface stream, wetland, or regionally significant habitat resources included in Metro's inventory;[1]

› classify the vegetation into four NVCS[2] classes — forest, woodland, shrubland, and herbaceous;

› further classify vegetation as either "natural/semi-natural" or "cultivated";

› update, refine and improve vegetation map annually as new aerial images become available.

In June of 2004 the Bureau of Planning & Sustainability began mapping vegetation based on information from reference data sources including 2003 aerial photos and 2002 multi-spectral

[1] Significant regional resources mapped by Metro as part of their Goal 5 mapping process. Adopted by the Metro Council in September of 2001. Upland resources included resource classes A, B, and C. For more information, contact Metro's Long Range Planning Office.
[2] "National Vegetation Classification System" developed by the Nature Conservancy for classifying terrestrial vegetation (Grossman *et al.*, 1998).

imagery. The map has been updated in subsequent years, using new aerials, to incorporate changes in vegetation since the original mapping. The mapping area includes all land within the City of Portland and the unincorporated parts of Multnomah County that are administered by the City of Portland.

The Bureau of Planning & Sustainability is also conducting limited field surveys to confirm the existence, location, and correct classification of vegetation patches. Field crews employed global positioning system (GPS) technology and digital photography to document the presence and/or location of different classes of vegetation where this information could not be confidently derived from available GIS reference sources (such as aerial photos).

The vegetation mapping project has been a collaborative effort involving Portland's Bureaus of Planning, Parks and Recreation, Environmental Services, and Corporate GIS. Metro also participated in the project by supplying data and advice on mapping protocols. An effort was made at the beginning of the project to acquire all mapped vegetation information developed by each agency for internal use. This information was combined into a single, regional vegetation dataset that served as a starting point for the mapping project. The vegetation dataset has been made available to all City bureaus and to Metro for their use. We are hoping to regularly update the dataset and keep the vegetation information accurate and current.

The following report provides a brief description of the project status, the vegetation mapping methodology, and the data sources used as reference. For a detailed description of the vegetation GIS data, please refer to the online metadata at http://www.portlandonline.com/cgis/metadata/viewer/display.cfm?Meta_layer_id=52135&Db_type=sde&City_Only=False.

project status

The initial mapping and classification of vegetation patches has been completed. The data will be updated each year as new aerial photos are made available. The following chart shows how much vegetation has been mapped as of **January 21st, 2009**:

Bureau of Planning Vegetation Mapping Project
Acres of vegetation in Portland and the County pockets

	previously mapped[1]		***currently mapped[2]***		***change in acres***	
	natural	cultural	natural	cultural	natural	cultural
forest	16,573	0	15,137	0	(1,436)	0
woodland	375	0	1,230	2,666	855	2,666
shrubland	406	0	896	53	490	53
herbaceous	2,962	0	1,970	5,316	(993)	5,316
total by category	*20,317*	*0*	*19,233*	*8,036*	*(1,084)*	*8,036*
totals		*20,317*		*27,269*		*6,952*

Notes:
[1] *previously mapped* vegetation refers to Metro's regional vegetation map layer digitized from 2000 and 2002 aerial photos.
[2] *currently mapped* vegetation refers to the Bureau of Planning & Sustainability vegetation map as of the date above.

methodology

The starting point for the vegetation mapping project was the 2000 regional vegetation map developed by Metro. More accurate vegetation information available for select areas around the City was incorporated into the regional dataset, superseding Metro data for these locations. This information includes vegetation maps created by the Bureau of Parks and Recreation for all of the natural area parks and habitat maps created by the Bureau of Planning & Sustainability for areas along the Willamette River and Columbia Rivers. All editing is performed in ESRI's ArcGIS 9 using custom tools developed by the Bureau of Planning & Sustainability.

The following is a summary of the vegetation mapping and classification methodology.

1) Mapping Area

All areas within a ¼ mile of a surface stream, wetland, or regionally significant habitat resource included in Metro's inventory were reviewed and remapped as necessary (Figure 1). The mapping effort is focused on areas that meet the following criteria:

