Buildable Lands and Land-Use Trends in the Columbia River Gorge National Scenic Area

As of October 2017

Columbia River Gorge Commission
EST. 1986

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INTRODUCTION

Purposes of this Report

The purpose of this report is to identify how much of the Columbia River Gorge National Scenic Area is dividable or vacant under the current Management Plan standards. A Buildable Lands Inventory (BLI) can tell planners and decision makers whether lands are being used to their land-use potential, which can help decision makers determine whether land-use policies are effective. Where lands are not used to their potential, decision makers can adjust policies to address unmet needs. In the National Scenic Area, a BLI can help evaluate whether agriculture, forest, and open space lands are being preserved for those uses, and whether residential development is occurring where the Management Plan intends it to occur.

This report documents:

1. The number and location by county of parcels that are vacant. This report does not evaluate parcels for their potential to be redeveloped.
2. The number and general locations of areas that may be divided under current land-use standards.
3. Changes in land-use that have occurred since the adoption of the current Management Plan
4. Use of LiDAR remote sensing to identify structures and building footprints within the NSA.

Key Findings

1. There are approximately 7,300 privately owned tax lots in the National Scenic Area outside of urban areas. Nearly 40 percent of these tax lots have no buildings or improvements. Note: this report uses tax lots because that is the base data point for county land-use information—most (but not all) tax lots are also legal parcels. Tax lots provide similar estimates as parcels.
2. There are 160 privately owned areas outside of the urban areas that may be divided into two or more parcels under current land-use standards.
3. Between 2001 and 2011, the change in acreage of agricultural and developed land was negligible. The amount of tree cover on designated Forest Land in the General Management Area (GMA) and Special Management Area (SMA) cumulatively decreased by 1.45%.
4. LiDAR data can be used to identify buildings in the NSA. LiDAR removes some of the uncertainty of relying on tax lot datasets from multiple sources. However, the results must still be field checked to account for any identified false positives and negatives.

Background

The Columbia River Gorge National Scenic Area Act was passed in 1986, establishing the National Scenic Area and authorizing Oregon and Washington to enact an interstate compact to create the bi-state Gorge Commission. The Act requires the Commission and U.S. Forest Service to write a Management Plan that includes land-use designations and policies for the protection and enhancement of the scenic, natural, cultural, and recreational resources of the National Scenic Area. The agencies first adopted the Management Plan in 1991.

The Act requires the agencies to review the Management Plan every ten years and revise it if necessary. The Plan was first reviewed and revised in 2004. The agencies are currently reviewing the Plan for the second time, a process that they expect to complete in 2019.

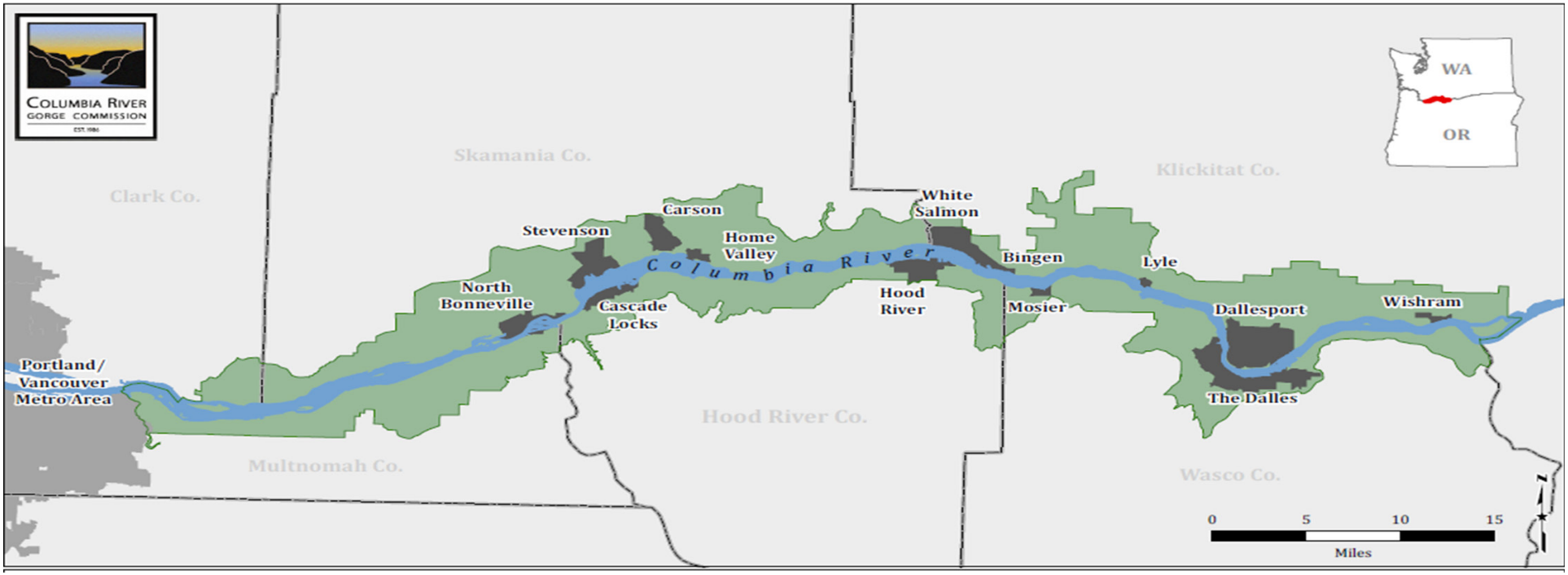
To inform the plan review process, the Commission asked for a buildable lands inventory for the NSA, excluding urban areas. This report uses techniques developed by local governments and research groups for geographically small rural jurisdictions in the states of Oregon and Washington to identify vacant and developed parcels of land, applying those techniques to lands in the National Scenic Area outside of the urban areas.

Buildable lands inventories can vary widely depending on methodology, assumptions, and data sets used. This report describes the details of and justification for these parameters.

Study Area

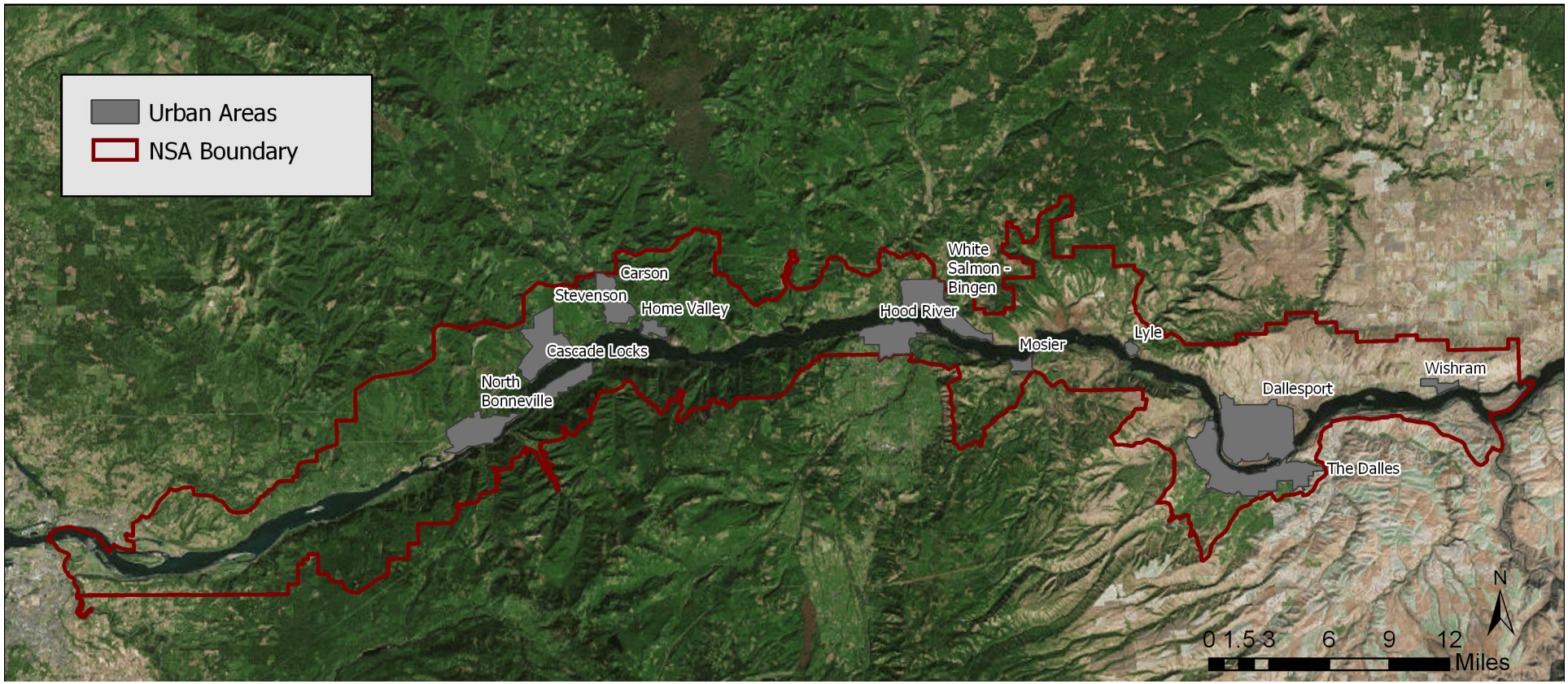
The National Scenic Area includes parts of Multnomah, Hood River, and Wasco Counties in Oregon, and Clark, Skamania, and Klickitat Counties in Washington. The Act designated 13 urban areas that operate outside the jurisdiction of the Gorge Commission and the U.S. Forest Service. The Act also designated several "Special Management Areas" (SMA) for which the U.S. Forest Service develops land-use standards. This report analyzes all National Scenic Area land outside of urban areas; SMAs are included and not separately analyzed.

Map of the NSA. The urban areas are in dark gray. The Portland-Vancouver metro area is in light gray on the western edge of the map.



INTRODUCTION

The topography, climate, and land-cover of the study area are quite varied because of the rain shadow effect created by the Cascade mountain range. The western end of the NSA is predominantly temperate rainforest while the eastern part is high desert plateau.

