A. Land Cover Mapping

This appendix briefly describes the process of creating the land cover map for the *Biodiversity Guide for the Greater Portland-Vancouver Region*. Land cover statistics are presented in Chapter 1, "Current Conditions," of the *Biodiversity Guide*.

Understanding land cover or vegetation patterns and their distribution on the landscape is an important part of identifying and prioritizing conservation opportunities. Having such information in a standardized, digital format allows for sophisticated modeling approaches that support data-driven decision making. The geographic scale at which the land cover mapping occurs determines the finest scale at which subsequent analyses of conservation value can occur. Put more simply, coarse-scale mapping efforts fail to capture habitat that exists at a finer scale, and unmapped habitat cannot be prioritized.

There is a direct tradeoff between data scale and the size of subsequent data sets. As landscapes are analyzed at a fine scale, data sets grow larger. Thirty-six 5-meter pixels fit into a single 30-meter pixel. As data sets get larger, more computing power and time are necessary, making some forms of analysis challenging or even impossible. For large geographic areas analyzed at a fine scale, the issue of database size becomes increasingly limiting. As a result, despite the existence of aerial imagery with 0.5-meter resolution or better, most regional mapping efforts have worked at a pixel size of 30 meters or larger, consistent with the resolution of Landsat Thematic Mapper (TM) satellite imagery. A 30-meter-resolution map is appropriate to address conservation efforts at a whole ecoregion or statewide scale. However, higher resolution is required to address the more localized conservation objectives in an urban environment that occur at a relatively fine scale.

In order to capture the finer scale land cover patterns of the greater Portland-Vancouver region, the *Regional Conservation Strategy* working group contracted with Portland State University's Institute for Natural Resources (INR) in 2011 to produce a land cover map of the greater Portland-Vancouver region at 5-meter pixel resolution (i.e., 25 square meters).

Land Cover

INR generated the initial land cover grids using a combination of 1-meter resolution LiDAR imagery (a laser based remote imaging technology that accurately measures the elevation and the height of objects), 1-meter 2009 National Agricultural Imagery Program (NAIP) imagery, and 30-meter Landsat TM satellite imagery. For areas of the region in which LiDAR was available (approximately 88 percent of the region), INR generated a 22-class land cover data set at a 4-meter resolution. Where LiDAR data were unavailable—mostly on the region's fringes, where land cover patterns occur in larger patterns—INR used Landsat TM satellite imagery and aerial photographs to create a 30-m, 10-class land cover grid. The first draft of the land cover map was created by combining these two data sets into a 5-meter land cover data set with 25 classes.

The resulting data were then augmented by the project team using a combination of modeling and hand digitizing from color and color infrared aerial photography. These steps allowed us to more fully distinguish land covers and land uses that computer-based approaches were unable to adequately distinguish among, such as bare ground, agriculture, and sand/cobble bars.

■ **Agriculture.** In order to successfully model conservation priority areas, we needed to be able to separate agricultural lands from other low-height vegetation classes (i.e., vegetation less than 13 feet tall), a task that the initial land cover did not attempt. The first draft of the land cover had 585,000 acres (32 percent of the region) combined into these low-vegetation classes. We analyzed various 30-meter land cover/vegetation data sets to see how we could accurately identify agricultural lands without writing over our more detailed land cover data (for example, the 30-meter data may not capture a narrow tree corridor that appears in the 5-meter data). We established rules based on elevation, patch size, and whether or not the patch occurred inside or outside urban growth boundaries/areas. Both modeled and manual techniques were used to create the agriculture class. Patches of low vegetation outside urban areas, below 600 feet, and greater than 2 acres in size were reclassified as agriculture. Within urban areas, patches larger than 4 acres were manually examined and reclassified where appropriate. Above 600 feet, polygons larger than 4 acres were manually classified. Through these processes we were able to reclassify 75 percent (440,000 acres) of low vegetation classes as either agriculture or clear cuts.