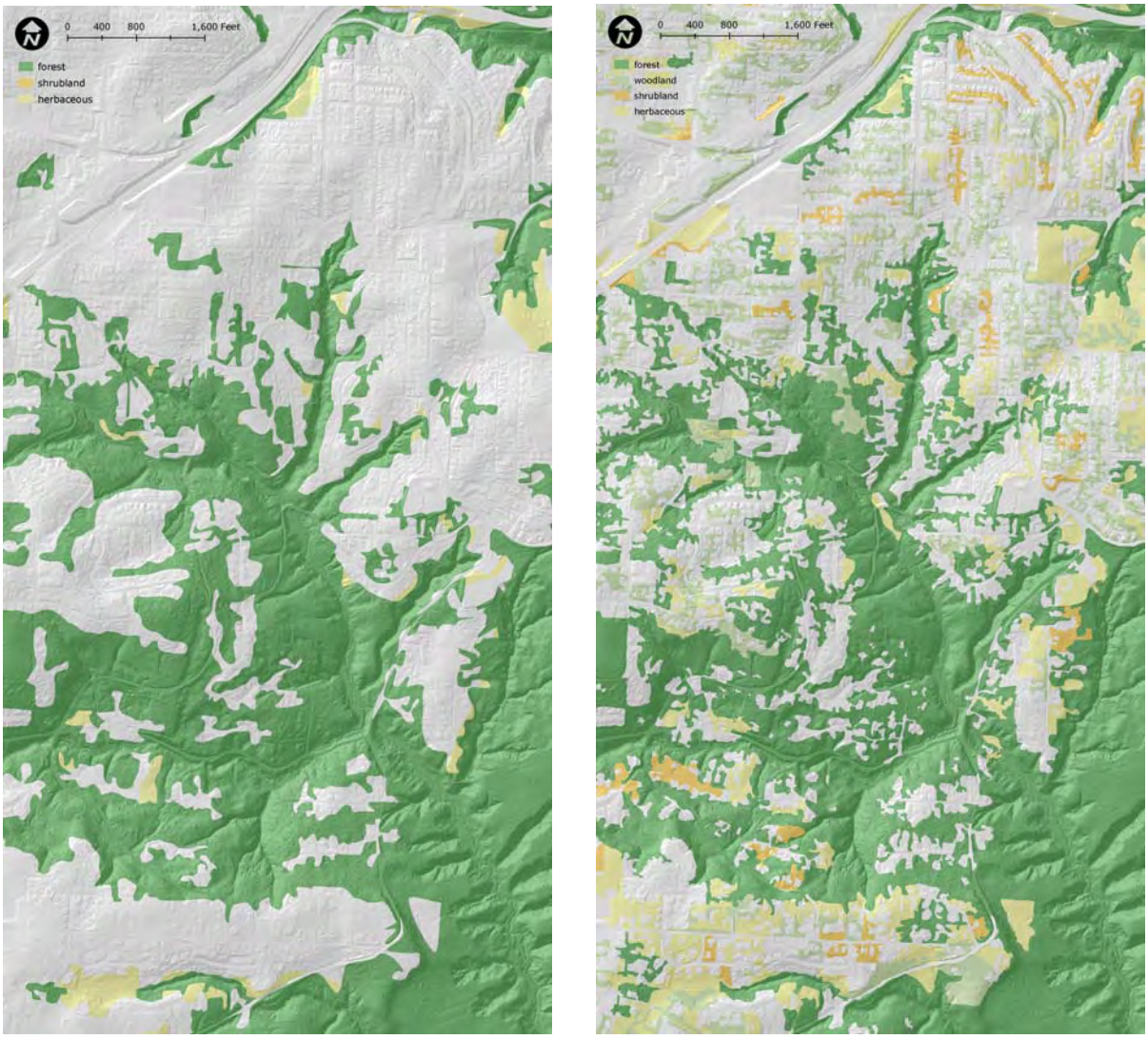
- Located with 300 feet of a river, stream/drainageway or wetland. Contiguous vegetation that begins within and extends beyond 300 feet from a river, stream/drainageway or wetland is mapped to its full extent;
- Comprised of forest vegetation and/or wetlands, at least 2 acres in size, plus any additional, adjacent woodland vegetation;
- Located within a current environmental overlay zone (e.g. c, p);
- Identified by Metro as regionally significant riparian corridor or wildlife habitat.

2) Vegetation Patches

City of Portland 6" resolution aerial photos are the primary reference sources for identifying vegetation patches. Other reference sources include Metro vegetation maps, LiDAR data, Portland Parks natural area assessments, and river habitat maps (refer to "Reference Data Sources" for more information).

For the purposes of this project, a vegetation patch is defined as:

> **Vegetation Patch**: *an area of contiguous vegetation greater than ½ acre in size containing a distinct pattern, distribution, and composition of vegetation relative to surrounding vegetated and non-vegetated areas (Figure 2).*



Original Vegetation Map Revised Vegetation Map

Figure 1. Comparison of original and revised vegetation map.

Figure 2. Example of a vegetation patch.

2) Vegetation Patch Classification

a) Vegetation Class

The National Vegetation Classification System (NVCS) was derived by The Nature Conservancy (TNC) for the purpose of classifying properties for conservation purposes. The broadest level of the NVCS contains seven classifications: forest, woodland, shrubland, dwarf-shrubland, herbaceous, nonvascular and sparse vegetation.