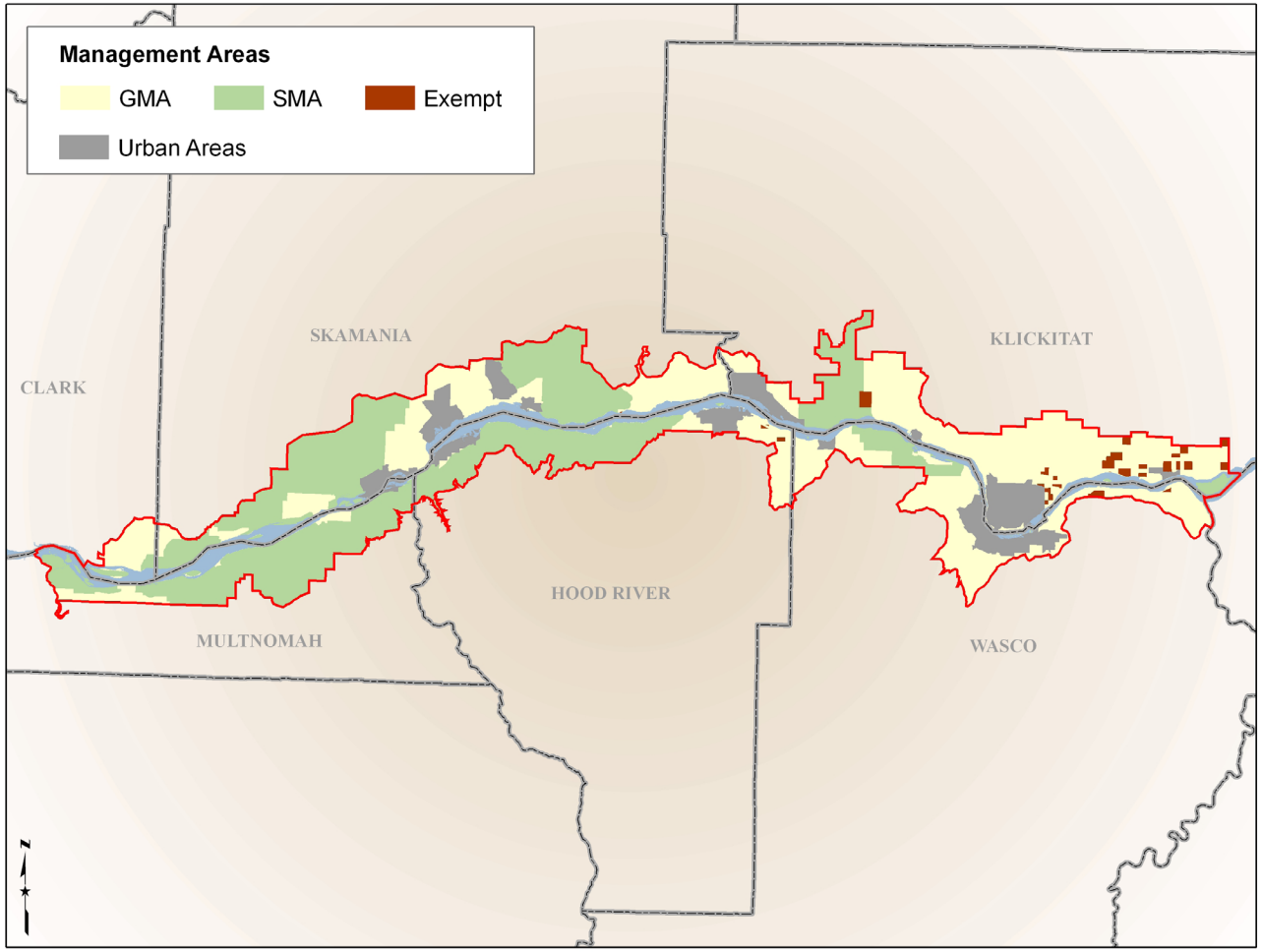


Left: Skamania Landing in the temperate rainforest of the western Columbia River Gorge.

Right: A vineyard overlooking Miller Island in the arid eastern Columbia River Gorge.

Administration

The NSA is jointly managed by the Columbia River Gorge Commission and the U.S. Forest Service. The Gorge Commission adopts policies for the GMA. The Forest Service adopts regulations for the SMAs and administers the Management Plan for federal lands and federal projects. Review and revision of the Management Plan is a collaborative effort between the Gorge Commission and Forest Service. The Gorge Commission adopts the revisions and the U.S. Secretary of Agriculture must concur that the Plan complies with the requirements of the National Scenic Area Act.

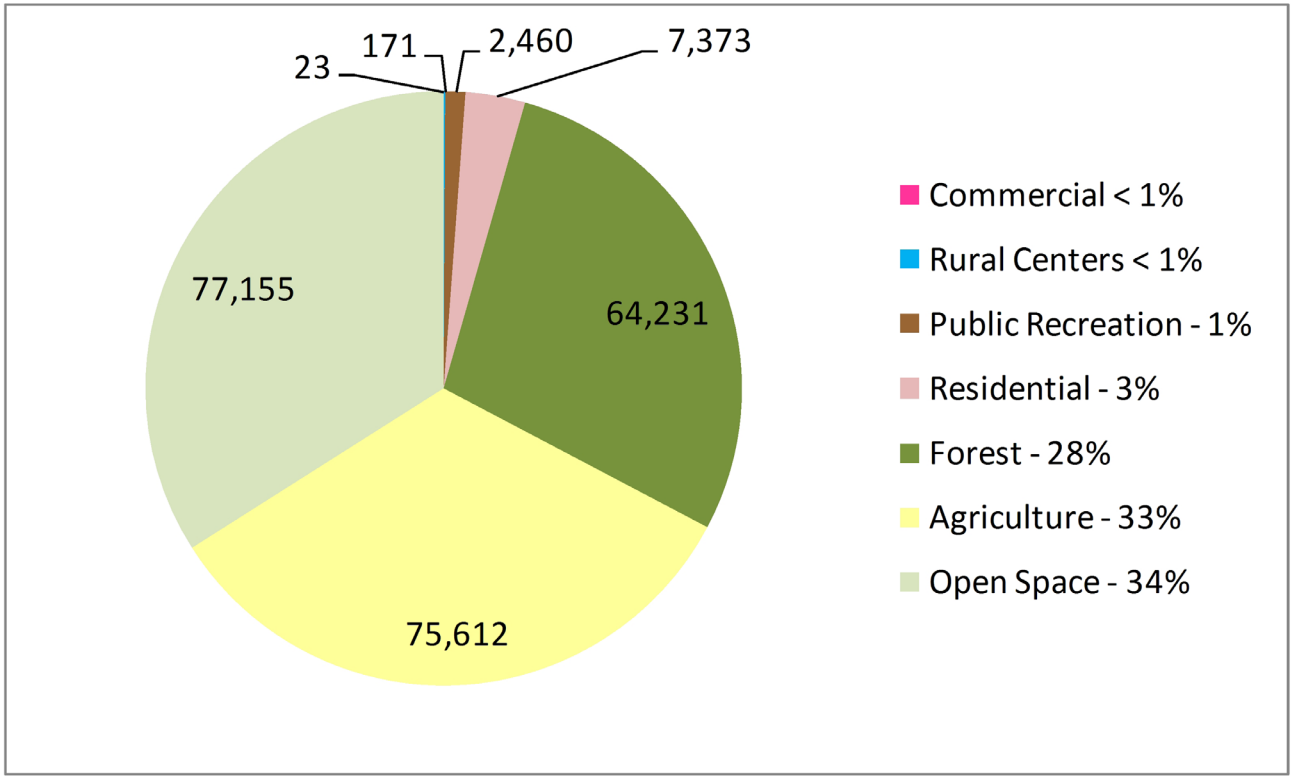


Land-use Designations

In 1992 the Commission and the Forest Service adopted land-use designations for the GMA and SMA portions of the NSA. These land-use designations are similar to zoning regulations found in most cities. The land-use designations dictate what uses are allowed on a property, such as agriculture or forestry, and also prescribe a minimum parcel size for each property.

For this report, land-use designations are used for two purposes. The first is to determine whether any part of a tax lot in the GMA is twice as large as the minimum size allowed by its land-use designation, and therefore eligible to be divided. Land divisions are not allowed in the SMA. The second will be to establish which land-use designations vacant tax lots and dividable areas are located.

A chart showing land-use designations by acreage and percentage of the NSA

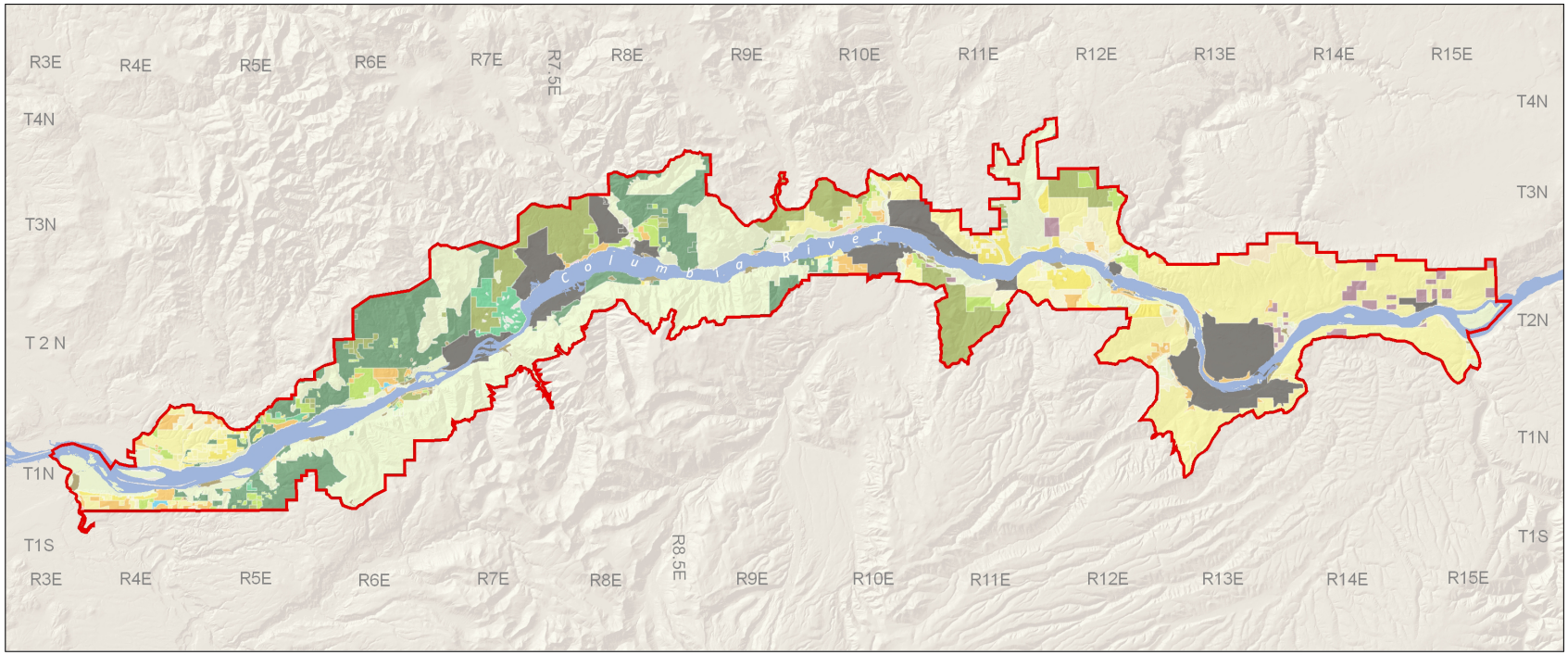


Acres of land per land use designation

A map showing the land-use designations in the NSA

Land Use Designations

Forest (SMA)	Agriculture (SMA)	Open Space	Urban Areas
Commercial Forest	Large-Scale Agriculture	Commercial Recreation	Residential
Large Woodland	Small-Scale Agriculture	Public Recreation	Rural Center
Small Woodland	Agriculture Special	Indian Trust Lands	Commercial



Buildable Lands Inventories in Oregon and Washington

Buildable Lands Inventories (BLI) are a common planning tool used to inform policy decisions related to urban and regional planning. BLIs are mandatory in both Oregon and Washington. In Oregon, BLIs are required to demonstrate whether a city or region's urban growth boundary has enough developable land to accommodate 20 years of residential development (e.g., ORS 197A.300–325, ORS 197.295–314; Oregon Metro, 2014; ECONorthwest, 2015). Washington's Growth Management Act requires counties and their cities to compare planning targets and objectives with actual growth and development that has occurred (PDS, Snohomish County, 2012).

Metro and Clark County Buildable Lands Inventory Methodologies

Metro is the regional government that oversees planning in the Portland metropolitan area, which includes part of Clackamas, Multnomah, and Washington counties. Every five years, Metro publishes an urban growth report to guide the Metro Council's growth management decisions. As a part of this report, Metro produces a BLI (Oregon Metro, 2014).