- **Bare ground.** Approximately 55,000 acres originally classified as bare ground (developed) included several land cover categories. We created polygons of these areas and examined them on high-resolution aerial photographs. Roughly 51,000 acres were reclassified as low vegetation, agriculture or clear cuts; with the remaining 3,500 acres added to the bare ground (developed) category.
- **Sand/cobble bars.** The initial modeled results brought to our attention that sand/cobble areas next to rivers were classified as pavement (i.e., developed) and consequently received a low habitat value. In order to more accurately capture this important habitat, we buffered major rivers by 50 feet and reclassified any developed land cover in that area (approximately 1,500 acres) into its own class.

After reaching the limit of our resources to improve the accuracy of several priority land cover classes, we created three levels of detail at which one can view data or calculate statistics: Land Cover Levels 2, 1, and 0.

LAND COVER LEVEL 2 (33 CLASSES)

The most complex of the three outputs, Level 2 retains the interim values that we used to refine and improve the initial land cover data set. Low-structure vegetation classes are differentiated by whether or not they fall within urban areas. Agriculture areas within urban areas are separated out, as are agricultural areas higher than 600 feet in elevation. Clear cuts have separate classes based on whether they were defined from within the LiDAR extent or by Landsat data.

LAND COVER LEVEL 1 (15 CLASSES)

For a simpler though still very rich land cover, we combined a number of Level 2 categories to create a data set with 15 classes for which we had high confidence.

LAND COVER LEVEL 0 (SIX CLASSES)

For regional statistics, modeling, and cartographic purposes, Level 0 may be the most useful of the three. Here we group land cover types into six classes: trees, agriculture, developed land, low vegetation, water, and sand bars.

Accuracy Assessment of Land Cover Data

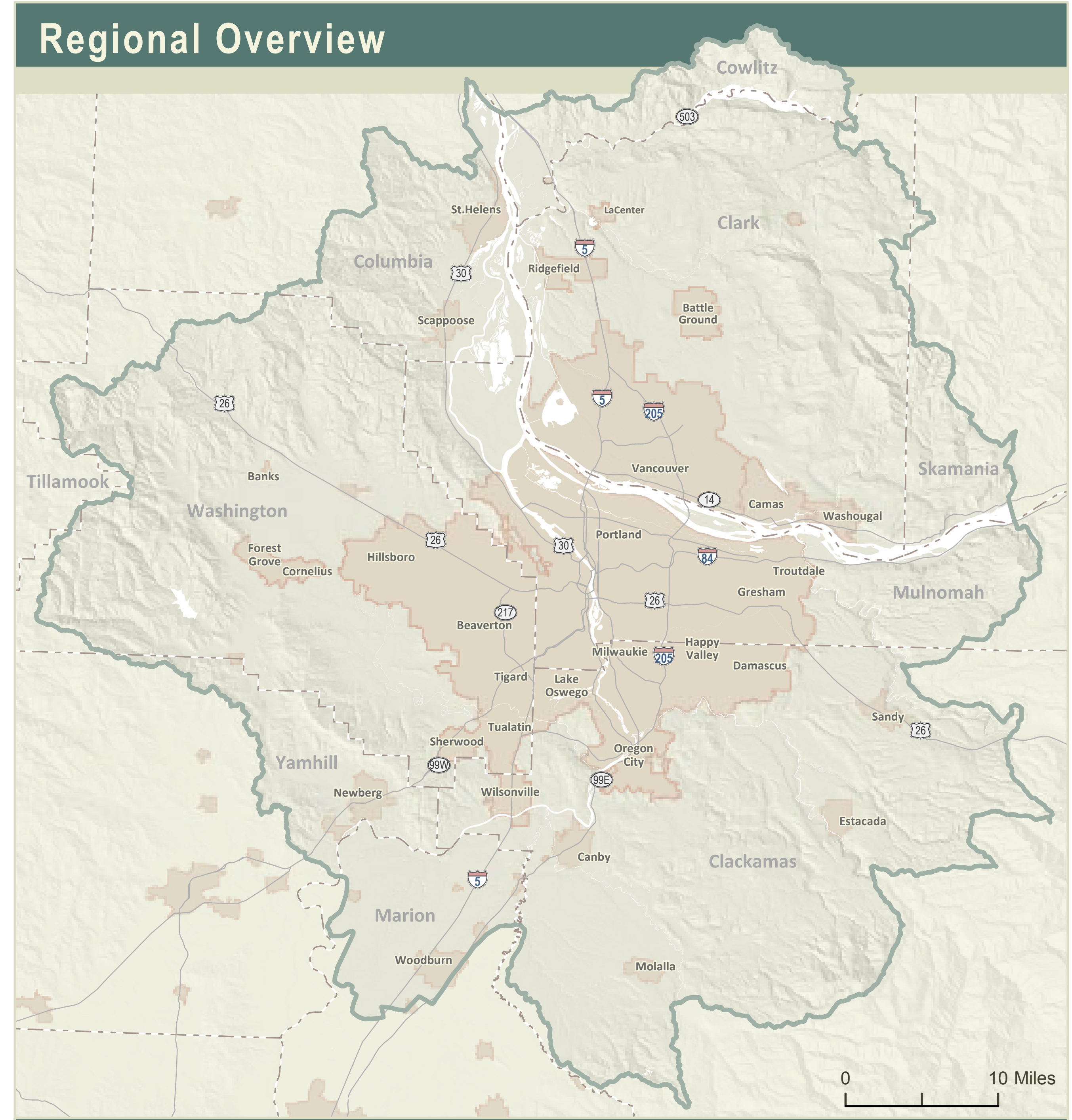
The project team completed a formal accuracy assessment by photo interpreting seven categories of the Level 2 mapped land cover to 2009 NAIP aerial photographs using 891 geographically stratified, random points. Overall accuracy was determined to be 94.3 percent.