For the purposes of this project, aerial photos were the primary reference for classifying vegetation patches into the following four NVCS classes (Grossman *et al.*, 1998) [3,4]:

Forest: *Trees with their crowns overlapping, generally forming 60-100% of cover.*

Woodland: *Open stands of trees with crowns not usually touching, generally forming 25-60% of cover. Tree cover may be less than 25% in cases where it exceeds shrubland and herbaceous vegetation.*

Shrubland: *Shrubs generally greater than 0.5 m tall with individuals or clumps overlapping to not touching, generally forming more than 25% of cover with trees generally less than 25% of cover. Shrub cover may be less than 25% where it exceeds forest, woodland, and herbaceous vegetation. Vegetation dominated by woody vines (i.e., blackberry) is generally included in this class.*

Herbaceous: *Herbs (graminoids, forbs, ferns and shrubs less than 0.5m tall) dominant, generally forming at least 25% of cover. Herbaceous cover may be less than 25% where it exceeds forest, woodland and shrubland vegetation. This includes shrubs less than 0.5 m tall.*

Figure 3 shows examples of each class. For more examples, refer to “appendix 1 | image supplement” at the end of this document. Note that the 0.5 m height as a determination of class is difficult to apply consistently when using aerial photos as the primary reference source. Calculating the exact height of shrubs and low-structure vegetation in a patch is not possible without field verification, Vegetation heights were therefore estimated by comparing the shadows cast with those of nearby features such as trees and houses. This is not possible in all areas. Therefore, the shrubland class tends to be applied to areas with larger, woody shrubs more easily visible on the current aerial photos.

[3] For the purpose of this project, the dwarf-shrubland class described by the NVCS is classified as herbaceous given there is no accurate way to distinguish small shrubs from grass and other low-structure vegetation on the aerial photos.
[4] Nonvascular (e.g. moss and algae) and sparse vegetation were not mapped. The NVCS defines sparse vegetation as areas with a predominance of boulders, gravel, cobble, talus, consolidated rock and/or unconsolidated material.

b) Vegetation Subgroup

Each vegetation patch was further classified into either “natural/semi-natural” or “cultivated” NVCS subgroups based on the following definitions (adapted from Grossman *et al.*, 1998):

> **Natural/Semi-Natural Vegetation**: *Natural vegetation is that which appears to be unmodified by human activities, occurring spontaneously without regular management, maintenance or planting. Semi-natural vegetation has a composition or structure that has been sufficiently altered by anthropogenic disturbances such that it no longer has the characteristics of natural vegetation assemblages found in comparable conditions the watershed. However, semi-natural vegetation is self-maintaining without significant human maintenance or management. This type of vegetation may be dominated by either native or non-native species.*

> **Cultivated Vegetation**: *Vegetation that is consistent with traditional landscaping and is highly manicured and regularly (annually, semi-annually or more frequently) managed and maintained. Cultivated vegetation is often dominated by turf grasses and ornamental shrubs and trees. Cultivated vegetation typically has low species and structural diversity. It is assumed that cultivated areas are managed using a combination of mowing, pruning, fertilizers and pesticides. Residential yards, common areas, golf courses, parks and rights-of-way are included in this management class. In areas where agricultural land uses occur, cultivated fields and orchards are also included.*

Figure 4 shows examples of the two NVCS subgroups. For more examples, refer to “appendix 1 | image supplement” at the end of this document. Most vegetation, particularly within an urban setting, has been subjected to human disturbance. Even where these impacts are apparent, if the patch appears to be self-sufficient and displays patterns consistent with uninhibited and un-maintained growth, the patch is identified as natural/semi-natural.

It is important to note that though natural/semi-natural areas may be dominated by native species, they need not be. An example of this would be a patch of Himalayan blackberry. Though these plants are not naturally-occurring in the Portland area, they are not generally planted or maintained and they distribute naturally, so they are mapped as a natural/semi-natural vegetation patch. The subgroup distinction is based on the pattern of plant distribution within the patch and the patch’s proximity to human features (such as houses and park infrastructure) rather than the type of vegetation present in the patch (which is often unknown).

Vegetation that has been planted as part of a restoration or enhancement project, includes a predominance of native vegetation, and is managed as a natural area, is classified as “natural/semi-natural.” While this type of vegetation is often routinely managed for multiple years, it is managed to create a more naturalistic vegetation assemblage that supports an array of ecologic functions.

Also note that forest vegetation is always designated as semi-natural/natural. This is appropriate because forested areas are dominated by trees which provide significant ecologic functions, such as