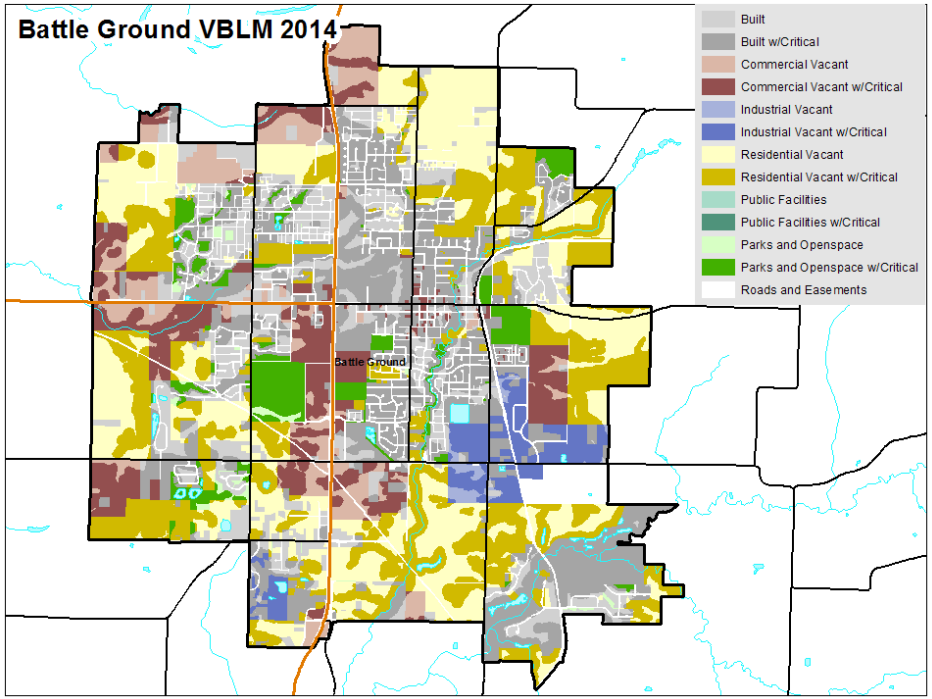
Metro's BLI is broken down into five basic steps: 1. Identify vacant tax lots by zoning class, 2. Remove tax lots that do not have potential residential or employment growth capacity, 3. Calculate deductions for environmental resources, 4. Calculate deductions for future streets, and 5. Calculate BLI estimates (Oregon Metro, 2014).

Clark County, Washington is home to several urban areas that are required to plan in accordance with the Washington Growth Management Act. Clark County's BLI is its Vacant Buildable Lands Model (VBLM) (Clark County Community Planning Department).

Clark County's methodology for the VBLM is similar to Metro's methodology for the Metro BLI. First, all parcels in the urban area are given a land-use designation based on the current comprehensive plan. Lands with certain designations, such as parks and open space, which do not have potential for residential or economic development, are excluded from the model. Constrained lands, such as those in floodplains, containing steep slopes, or that are priority habitat for sensitive plant and animal species, are also excluded. Once the classified land inventory is complete, several assumptions developed by the planners are applied to the model. The output of the model shows how many net developable acres are in residential, commercial, and industrial areas. The model also extrapolates the capacity of residential land to support new residents, and the capacity of commercial and industrial land to support new employment (Clark County Community Planning Department).

Primary Source for the National Scenic Area BLI

A Map showing built and vacant parcels in Battle Ground, WA as identified by the Vacant and Buildable Lands Model.



Source: http://gis.clark.wa.gov/vblm/

This BLI utilized a combination of tax assessor data and aerial imagery. Tax assessor data was the primary data source because it is more current than the latest available imagery. Tax assessors physically inspect properties to calculate their tax value. Additionally, using tax assessor data allows staff to create a model that can be easily re-run as tax assessors update their data. The Gorge Commission recieves updated tax lot information from the counties every six months.

This report also documents a sample use of LiDAR to identify building footprints and locations. LiDAR, a remote sensing technology described in detail on page 9, is superior to tax assessor data for detailed locational information of buildings. Tax assessor data describes the presence or absence of a building, but LiDAR identifies where on the tax lot a building is located. However, LiDAR data is not consistently available or uniformly updated within the NSA, so at this time should only be considered a supplement to and not a substitute for tax assessor data.

The LiDAR data sample for this report identified all of the buildings that the tax assessor data identified, but also included several false positives (identifying a building where none exists), which had to be manually removed. For future BLIs, LiDAR could be used to create a base level of built lands, which could then be regularly updated tax assessor data.

Using LiDAR Data to Assist with Identifying Vacant Parcels

Tax assessor data differs from county to county and does not necessarily reflect the impact that physical structures have on the scenic resources of the NSA. Because of that, this report will demonstrate how remote sensing techniques, such as LiDAR rooftop extraction, can be used to identify man-made structures and aid in future BLIs.

The use of LiDAR remote sensing data in the field of urban and regional planning (in this case building extraction) is expanding. A group of scholars with the Civil Engineering Department at the University of New Brunswick studied the efficacy of extracting building forms using LiDAR data by comparing buildings predicted using LiDAR with ground truth information derived from ground surveys and stereo photography. The researchers found that the LiDAR data analysis alone was 85.66% to 98.96% accurate in predicting the area of the buildings and 70.53% to 97.71% accurate in predicting the height of the buildings, depending on the location (Shiravi, Zhong, & Boykaei, 2012).

Another set of scholars combined LiDAR and multi-spectral imagery into the same analysis to improve the accuracy of building detection. The authors point out that while LiDAR data is a valuable tool in building detection, it has a few flaws. For example, one is that LiDAR does not usually provide geometrically precise boundaries for buildings. Another is that typical LiDAR building extraction requires setting a threshold for identification, but with no standard way to do so. By combining LiDAR and multi-spectral imagery, the researchers created a model that successfully predicted buildings 92.2% to 97.2% of the time, depending on location (Awrangjeb, Fraser, & Ravanbakhsh, 2010). This improved accuracy indicates that LiDAR should be used in combination with multi-spectral imagery to achieve the highest levels of accuracy.

An illustration of a plane collecting aerial LiDAR imagery.

Source: www.dnr.wa.gov

What Is LiDAR?

LiDAR stands for Light Detection And Ranging, and the physics behind it are relatively simple. By pointing a laser at a surface repeatedly at closely spaced intervals and measuring the time it takes for the light to return to the source, very accurate three-dimensional information can be obtained. Billions of these measurements can yield an extremely detailed three-dimensional rendering of the terrain.

The instrument that collects the data is made up of a laser, a scanner, and a GPS receiver. The instrument is mounted to a light aircraft, car, or static survey platform where an eye-safe laser measures objects with an accuracy of about one inch. Scanning over 100,000 points per second, the laser reflects off of trees, buildings, streets, shrubs, people, and the ground.

LiDAR point clouds are used to create derivative products, such as the digital surface model (DSM) on the top right of this page. Elevation models often show the surface of the earth without vegetation, but some depict information such as forest canopy, slope angle, slope direction, stream flow, elevation contours, people, 3D models of buildings, and more (Washington State Department of Natural Resources).

LiDAR DSM hillshade showing the CRGC office in White Salmon, Washington

Aerial imagery of the same area.

DATA

Data Layers Used

Name	Type/Format	Source	Usage
NSA Boundary	Shapefile	CRGC Geodatabase	Define Study Area and provide clip feature for other data.
Taxlots	Shapefile	Individual Counties	Identify individual parcels that are developed, undeveloped, undevelopable, or subdividable.
Urban Area Boundaries	Shapefile	CRGC Geodatabase	Exclude areas within the NSA that are outside of the CRGC jurisdiction.
Slopes over 30%	Shapefile	CRGC Geodatabase	Exclude parcels that are unbuildable because they are comprised of slopes greater than 30%.
Orthoimagery	Image Layer	ESRI NAIP False Color	Field truth vacant parcels identified from assessor's data
Land Use Designations	Shapefile	CRGC Geodatabase	Establish the minimum lot size of a parcel and determine if it is eligible for subdivision
Aerial Imagery	Basemap	ESRI	Reference and quick visual analysis
LiDAR	Point Cloud	Puget Sound LiDAR Consortium	Determine accuracy of using LiDAR data for building extractionin test study area.
Landuse/Landcover	Raster	Multi-Resolution Land Characteristics (MRLC) Consortium	Conduct land use change analysis between 2001 and 2011
U.S. Forest Service Owned Lands	Shapefile	U.S Forest Service Columbia River Gorge Office	Identify parcels that are in private ownership.

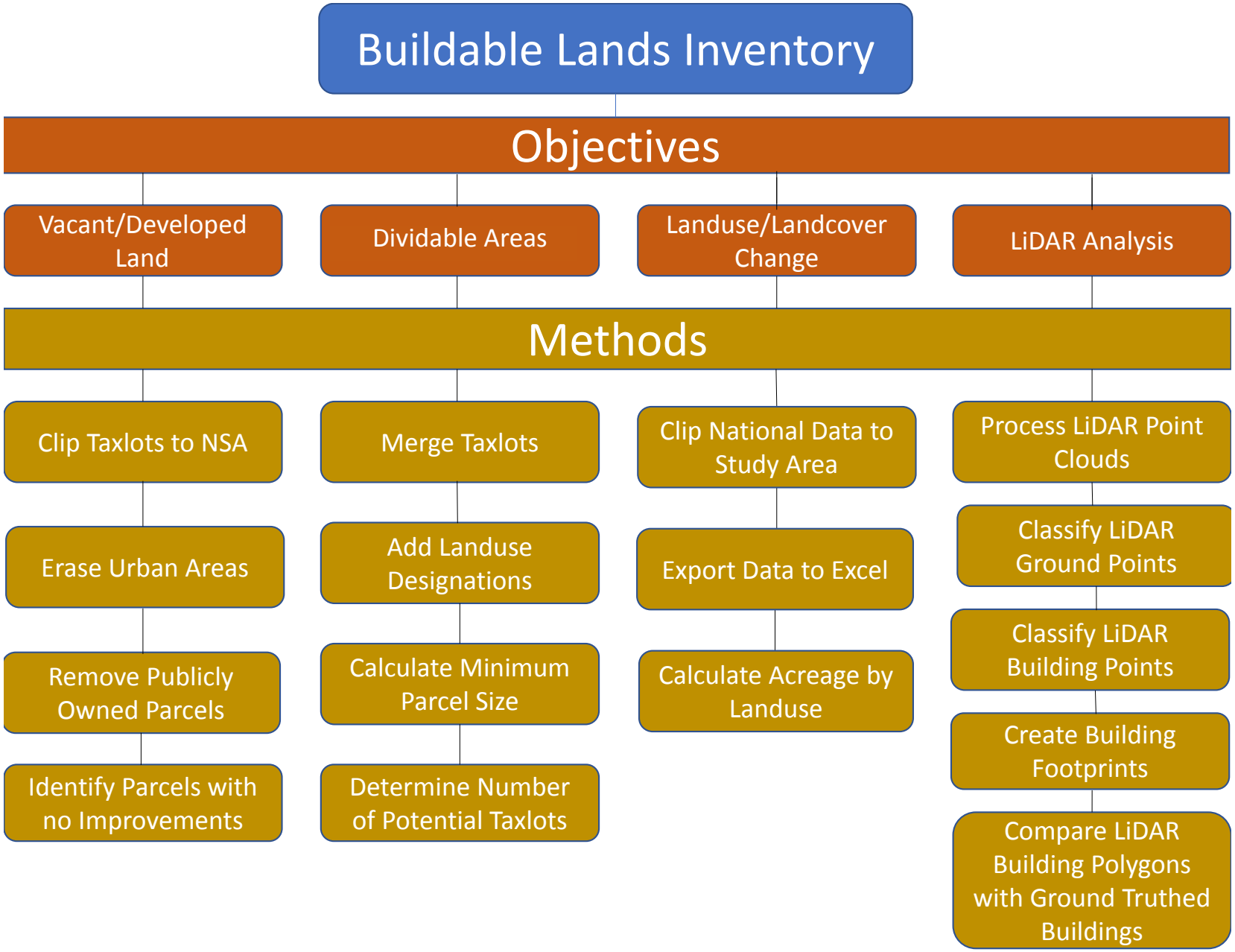
Data Processing

Most of the data layers were ready to use or had been processed by the author previously. The LiDAR data were processed using tools available in ArcGIS Pro and LAStools. The slope analysis was derived from a 10 meter Digital Elevation Model (DEM) downloaded from USGS EarthExplorer and performed with ArcMap 10.4.