Limitations of the Data Set

Despite our best efforts, funding and technological limitations prevented us from accurately mapping the following cover types of interest:

- Lawns, ball fields, golf courses and other grass-dominated fields typically associated with development were not mapped as a unique type but were included within other cover types of similar height.
- Agricultural trees such as orchards or Christmas tree farms and street trees were merged with tree cover types of similar height.
- Oak trees were not specifically identified.
- Vineyards were not specifically identified and are likely included in natural vegetation of similar height.
- Native prairie was not identified as a unique type and was merged with the lowest stature vegetation classes.
- Old-growth forest is not specifically mapped, although tree heights are available for the 88 percent of the region (i.e., the area with LiDAR coverage).

FIGURE A-1



The RCS region: 1,829,500 acres (2,850 square miles)

Oregon (1,334,800ac / 73% of RCS)
- Clackamas County (458,000ac / 25% of RCS)
- Columbia County (102,400ac / 5.6% of RCS)
- Marion County (69,300ac / 3.8% of RCS)
- Multnomah County (228,400ac / 12.5% of RCS)
- Tillamook County (700ac / 0.01% of RCS)
- Washington County (412,200ac / 22.5% of RCS)
- Yamhill County (63,800ac / 3.5% of RCS)

Washington (494,700ac / 27% of RCS)
- Clark County (395,100ac / 21.6% of RCS)
- Columbia County (57,800ac / 3.2% of RCS)
- Skamania County (41,800ac / 2.3% of RCS)