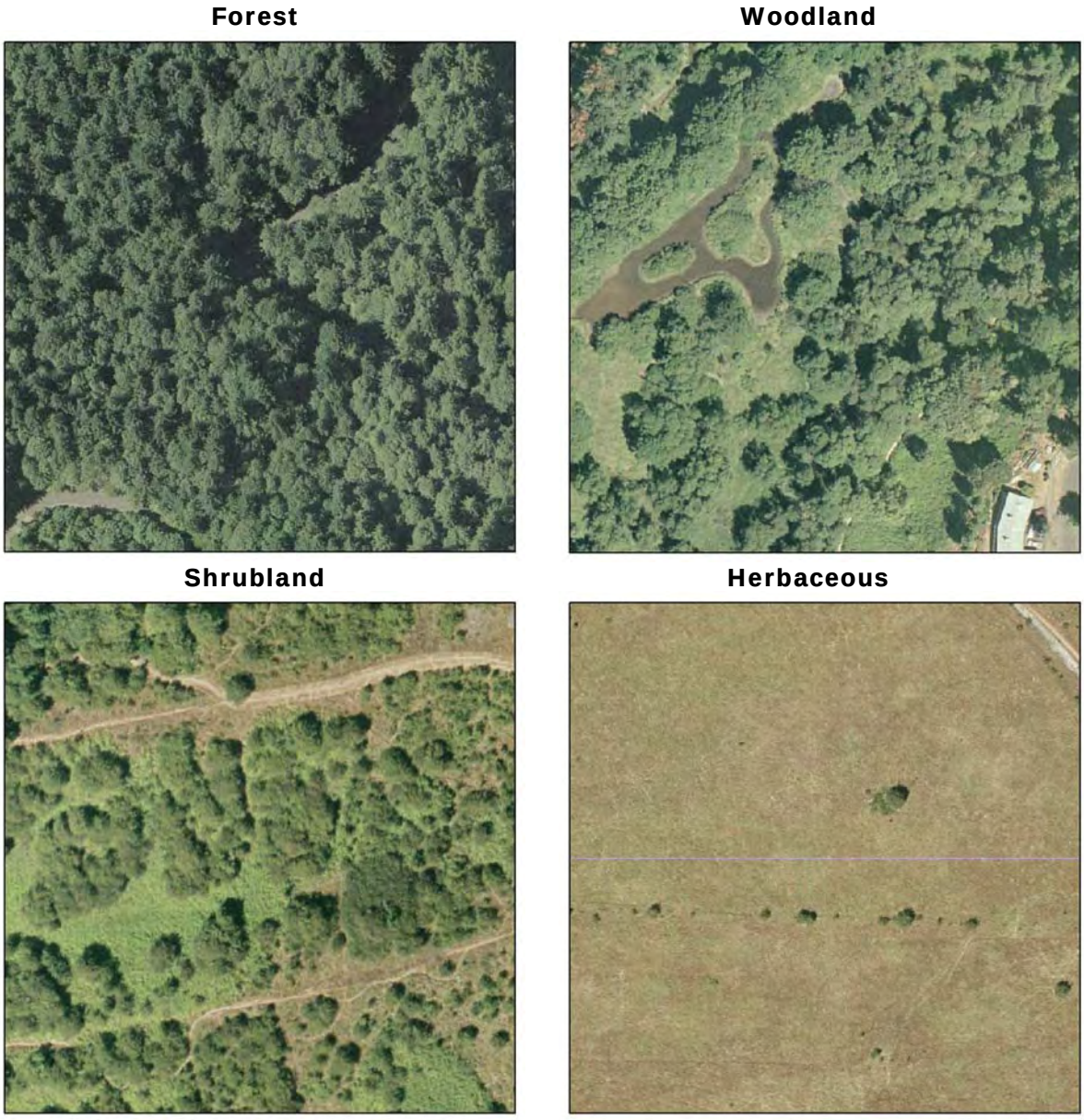


Figure 3. Examples of each of the four NVCS vegetation classes.

Natural/Semi-Natural **Cultivated**

Figure 4. Examples of the two NVCS subgroups.

rainwater capture, nutrient uptake, organic inputs, wildlife cover, etc. In addition, the forest canopy itself is not regularly maintained.

Figure 5 summarizes the vegetation classification process.

4) General Mapping Protocol

Vegetation patches are mapped using the following protocol:

1. *Understand the landscape and general character of the vegetation*. At a scale of 1:8,000, which is approximately a quarter section, the general distribution and character of vegetation is observed. Other land use (e.g. residential, commercial) patterns are noted.

2. *Look at previously mapped vegetation patches*. Still at a scale of ~1:8,000, the previously mapped patches are reviewed to determine where refinements may be necessary. The patch should be refined if:

    - There are different patterns, distributions or character of vegetation included within the patch boundary;
    - Vegetation of the same character and patterns as adjacent vegetation is not included in the patch;
    - Patches that are not mapped to the smallest appropriate unit. For example, if a 4-acre area is mapped as woodland, but there are distinguishable ½-acre areas of herbaceous vegetation, then the herbaceous vegetation should be mapped as a separate patch;
    - In some cases, the boundary of a patch may be accurate but the vegetation type has changed. For example, a woodland patch may have developed into a forest patch.

3. *Refining and creating patches*. At a scale of approximately 1:3,000, distinct patches are mapped. This process includes both creating new patches and refined previously mapped patches.

    Below are the steps for refining and creating patches:

    i. First, vegetation that meets the forest or herbaceous NVCS classification is mapped. The guidelines to map forest vegetation patches are as follows:

        - A 4-lane road or highway splits a forest patch. Roads with less than 4 lanes split a patch where the road is clearly visible (i.e., no overhanging canopy). Where large vegetated areas located on two sides of a street are connected via a single tree overhanging the street, the two patches should be mapped separately;