Potential Data Issues

Overall, the quality of the data was adequate for the analysis and does not raise any issues. The level of accuracy of the tax lot data may be inconsistent because the parcel shapefiles are maintained by six different entities. Additionally, the accuracy of the Commission's land-use designation varies from the tax lot data. These discrepancies do not invalidate the existence of any parcel or land-use designation but merely introduce small but acceptable uncertainty into the exact location of those lines. There is nothing to indicate that the data provided would be invalid as a planning tool for conducting analyses within the NSA.

Methodology Overview



METHODS

Vacant and Developed Lands

The first component of the BLI involved creating a shapefile that identified all the undeveloped parcels in the NSA that fall under the purview of the Columbia River Gorge Commission. Since the purpose of the BLI is to allow the Commission to track changes over time, it made sense to create a model that can be re-run as the inputs are updated (Appendix 1). Methods used to create this model were consistent with the advice from Steve Erickson, Principle GIS Specialist at Metro, and best practices used by Clark County that were discovered in the literature review. GIS data at the Commission is typically updated every 6 months. The method for conducting the analysis can be found below. All geoprocessing was performed in ArcGIS Pro.

1. Clip tax lots to NSA Boundary - The tax lot information collected from the counties extended far beyond the scenic area boundary, so it was necessary to clip the information so that only tax lots within the NSA were considered.

2. Remove urban areas from tax lots – The Management Plan does not directly apply to land-use in the designated urban areas, so it was necessary to remove urban area information. Most cities in the National Scenic Area have their own detailed BLIs that already contain this information so there is no need to replicate it here. Unincorporated urban areas do not have individual BLIs.

3. Identify tax lots under public ownership and remove them - Many tax lots in the NSA are owned by the federal government or the states. These lands are typically intended to be vacant and have no potential for development, so it was necessary to remove them from the analysis. Examples of publicly owned properties are state parks and national forests.

4. Identify undeveloped parcels – The process of selecting undeveloped parcels from the tax lot data was different for every county. For example, each county uses its own field names and methods for identifying unimproved or vacant parcels. The Select Feature by Attribute tool therefore had to be unique to each county. For this reason, the above steps were performed on each county separately instead of merging all the counties at the beginning of the analysis. For this analysis, a parcel was considered vacant if the tax assessor's improvement value was equal to $0.

Dividable Lands Inventory

The second part of the BLI involved identifying areas that have the potential to be divided into smaller tax lots. Identifying dividable areas helps identify future potential development. The process is outlined below. All analyses were conducted in ArcGIS Pro. Here again, a model was created to re-run the analysis as needed (Appendix 2). All geoprocessing was conducted in ArcGIS Pro.

1. Clip tax lots to NSA Boundary - The tax lot information collected from the counties extends far beyond the scenic area boundary, so it was necessary to clip the information so that only tax lots within the NSA were considered.

2. Remove urban areas from tax lots – The Management Plan does not directly apply to land-use in the designated urban areas, so it was necessary to remove urban area information. Most cities in the National Scenic Area have their own detailed BLIs that already contain this information so there is no need to replicate it here. Unincorporated urban areas do not have individual BLIs.

3. Intersect tax lots to land-use designations layer – To know what the land-use designation, and therefore minimum size, for each tax lot was, the tax lots were joined to the land-use designation layer using the Intersect tool in ArcGIS. The resulting output layer contained both tax lot information and land-use designations.

4. Create field for minimum parcel size – The land-use designation was a text field, but a numeric field was necessary for the Boolean operation performed in a subsequent step. A new field was added and Field Calculator was used to add a number that corresponded to the minimum parcel size of the land-use designation.

5. Calculate area of each record – The Add Geometry Attributes tool was used to add a field for the acreage of each record.

6. Add field for representing whether a tax lot is dividable - A new field was added and a Boolean operation was performed. If the tax lot size was twice the minimum parcel size allowed under the land-use designation, the result was true (dividable). This analysis did not account for adjoining tax lots that are considered consolidated under the Commission's rules.

7. Create dividable areas layer – The Select by Attribute tool was used to select areas that were dividable. A new layer file of said areas was created.

8. Calculate number of potential tax lots - A new field was added to the dividable tax lots and a python script was used to calculate the number of potential tax lots that could be created from each dividable parcel.

METHODS

Land-use/Land-cover Change

To determine what changes have occurred to the landscape of the NSA since the adoption of the current Management Plan, an analysis of National Land-Cover Dataset (NLCD) data from 2001 and 2011 was conducted. NLCD data from 2016 will not be available until 2018 and so were not used in this analysis.

1. Clip national data to the study area - The data from the Multi-Resolution Land Characteristics Consortium covers the entire U.S. The data were clipped so that only areas within the NSA (excluding urban areas) were included.
2. Export data to Excel - The NSA-specific data were exported to an Excel format and analyzed in a comparative table.
3. Symbolize raster to display land-use types - The raster datasets from 2001 and 2011 were symbolized by land-use codes in order to display where different land-uses are located in the NSA.

LiDAR Building Extraction

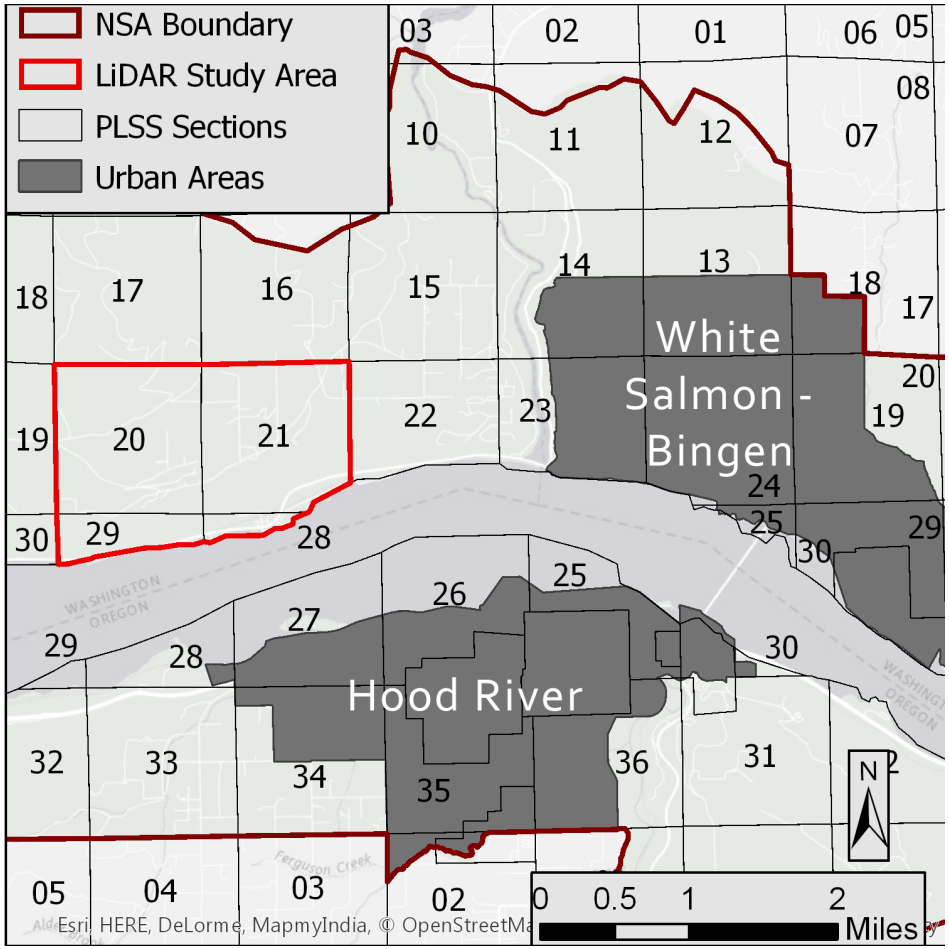
To assess whether LiDAR data might be used for future work in identifying built parcels or building footprints, a preliminary analysis of a small portion of the NSA was conducted using LiDAR point clouds from the Puget Sound LiDAR Consortium. This process is outlined below.

1. Combine LAS files - The separate LAZ files that comprise the study area were merged using LASmerge in LAStools. The output was saved as a LAS file instead of the compressed LAZ file so that the data could be analyzed using ArcGIS.
2. Add data to ArcGIS - The LAS file was added to ArcGIS Pro and the vertical units were changed to match the data frame.
3. Pre-process data - The Tile LAS tool was used to split the data into 250mb tiles to aid in processing.
4. Identify ground points - The Classify LAS Ground tool was used to find any ground points. Points already classified as ground by the vendor were reused.
5. Classify Building Points - The Classify LAS Building tool was used to classify building points.
6. Group building points - The LAS to Multipoint tool was used with the filtered building points.
7. Convert grouped points into building polygons - The Aggregate Points tool was used to derive building polygons.

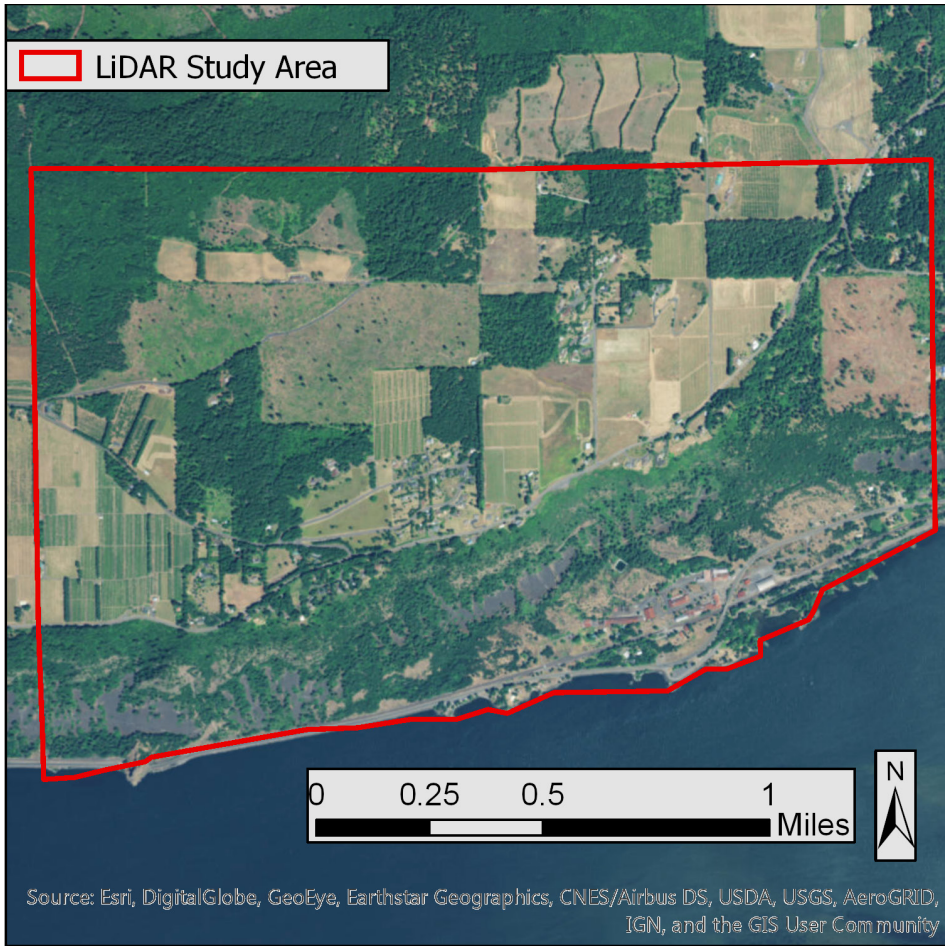
LiDAR Study Area

To test the efficacy of building identification using LiDAR analysis in the NSA, a small subsection of the NSA was chosen so that the results of the LiDAR analysis could be compared to buildings identified through manual analysis of aerial imagery and tax assessor data, a tedious and time consuming process. The area chosen is in eastern Skamania County, Washington near the communities of Underwood, White Salmon, and Hood River. Specifically, the 1,473 acre study is comprised of sections 20, 21, 29 and 30 in township 03N Range 10E as shown on the maps below. The area was chosen because it has a mix of densities, development types, and tree cover, so it represents many of the areas in the larger study area.