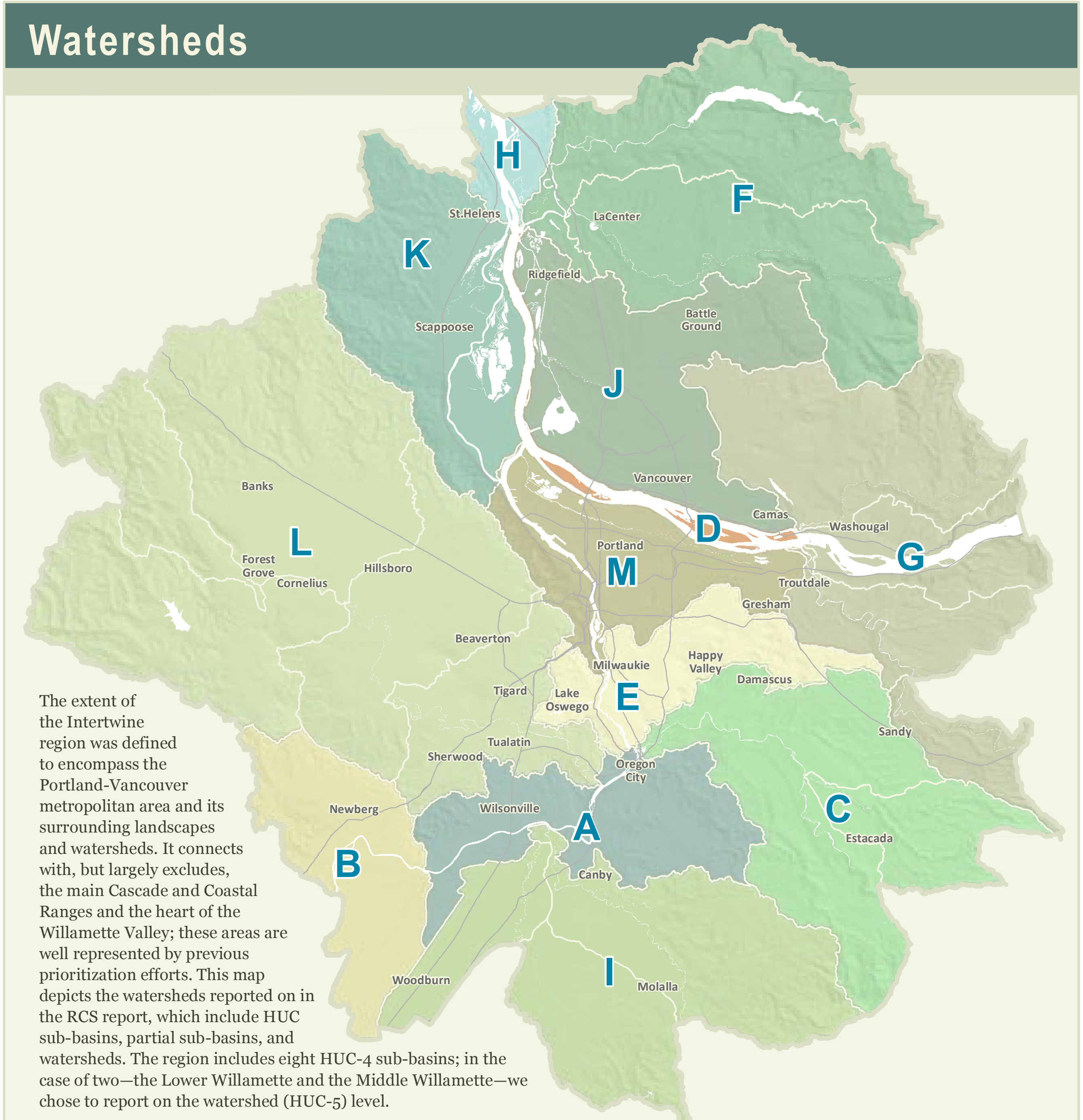
Urban areas (372,500ac / 20% of RCS)

within Oregon (284,000ac / 15.5% of RCS)

within Washington (88,500ac) / 4.8%

FIGURE A-2

Watersheds



The extent of the Intertwine region was defined to encompass the Portland-Vancouver metropolitan area and its surrounding landscapes and watersheds. It connects with, but largely excludes, the main Cascade and Coastal Ranges and the heart of the Willamette Valley; these areas are well represented by previous prioritization efforts. This map depicts the watersheds reported on in the RCS report, which include HUC sub-basins, partial sub-basins, and watersheds. The region includes eight HUC-4 sub-basins; in the case of two—the Lower Willamette and the Middle Willamette—we chose to report on the watershed (HUC-5) level.