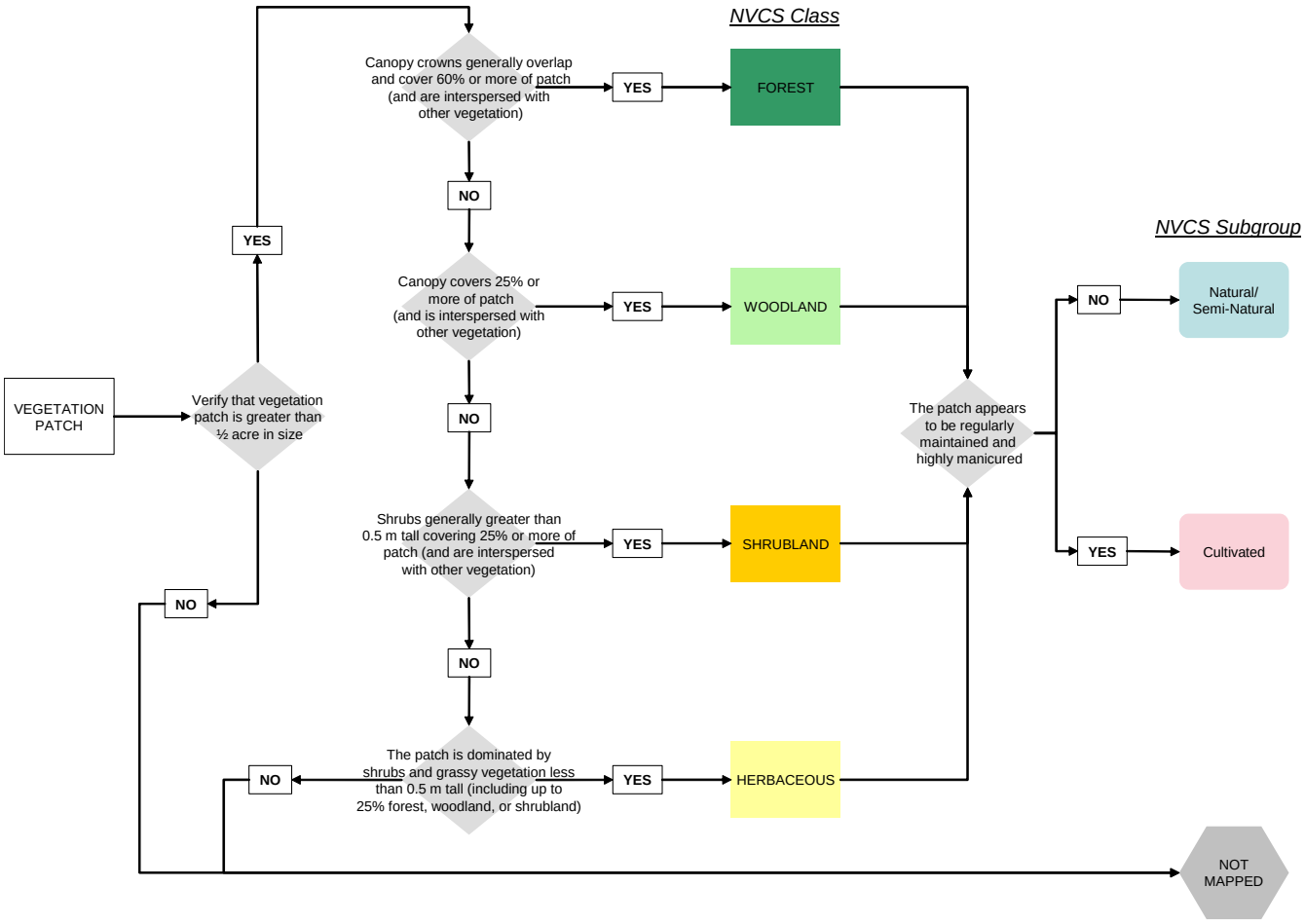


Figure 5. Summary of the vegetation classification process.

- A narrow section of a forested area, which is one or two trees wide, can create a break between patches, provided that the two resulting vegetated areas are large enough to meet the ½ acre threshold;
- A significant change in character, even when the vegetation type and distribution is similar, can create a natural break between two forest patches. For example, a break between areas would likely occur where there is a significant shift from closed forest canopy with very few buildings or impervious area, to a primarily developed area with thin strips of trees between structures and yards. In this situation the closed forest canopy with few building/impervious would be a separate patch from the thin strip of trees that extends away from it.

The guidelines to map herbaceous patches are:

- When an area of predominantly herbaceous vegetation contains a narrow area of trees or shrubs located along its perimeter, and the trees do not meet the ½ acre criterion, the trees or shrubs should be included within the boundary of the herbaceous patch;
- When an area of predominantly forest, woodland or shrubland vegetation has a narrow area of herbaceous vegetation located along its perimeter, and the herbaceous vegetation does not meet the ½ acre criterion, the herbaceous vegetation should not be included within the boundary of the patch;
- Within developed areas, highly managed herbaceous vegetation that is fragmented or separated from larger vegetated areas by buildings, driveways, parking areas, etc. is generally excluded. The intent is to include larger structure vegetation when appropriate.

ii. Second, woodland and shrubland vegetation is mapped. There is a range of vegetation that meets woodland and shrubland vegetation classifications and often the differentiation is not clear. The following guidelines are used to differentiate between woodland and shrubland vegetation:

- Trees within a woodland patch generally make up about half the land cover but do not create significant closed canopy. The understory could be shrubs or herbs or sparsely vegetated; native or non-native;
- The trees should be distributed across the patch;
- When a vegetation contains relatively minimal canopy coverage (e.g. 25-30%) and the character of the vegetation doesn't appear to be woodland (e.g. intensely managed turf grass understory with very few, non-consolidated trees and shrubs), the patch should be classified as herbaceous vegetation;

- Shrubland vegetation should have a predominance of shrubs throughout the patch. Trees and grass may be present, but should occur throughout less than half the patch.

iii. Third, the vegetation management classification of semi-natural/natural or cultivated, is determined as follows:

- Forest is always classified as natural/semi-natural;
- Cultivated areas typically include yards, landscaped areas around buildings, golf-courses, ball parks and soccer fields, and rights-of-way. These areas are intensely managed and typically include turf grass and ornamental shrubs and trees. These areas generally lack structural diversity (e.g. sparse trees interspersed across lawn);
- Irrigated areas are usually, but not always, classified as cultivated. Other indicators, such as structural diversity, are used to determine if irrigated areas should be classified as semi-natural/natural;
- Semi-natural/natural vegetation is typically, but not always, found around rivers, streams and wetlands and in parks and natural areas. However, semi-natural/natural vegetation can be found in yards, around buildings, and adjacent to ball parks and soccer fields. These areas typically include a mix of trees, shrubs and grasses that do not appear to be mowed, pruned or otherwise treated. The vegetation may be dormant in the summer due to lack of irrigation;
- Areas maintained to restore a more natural vegetation pattern are considered semi-natural. These areas may be managed to remove invasive plant species and irrigation may occur;
- Topography is used to help differentiate between areas that are cultivated and areas that are not. Very steep areas are not typically cultivated.
- In cases where a patch meets one vegetation type, but two management types are present, the patch is split to differentiate between the management types.

iv. Finally, visible, non-vegetated areas (e.g. buildings, bare soil) are excluded or removed from vegetation patches as necessary using the following guidelines:

- Visible buildings, driveways, parking areas are removed from vegetation patches;
- Vegetation that overhangs a non-vegetated area (e.g. a driveway) is included within the vegetation patch;
- Areas of bare soil, gravel, rocks are removed from a vegetation patch when the area is greater than ¼ acre in size;
- Large trails (5' wide or more) visible on the aerial photos are not included in the vegetation patch.

4. *Reassess the general pattern and distribution of vegetation*. Returning to a scale of 1:8,000, the general pattern, distribution and character of vegetation is assessed based on the refined vegetation patches.

4) Field Survey Methodology

Project staff visited properties owned by the public and privately-owned properties where vegetation patch was visible from public right-of-way. Field crews used visual assessment and, when GPS-satellite coverage was available, GPS data collection.

Field crews carried copies of a standard field visit form for notes and sketches, and a map with 6"-resolution aerial photographs of the vegetation patch and the surrounding area. All notes and maps for a particular field visit were scanned and stored in Acrobat PDF format. Digital photos of the patch were also taken in some cases. All digital documentation and photos are available from the Bureau of Planning & Sustainability.

reference data sources

The following sources were used as the main reference data for determining the presence and/or location of vegetation patches:

Source:	**City of Portland Aerial Photos**
Created By:	Varies; refer to metadata
Data Format:	Geo-referenced TIFF images
Date of Acquisition:	2007 aerials – July 12 - August 28, 2007 2006 aerials – June 23-27, 2006 2005 aerials – July 3 & 4, 2005 2004 aerials – July 21, 22, 24, 2004 2003 aerials – July 18 & 19, 2003 2002 aerials - August 2002
Description:	Natural color ortho-rectified digital imagery. All photography has been rectified to adjust for curvature of the earth. Photo resolution for all years is 6".
Notes:	Data is viewable for specific properties via www.portlandmaps.com
Metadata Reference:	http://geode.metro-region.org/metadata/index.cfm?startpage=main.cfm?db_type=rlis (listed by aerial year)

Source:	**City of Portland LiDAR data**
Created By:	Varies; refer to metadata
Data Format:	Geo-referenced ERDAS Imagine images
Date of Acquisition:	West Hills/Columbia Slough – March, 2005 All other areas – March/April, 2007
Description:	A 3-foot rasterized digital elevation model (DEM) and digital surface model (DSM) of all Portland area LiDAR point returns collected and processed to date.
Notes:	Average vertical accuracy +/- 6"
Metadata Reference:	none currently available

Source:	**2002 Multispectral Image Classification**
Created By:	City of Portland Bureau of Environmental Services/Bureau of Planning & Sustainability
Data Format:	ERDAS Imagine 8.7 images
Date of Acquisition:	June 1st to June 20th, 2002

Description:	Classified 4-band 1.1-meter multispectral image data for the Portland metropolitan area. Classes are vegetation, bare soil, impervious surfaces, and water. Refer to the metadata link below for a complete description of the methodology.
Notes:	Overall classification accuracy – 89.3% (Kappa 0.8443).
Online Metadata:	\\cgisfile\data\Images\Multi-Spectral\June_2002\Classified_Images\June_2002_Classification_METADATA.htm (metadata available to City of Portland employees only. Can be made available to outside parties upon request.)