The study area in relation to the urban areas of White Salmon-Bingen and Hood River. PLSS sections 20,21,28, and 29 are included.

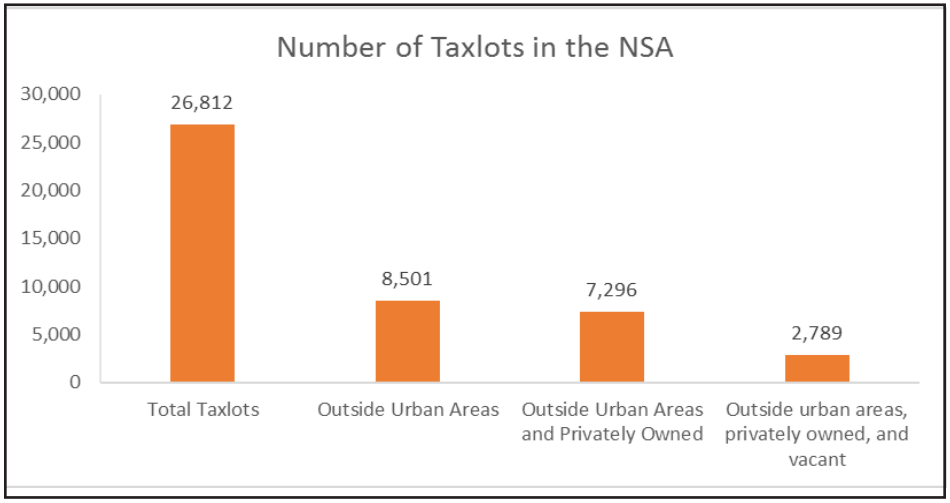


A close-up view of aerial imagery of the study area. The study area includes commercial, residential, agricultural, and forested land.



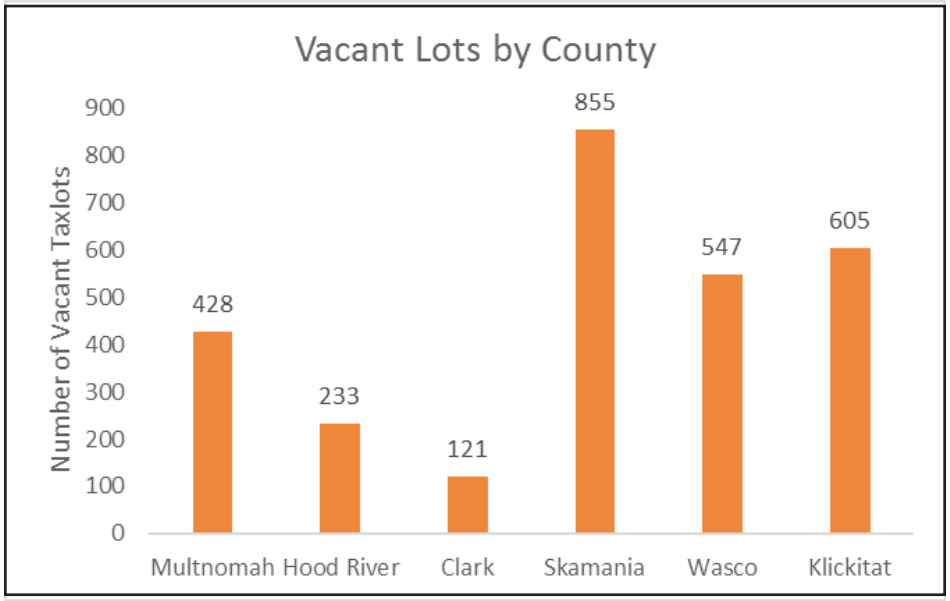
Results Overview

The built vs. vacant land study and the dividable lands study produced valuable information that can be used by the Commission to evaluate the impact that the Management Plan has had on the NSA. The LiDAR analysis demonstrated that feature extraction using LiDAR data could be used in future work with buildable lands in the NSA. The land-use/ land-cover change analysis showed that only forest lands showed any significant change over the time period between 2001 and 2011, where data were available. Detailed results of the four studies are below.



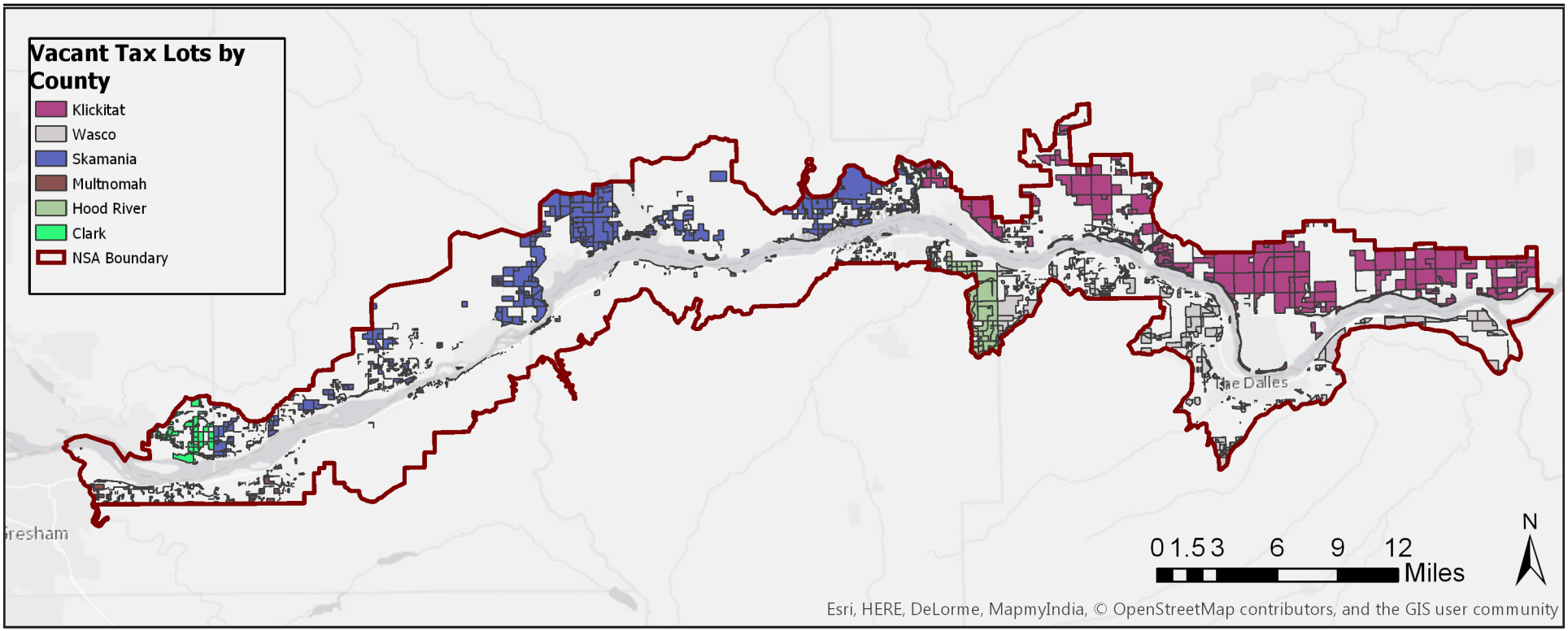
Built vs. Vacant Land

There are 26,812 tax lots within the NSA boundary, including urban areas, and 8,501 of those are located outside of urban areas. Of these 8,501 tax lots, 7,296 are privately owned, and 2,789 are vacant. “Vacant” in this context simply means that there is no physical building on the tax lot. This study does not indicate if the tax lots are being used for agricultural, forest, or other purposes that do not require a physical building for their operation. For example, an agricultural tax lot with no structures may still be a viable and productive farm. Therefore, the number of vacant tax lots identified in this analysis should not be equated with the number of unused tax lots in the area (the number of unused lots is likely lower).



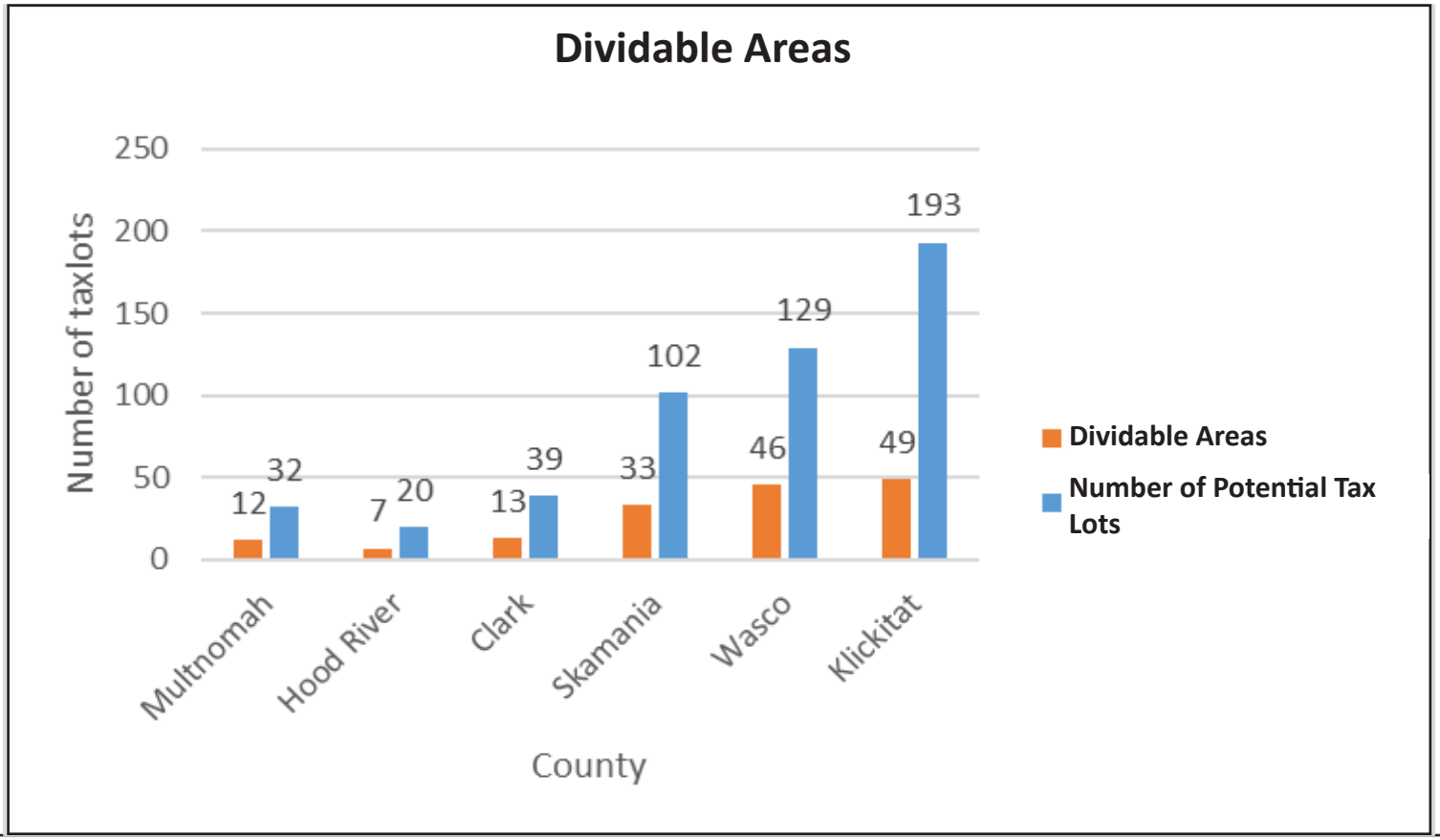
The map on the following page shows the geographic distribution and size of vacant parcels in the NSA. The eastern NSA counties of Wasco and Klickitat accounted for more than one-third of the vacant tax lots in the NSA. Skamania county, which also accounts for more of the NSA’s area than any of the other counties, had the greatest number of vacant tax lots. The western NSA counties of Multnomah and Clark accounted for less than one-fifth of the vacant tax lots.