RCS Defined Watersheds

HUC 5 watersheds are lightly outlined * Represents a partial sub basin

- A - Abernethy Creek-Willamette River Watershed (87,000 ac)
- B - Chehalem Creek-Willamette River Watershed (78,000 ac)
- C- Clackamas Sub Basin * (158,500 ac)
- D - Hayden Island-Columbia River Watershed (18,500 ac)
- E - Johnson Creek Watershed (60,000 ac)
- F - Lewis Sub Basin* (221,000ac)
- G - Lower Columbia-Sandy Sub Basin* (217,500ac)
- H - Lower Columbia-Slatskanie Sub Basin* (22,000ac)
- I - Molalla-Pudding Sub Basin* (181.000ac)
- J - Salmon Creek-Frontal Columbia River Watershed (131,500ac)
- K - Scappoose Creek-Frontal Columbia River Watershed (181,000ac)
- L - Tualatin Sub Basin (453,500ac)
- M - Willamette River-Frontal Columbia River Watershed (78,000ac)

FIGURE A-3

Topography

Although land use in the Intertwine region is diverse, it is largely consistent with elevation zones. This hypsometric map colors the region in five elevation classes. Large patches of forest are generally constrained to the highest elevation zones. Agriculture and (sub)urban development dominate the 50-200' and 200-600' zones, with agriculture extending above 600' mostly in the eastern portion of the region, where it often intergrades with forest.

Elevation range 0 - 50 feet
8.2% of the Region (150.000 acres)
ColumbiaRiver and lower portions of the Willamette River

Elevation range 50 - 200 feet
19.3% of the Region (354.000 acres)
Mostly Floodplain, Urban and Agriculture areas

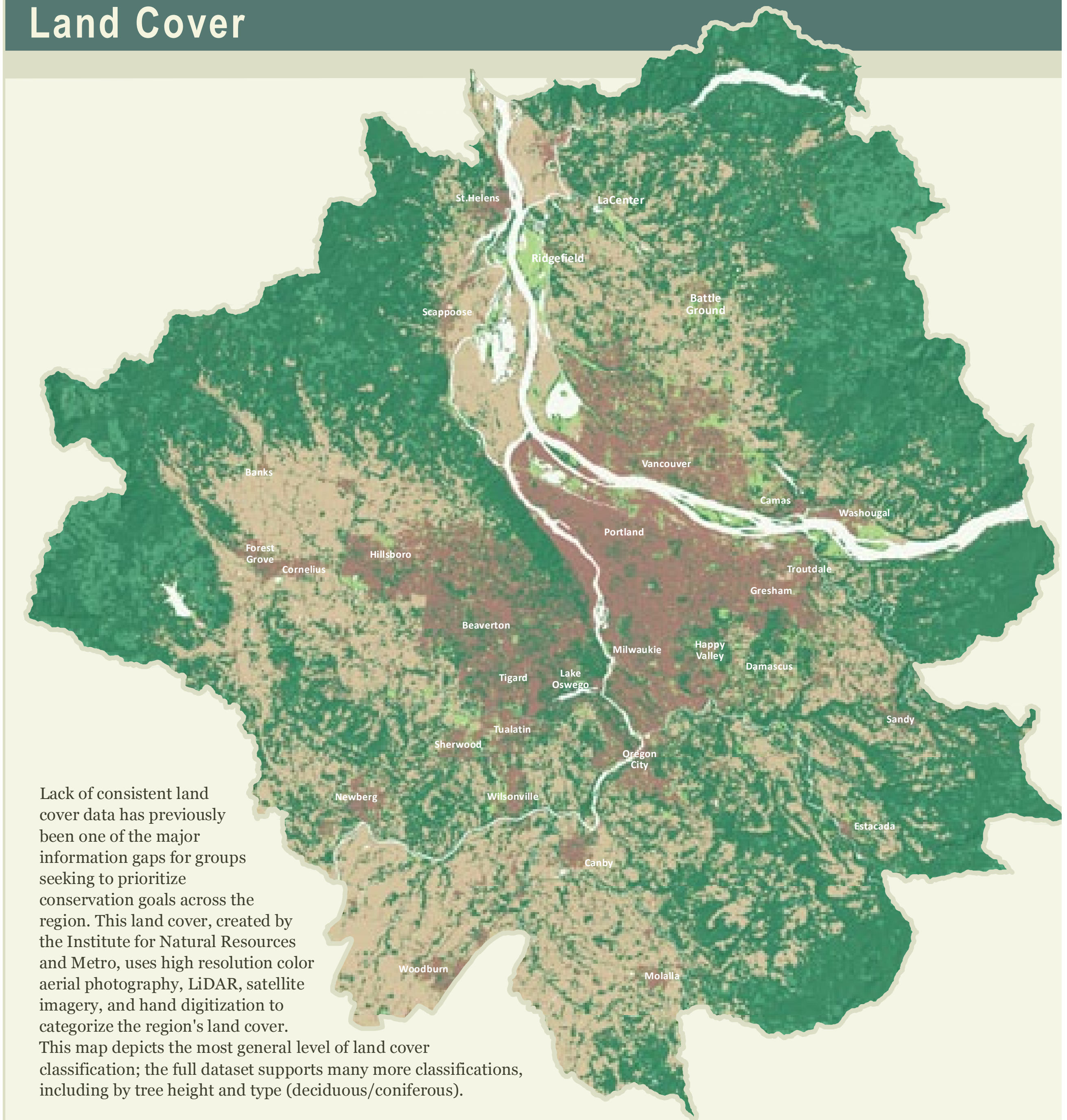
Elevation range 200 - 600 feet
34.2% of the Region (627.000 acres)
Mostly Agricultue and Urban areas