Source:	**Parks Vegetation Assessment**
Created By:	City of Portland Bureau of Parks and Recreation
Data Format:	ESRI Shapefile
Date of Acquisition:	May 2003 through October 2004
Description:	Vegetation patches as digitized by Parks natural area assessment team using 2002 and 2003 aerial photographs. Patches were visited in the field by Parks technicians, data about the patch was collected and recorded, and patch geometry and classes were changed as necessary based on the field data.
Notes:	Please contact the City of Portland, Bureau of Parks and Recreation for more information about the natural area assessment.
Online Metadata:	None available.

Source:	**River Habitat Maps**
Created By:	City of Portland Bureau of Planning & Sustainability (original mapping done on contract with Adolfson and Associates, Inc.)
Data Format:	ESRI Shapefile
Date of Acquisition:	November 1999 through April 2000
Description:	Wildlife habitat areas along the Willamette and Columbia rivers. Habitat areas were defined as plant species and plant communities that support avian, mammalian, reptilian and amphibian species that use the riparian area. The boundaries of the habitat area were mapped using 1998 and 1999 aerial photos and field visits.
Notes:	Modified by City of Portland, Bureau of Planning & Sustainability using 2000 and 2001 aerial photos to refine the habitat boundaries and incorporate vegetation changes since the original date of acquisition.
Online Metadata:	None available.

Source:	**Metro 2000/2002 Vegetation**

Created By:	Metro
Data Format:	ESRI Shapefile
Date of Acquisition:	July 2000
Description:	This is a simple vegetation land-cover layer collected via interpretation of Metro's 2000 digital orthophotographs. Polygons were digitized around forest, woody non-forest vegetation, open space, and developed gaps. Forest land-cover types were delineated for the entire area within the Metro Service District and all sections within one mile beyond the District boundary. Woody non-forest vegetation and open space was delineated only within 300 feet of a mapped stream within the Metro Service District and all sections within one mile beyond the District boundary. Updated with 2002 aerial photos.
Notes:	Minimum patch mapping size used by Metro was 1 acre.
Online Metadata:	http://geode.metro-region.org/metadata/display.cfm?Meta_layer_id=1997&Db_type=rlis

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references

Grossman, D.H., D. Faber-Langendoen, A. S. Weakley, M. Anderson, P. Bourgeron, R. Crawford, K. Goodin, S. Landaal, K. Metzler, K. Patterson, M. Pyne, M. Reid, and L. Sneddon, 1998. *The National Vegetation Classification System: Development, Status, and Applications*. The Nature Conservancy, Arlington, Virginia, 139 p. (available online at http://www.natureserve.org/library/vol1.pdf)

appendix 1 | image supplement

This image supplement features aerial photographs of correctly mapped patches of each of the NVCS classes and subgroups used in the vegetation mapping project. It is intended a visual reference to complement the textual description of the vegetation mapping methodology contained in this document.

The primary goals of this supplement are:

› to help foster consistency and accuracy in future additions or modifications to the vegetation GIS data;

› to better illustrate the range of different types of vegetation that fall within each NVCS class and subgroup.

Each map shows a vegetation patch (outlined in yellow) and any surface streams present in the patch (in blue). A brief description of each map describes what the patch represents (NVCS class and subgroup) and why.

Figure 1. Cultivated Herbaceous Vegetation Patches

A. These patches are marked cultivated herbaceous due to proximity to roads and human activity.
B. The herbaceous patches in this cemetery are divided by paved roads and paths.
C. A backyard patch of herbaceous vegetation follows the edge of bordering woodland patches.
D. Geometric planting patterns are an indication of a cultivated vegetation patch.

Figure 2. Semi-Natural / Natural Herbaceous Vegetation Patches

A. This herbaceous patch is semi-natural/natural because it is unmaintained and near the river.
B. An unused lot allowed to grow with vegetation is marked semi-natural/natural.
C. This cleared area in the middle of a forest patch is semi-natural/natural herbaceous.
D. This herbaceous patch near new development remains undisturbed and contains a small pond.

Figure 3. Cultivated Shrubland Vegetation Patches

A. Rose beds in Washington Park constitute a cultivated shrubland patch.
B. Small trees in this vegetation patch may eventually meet cultivated woodland status.
C. Connected backyards over ½ acre form a cultivated vegetation patch.
D. This cultivated shrubland patch consists of highly manicured low hedges.

Figure 4. Semi-Natural / Natural Shrubland Vegetation Patches

A. This semi-natural/natural shrubland contrasts with nearby forest and herbaceous patches.
B. These shrubland patches are distinct from the surrounding herbaceous in this wetland area.
C. A stream runs along the center of this semi-natural/natural shrubland patch in Kenton.
D. A patch of cultivated shrubland lies adjacent to the south of this semi-natural/natural patch.