A map of undeveloped parcels in the NSA, according to county tax assessor's data.

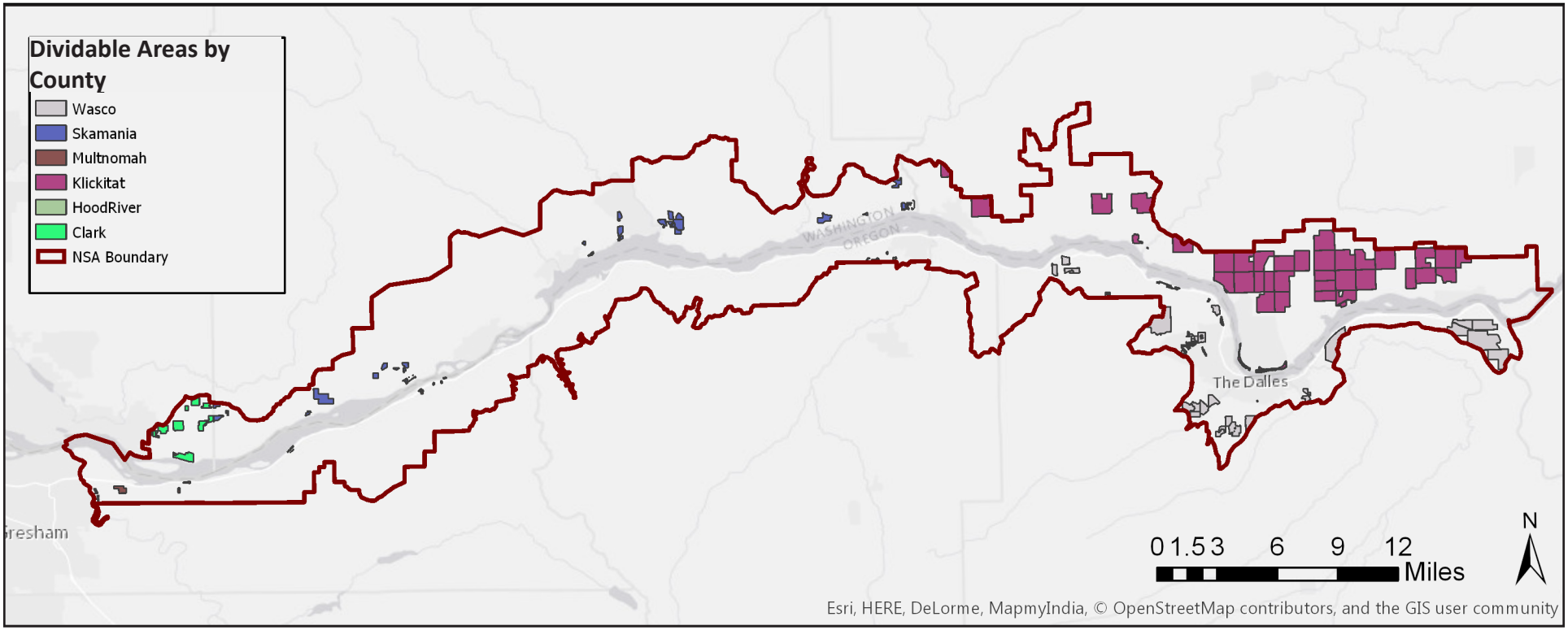


Dividable Lands

Of the 8,501 tax lots in the study area, only 160 areas are eligible for land division under the current minimum parcel size designations. Klickitat and Wasco counties had the highest number of areas eligible for land divisions—49 and 46 areas respectively. Hood River County had the fewest, with only 7 dividable areas. If all 160 areas eligible for land division were divided into the smallest lot sizes allowed, they would create 355 new tax lots.



A map of areas in the NSA eligible for division under the current Land-Use Designations.

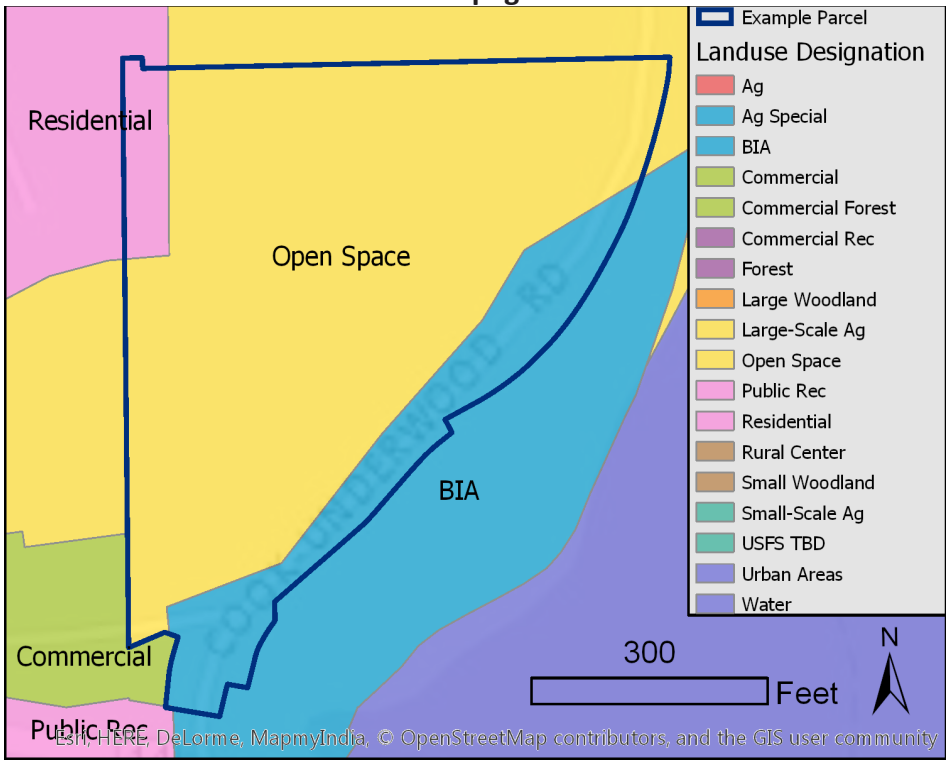


Dividable and Vacant Lands by Land-Use Designation

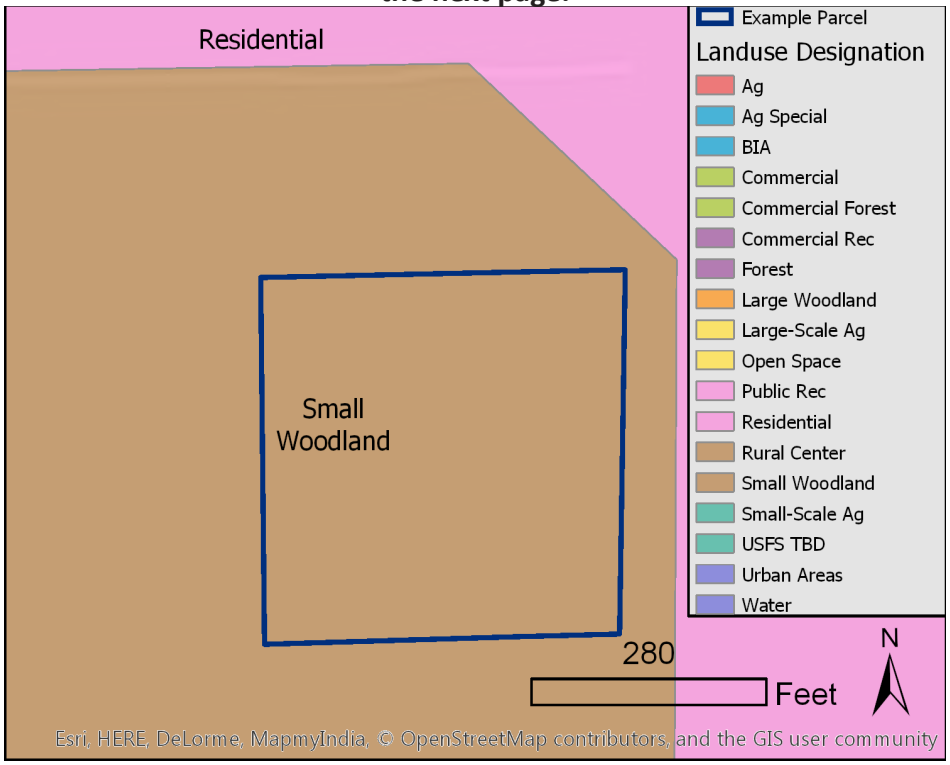
To evaluate the past and future potential impacts that the NSA Land-Use Designations might have on built and dividable tax lots, the two previous datasets were compared to the zoning of the individual tax lots. To do this for vacant tax lots, the ArcGIS Spatial Join tool was used to find vacant tax lots that are located entirely within one NSA Land-use Designation. For dividable tax lots, the ArcGIS Summarize tool was used to aggregate dividable tax lots by land use designation.

The number of vacant tax lots presented here are not equal to the number of vacant tax lots presented previously. That is because this analysis only looked at tax lots that are located entirely within one Land-use Designation. Split zone tax lots are not addressed at this time and will be addressed either when the Commission establishes a methodology for doing so or when there is time to review each split zone lot and determine its development potential.

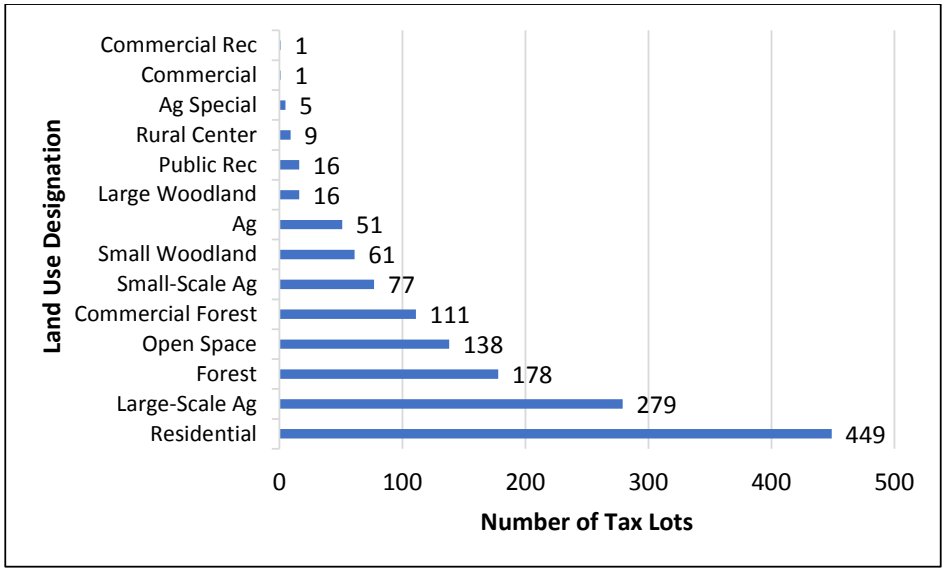
Below is an example of a split zoned parcel. This parcel has three zonings. It would not be included in the vacant tax lot figures on the next page.