Elevation range 600 - 1,000 feet
16.4% of the Region (301.000 acres)
Transition lands; mix of agriculture and forest

Elevation range 1,000 - 4,380 feet
21.6% of the Region (396.000 acres)
Natural and industrial forest lands

FIGURE A-4

Land Cover

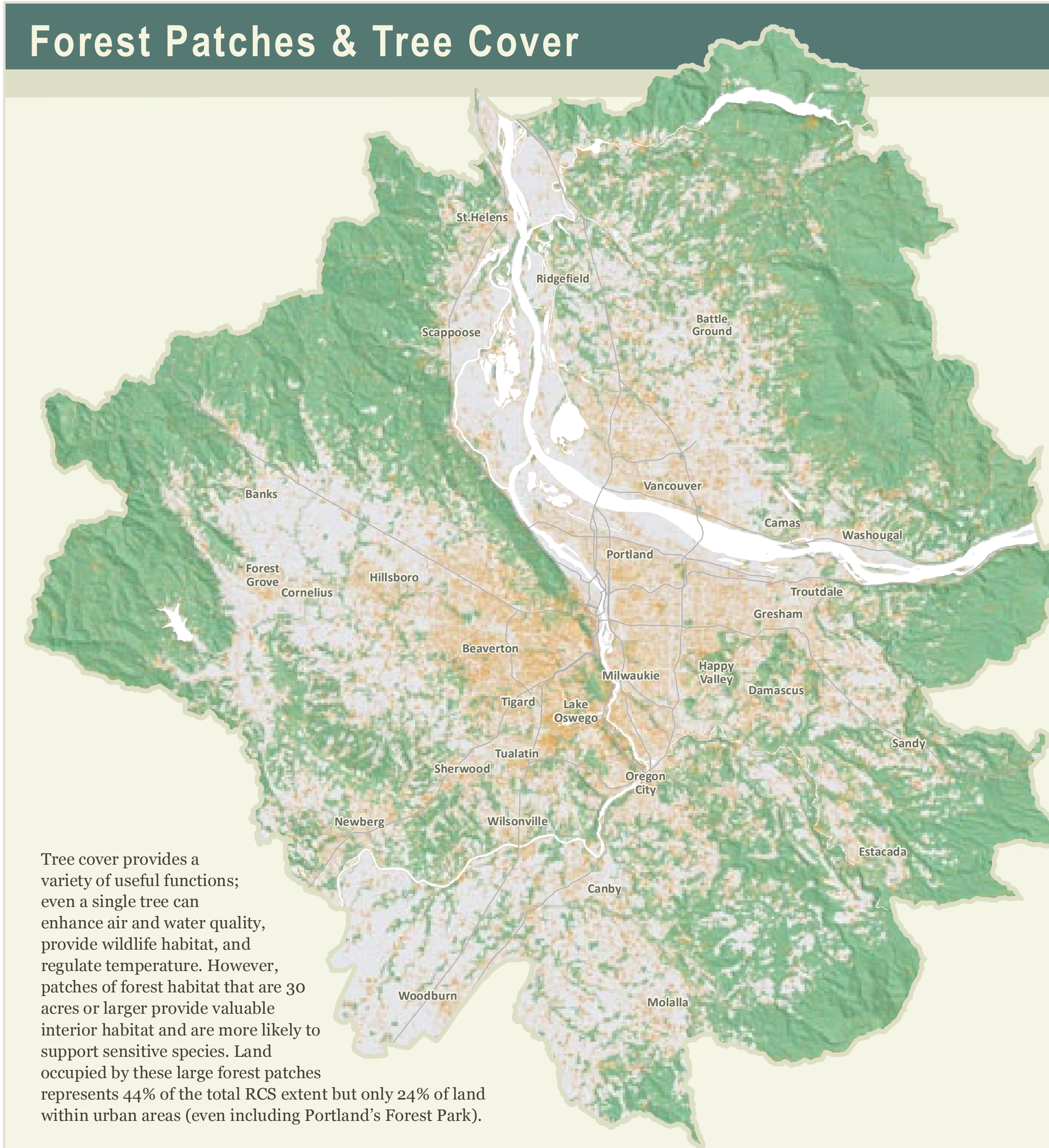


Lack of consistent land cover data has previously been one of the major information gaps for groups seeking to prioritize conservation goals across the region. This land cover, created by the Institute for Natural Resources and Metro, uses high resolution color aerial photography, LiDAR, satellite imagery, and hand digitization to categorize the region's land cover. This map depicts the most general level of land cover classification; the full dataset supports many more classifications, including by tree height and type (deciduous/coniferous).

- **Conifers & hardwoods over 14ft tall** — 49.1% of the Region (898,000 acres)
- **Clear cuts or recently modified forest** — 5.0% of the Region (92,000 acres)
- **Sparse vegetation/grasses/low shrubs 0-13ft** — 7.7% of the Region (141.500 acres)
- **Agriculture** — 22.1% of the Region (405,000 acres)
- **Developed - paved areas and buildings** — 12.9% of the Region (235,000 acres)
- **Water** — 3.1% of the Region (57,000 acres)