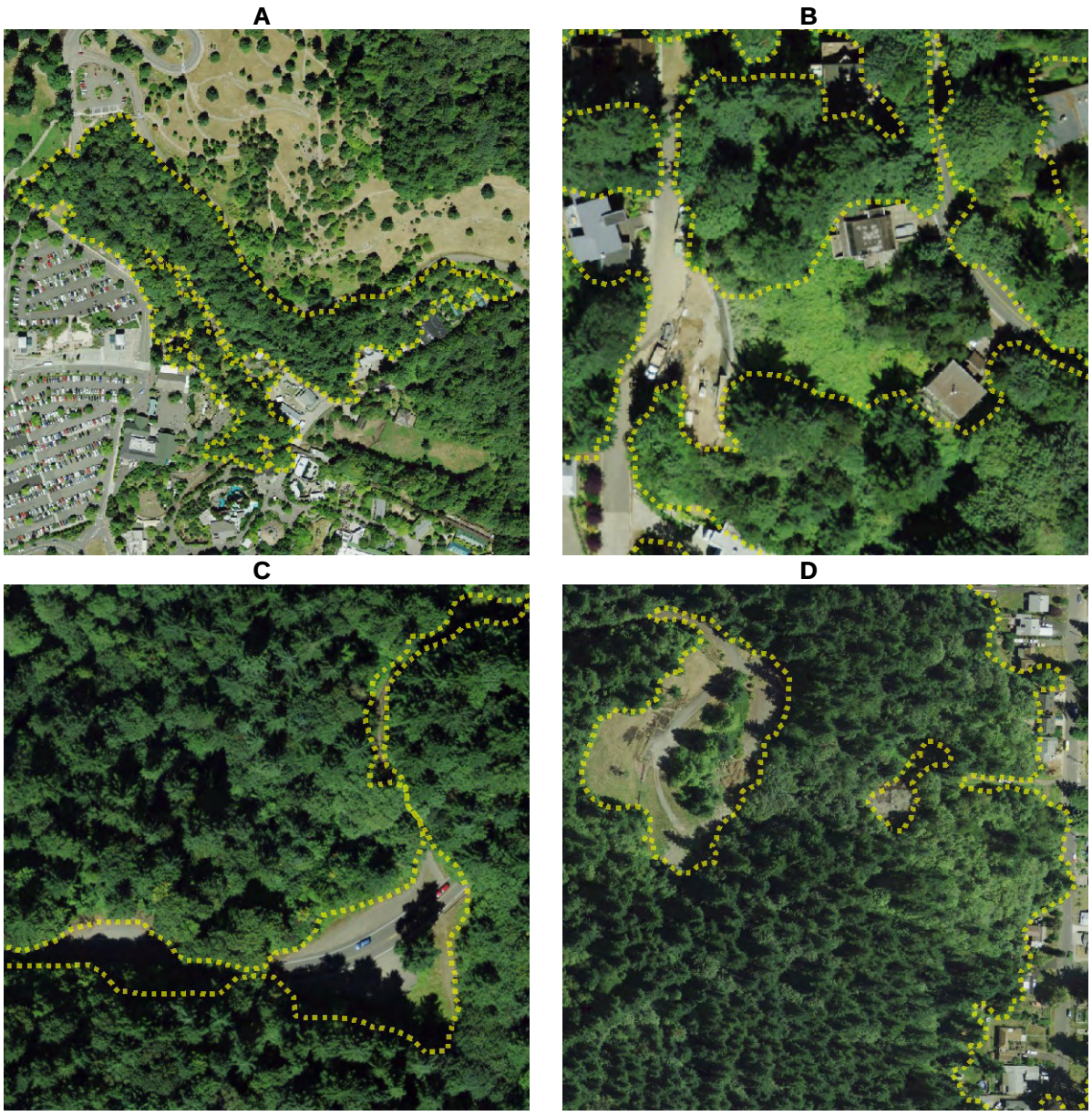
Figure 5. Cultivated Woodland Vegetation Patches

A. These cultivated woodland patches are composed of tree canopy that overhangs the street.
B. Vegetation in this golf course shows the distance woodland patches should connect or break.
C. Two cultivated woodland patches split from a forest patch as they reach into a residential area.
D. Tree canopies overlap in this residential area to form a cultivated woodland patch.

Figure 6. Semi-Natural / Natural Woodland Vegetation Patches

A. Semi-natural and natural woodland patches often border cultivated vegetation.
B. Many woodland patches are found along the borders of denser natural forest patches.
C. This natural woodland area lies between natural shrubland and forest patches.
D. This woodland patch borders cultivated herbaceous, but its interior is not maintained.

Figure 7. Semi-Natural / Natural Forest Vegetation Patches



A. Forest patches can be extensive and border many land use and vegetation patterns.
B. Forest patches should be broken and not connect across areas of lower vegetation.
C. Highways split forest patches when the tree canopy does not touch over the roadway.
D. Forest patches can be large enough to encircle smaller areas that lack vegetation.