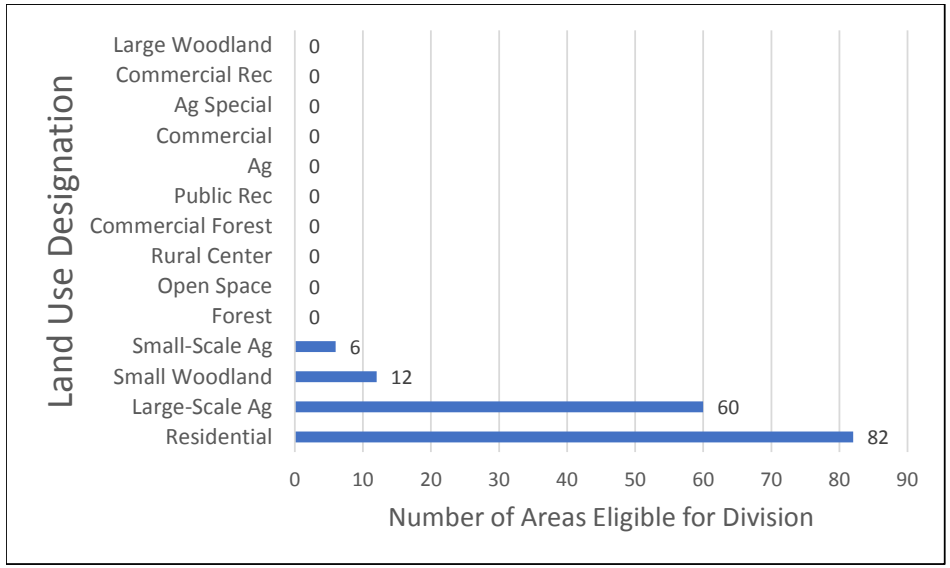
Below is an example of a tax lot that lies entirely within a single Land-use Designation. It would be included in the vacant tax lot figures on the next page.



The number of vacant tax lots in each Land-Use Designation.



The number of dividable areas in each Land-Use Designation.



Land-use/Land-cover Change

The land-use/land-cover change study indicated that in the ten years between 2001 and 2011, there were no significant changes in land-cover in the NSA. Change in acreage was negligible (less than 100 acres) for all land-cover types identified in the NLCD model except forest cover.

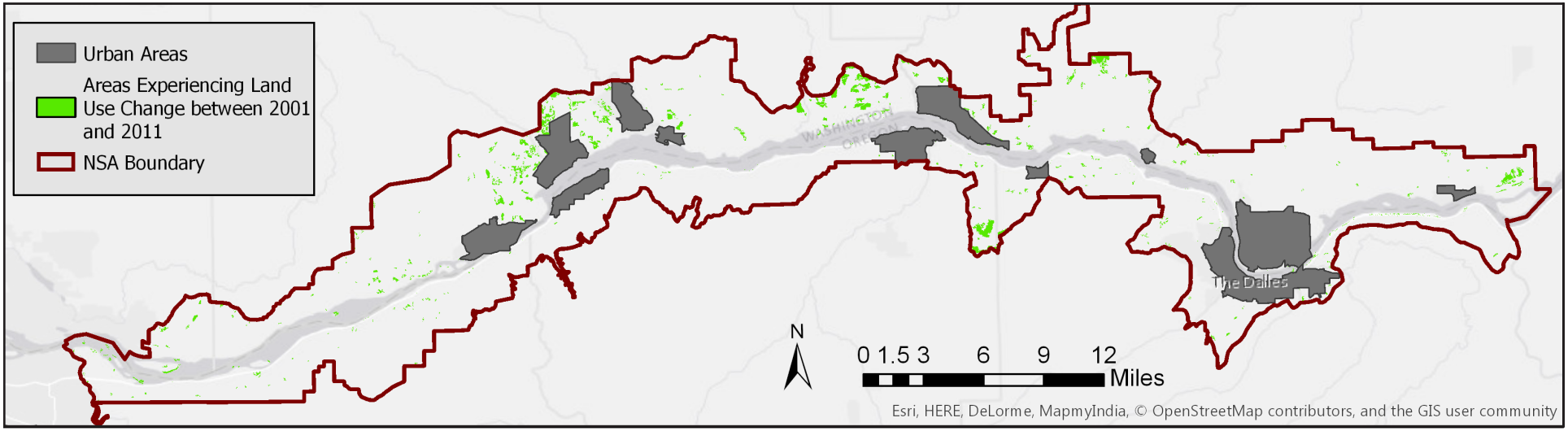
There were 1,637 fewer acres of identified forest cover in 2011 than in 2001, a -1.45% change since 2001. The majority of this loss occurred in southeastern Hood River County and northwestern Klickitat County. However, this fact should not be misconstrued to mean that the NSA has lost forest land.

Land-use and land-cover, while often used synonymously, are not equivalent. For example, within the GMA, forest practices such as clearcutting are allowed, so long as they are consistent with the Oregon and Washington Forest Practices Acts. While the aerial imagery-derived NLCD model would identify a clearcut area as a loss of forest cover, that area may still be designated and used as forest land. An in-depth investigation would be necessary to identify which areas of forest cover loss represent actual changes in land-use.

This graph shows changes in land-use and land-cover in the NSA between 2001 and 2011. The development types are established by the Multi-Resolution Land Characteristics (MRLC) Consortium. Details of each Development Type can be found at https://www.mrlc.gov/nlcd06_leg.php

Development Type	2001 (Acres)	2011 (Acres)	% Change	Change (Acres)
Developed, Open Space	9,429	9,358	-0.76	-71
Developed, Low Intensity	4,551	4,543	-0.19	-8
Developed, Medium Intensity	1,384	1,473	6.45	89
Developed High Intensity	268	278	3.65	10
Forest	113,082	111,445	-1.45	-1,637
Cultivated Crops	10,870	10,899	0.27	29
Pasture Land	3296	3258	-1.16	-38
Wetlands	5744	5711	-0.58	-33
Barren Land	3506	3449	-1.63	-57

This map highlights only those areas in the NSA that showed changes in land-use/land-cover between 2001 and 2011. For a detailed breakdown of land-use and land-cover in the NSA in 2001 and 2011 see appendices 3 through 5



LiDAR Building Identification

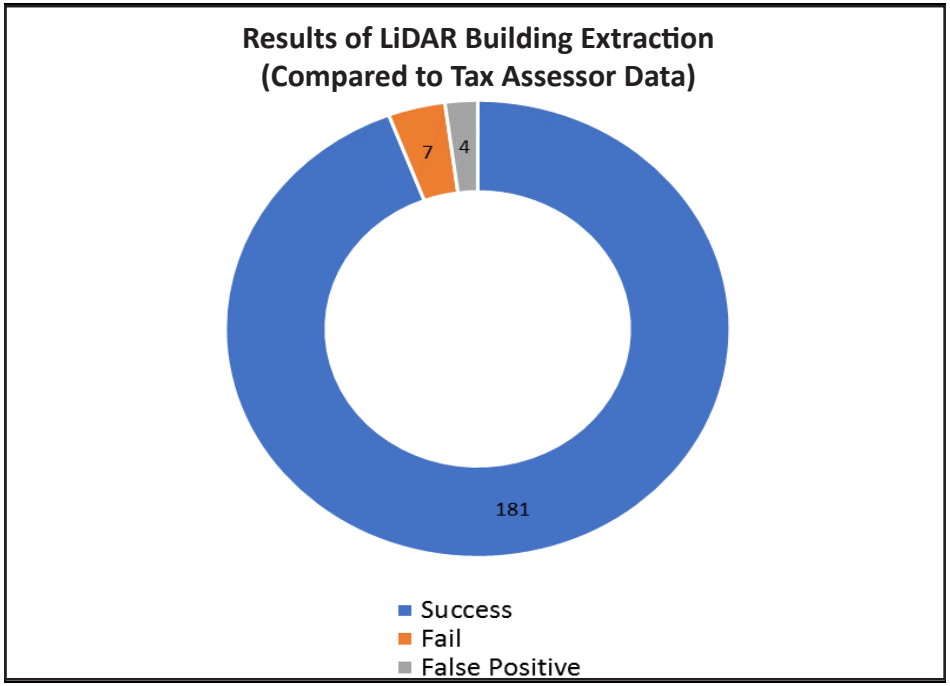
The LiDAR model performed very well in identifying buildings in the study area compared to the tax assessor's data. The model successfully identified 181 of the buildings recorded by the tax assessor, and only failed to identify seven of the structures. However, this failure could be attributed to structures that were constructed subsequent to the LiDAR data collection date in 2015.

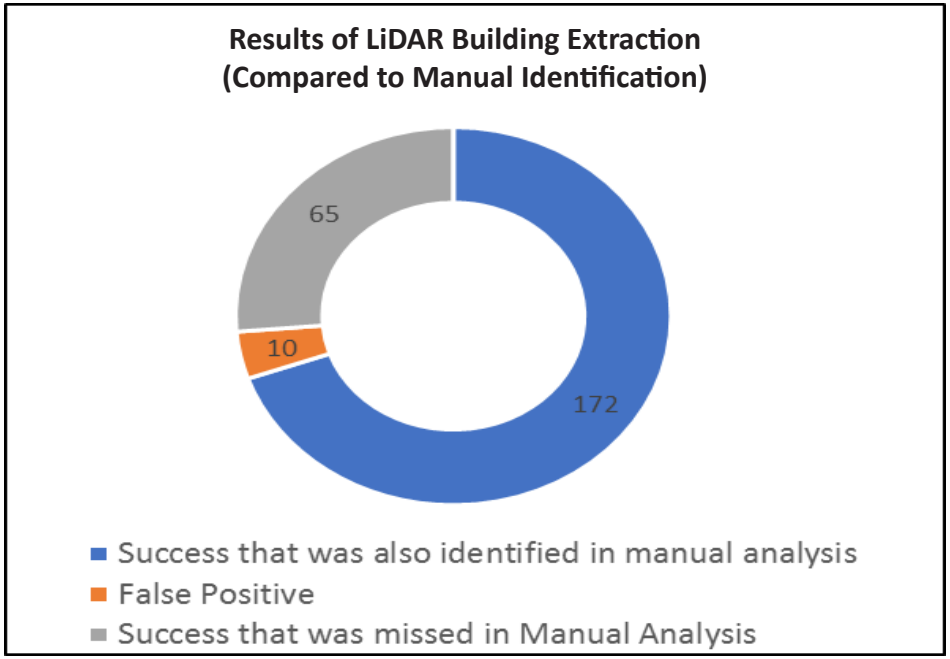
The model also identified four buildings that were not recorded by the tax assessor (labeled as false positives in the diagram below). However, a manual analysis of aerial imagery showed that there were in fact buildings in those locations and the model did not have any real false positives.

As stated previously, the advantage that LiDAR building extraction has over tax assessor data is that it shows the location of a building on a property and can identify multiple buildings, as opposed to providing a "built or unbuilt" metric that contains no locational information.

To further test the accuracy of the LiDAR extraction, a manual analysis of aerial imagery was conducted to identify existing buildings in order to create a baseline from which to measure the success of the LiDAR model in identifying buildings.