FIGURE A-5

Forest Patches & Tree Cover

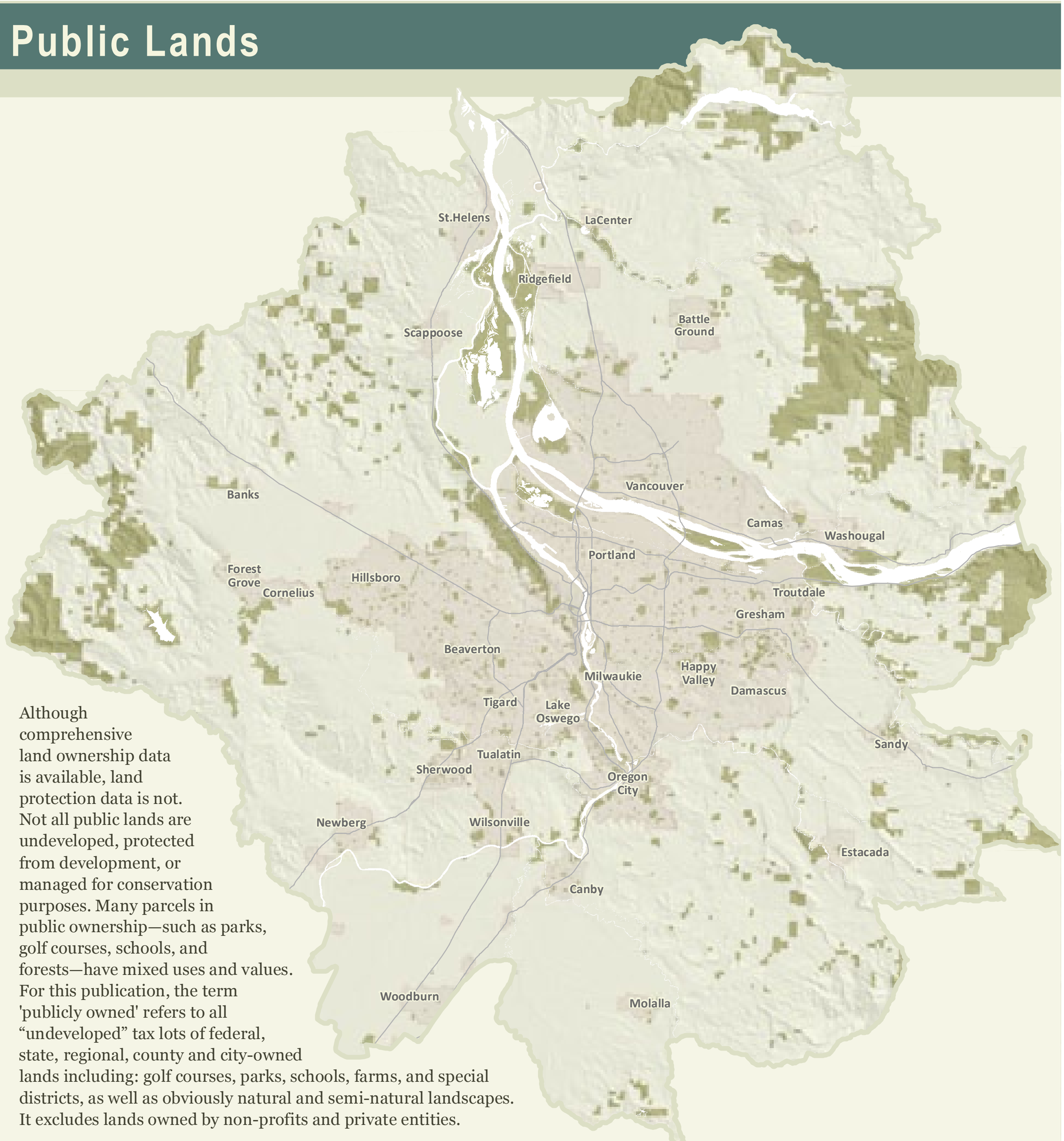


Tree cover provides a variety of useful functions; even a single tree can enhance air and water quality, provide wildlife habitat, and regulate temperature. However, patches of forest habitat that are 30 acres or larger provide valuable interior habitat and are more likely to support sensitive species. Land occupied by these large forest patches represents 44% of the total RCS extent but only 24% of land within urban areas (even including Portland's Forest Park).

Forest patches 30 acres or larger	- 44% of the region. The largest of these patches are in the mountainous, sparsely-populated fringes of the region.
Trees in patches smaller than 30 acres	- 54% of the region. Urban areas contain substantial tree cover but few large forest patches.
All other land cover types	- 46% of the region. This category includes developed lands, agriculture, grasses, water and shrubs.

FIGURE A-6

Public Lands



Although comprehensive land ownership data is available, land protection data is not. Not all public lands are undeveloped, protected from development, or managed for conservation purposes. Many parcels in public ownership—such as parks, golf courses, schools, and forests—have mixed uses and values. For this publication, the term 'publicly owned' refers to all "undeveloped" tax lots of federal, state, regional, county and city-owned lands including: golf courses, parks, schools, farms, and special districts, as well as obviously natural and semi-natural landscapes. It excludes lands owned by non-profits and private entities.

Public lands in the RCS:

- 13% of total acreage	Federal: 3.8% State: 6.1% Local, regional, and special districts: 3.2%
- 9% of urban acreage (UBGs, UGAs)	Federal: 0.2% State: 0.5% Local, regional, and special districts: 8.2%
- 14% of non-urban acreage	Federal: 4.8% State: 7.5% Local, regional, and special districts: 1.9%