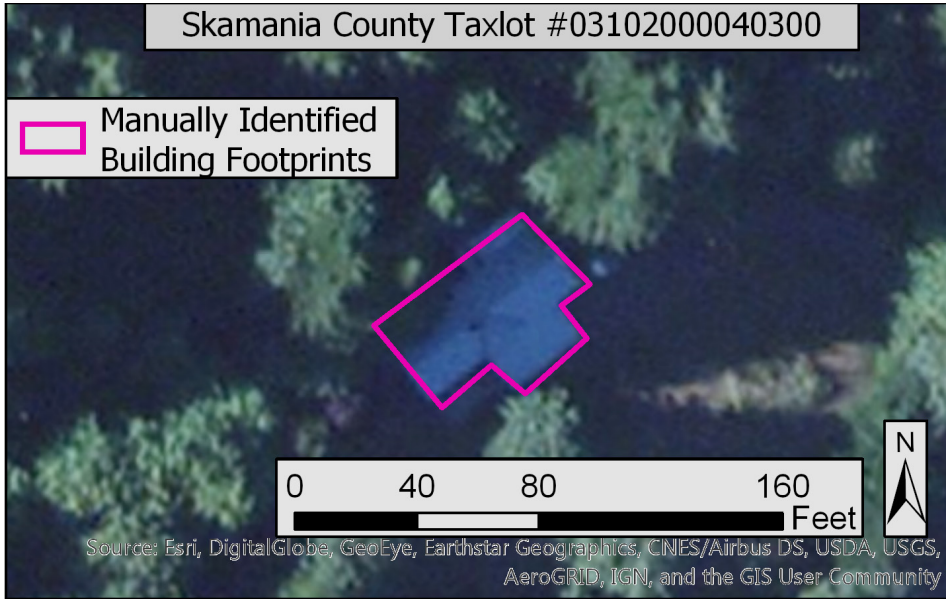
When compared to tedious manual analysis, the LiDAR method performed far better. The LiDAR model predicted every building that was identified in the manual analysis. Additionally, the LiDAR model identified 65 structures that were missed in the manual analysis. Only 10 buildings identified by the LiDAR method proved to be false positives, or buildings that did not exist.



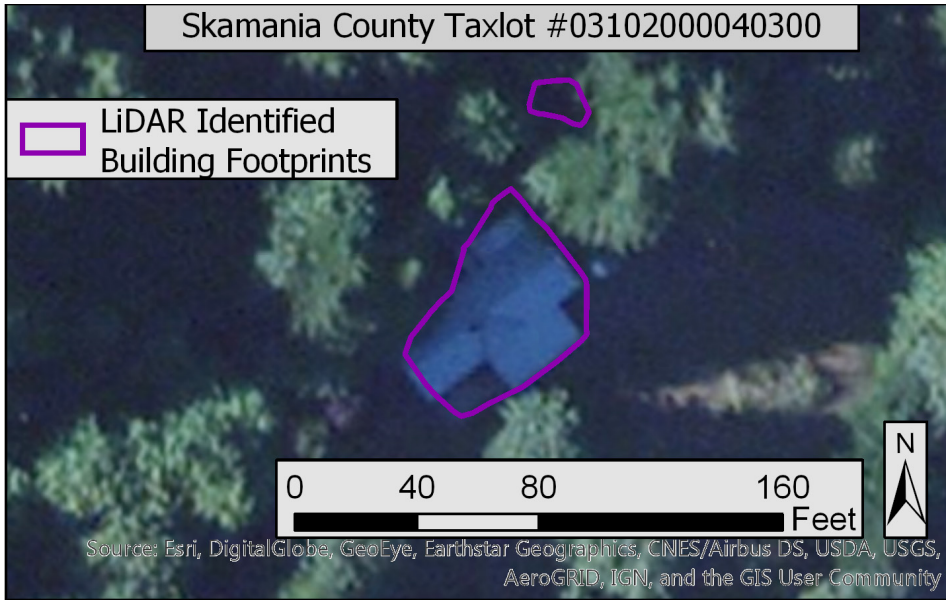


Example of LiDAR Identification vs. Manual Visual Identification

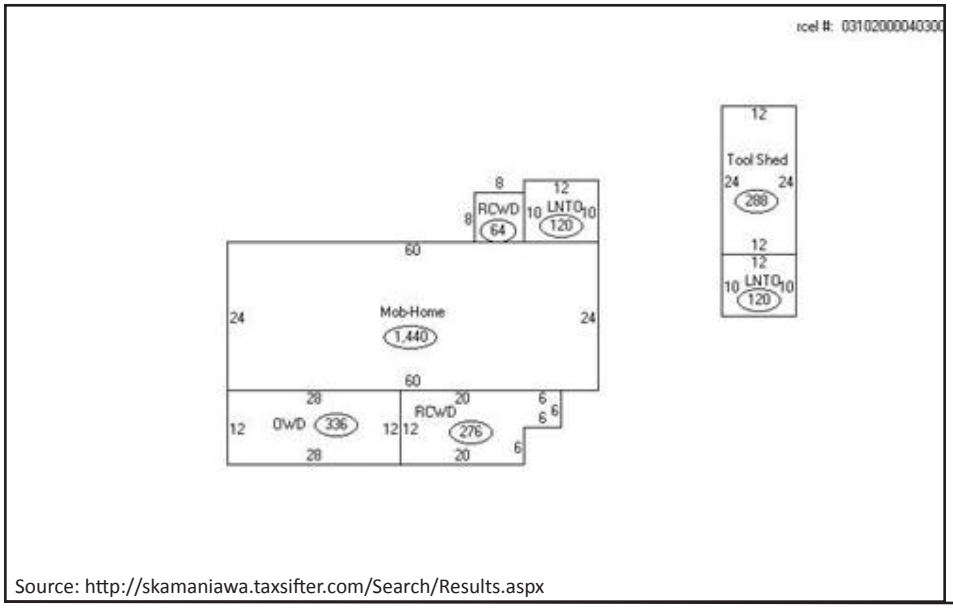
A manual analysis found only one structure on this wooded parcel.



The LiDAR analysis shows two structures on the parcel.



Public tax assessor data confirms that there are two structures.



LiDAR was able to locate this shed despite thick tree canopy

CONCLUSION

Summary

The analyses in the vacant lands inventory and the dividable lands inventory produced results that will help guide the Gorge Commission in the current review and revision of the Management Plan.

The LiDAR analysis shows that LiDAR data, if available for the entire study area, could be used in place of local tax assessor data. This would eliminate the uncertainty of using data from multiple sources with disparate standards.

The vacant lands study shows that there are a significant number of tax lots that have not been developed with a physical building, but does not indicate if those tax lots are being used for agricultural, forest, or other purposes that do not require a physical building for their operation.

The dividable lands study shows that there are few tax lots that may be divided into new parcels under the current minimum parcel sizes allowed in the Management Plan.

The LiDAR analysis shows that a future inventory of buildable lands in the NSA could theoretically rely on LiDAR remotely sensed data instead of county tax assessor information. This would remove the uncertainty of relying on different data sets from each county that have been developed using different standards.

Future Work

The Commission can use the information presented here to help identify areas in which the standards set forth in the Management Plan have successfully protected resources. In places where protection has exceeded management goals, guidelines may be relaxed. Conversely, where goals are not being met, the Commission can consider whether to adjust those standards going forward.

While this BLI provides information regarding the current state of development in the NSA, it does not consider future changes in policy, socio-economic issues, or community interests and needs. However, knowing the location of vacant parcels and dividable parcels allows the Commission to plan for these changes, such as projected increases in density. Therefore, maintaining an updated, current BLI is necessary to inform the Commission in future reviews and revisions of the Management Plan.

The promising results of the LiDAR analysis suggest that remote sensing techniques could be used in conjunction with tax assessor data to identify built and vacant parcels in the NSA. The advantage of using LiDAR as a primary data source is that it would provide a uniform method of identifying built parcels in the NSA, versus relying on local tax assessor data that uses different methodology in each county. The downside is that obtaining LiDAR data is currently expensive, requires more staff time, and the data would need to be collected at specific intervals to monitor change in the built environment of the NSA, adding to the cost and time needed. Other remote sensing data, such as LANDSAT satellite data, could be used, but this would require an additional study to determine the viability of using such data.

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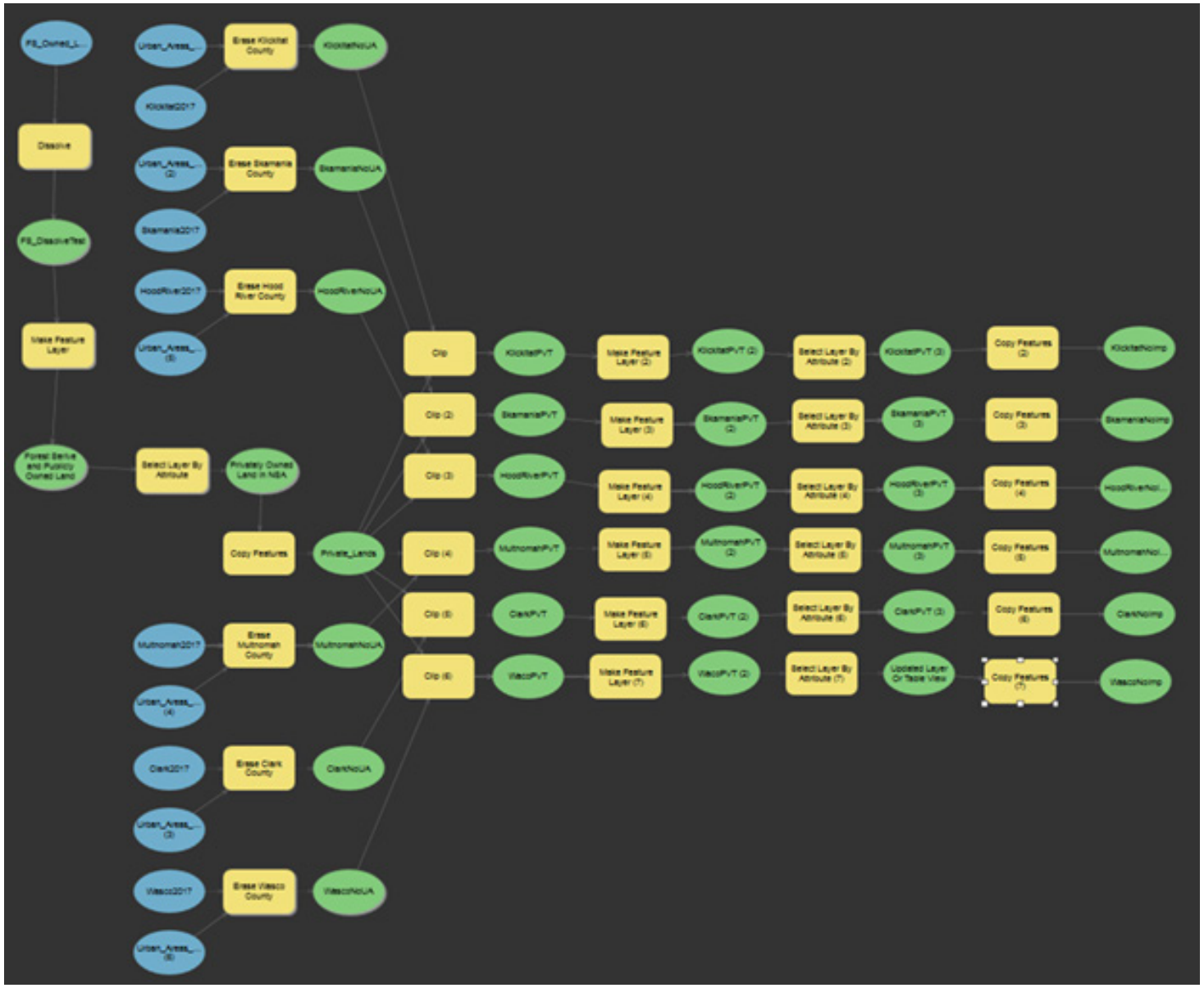
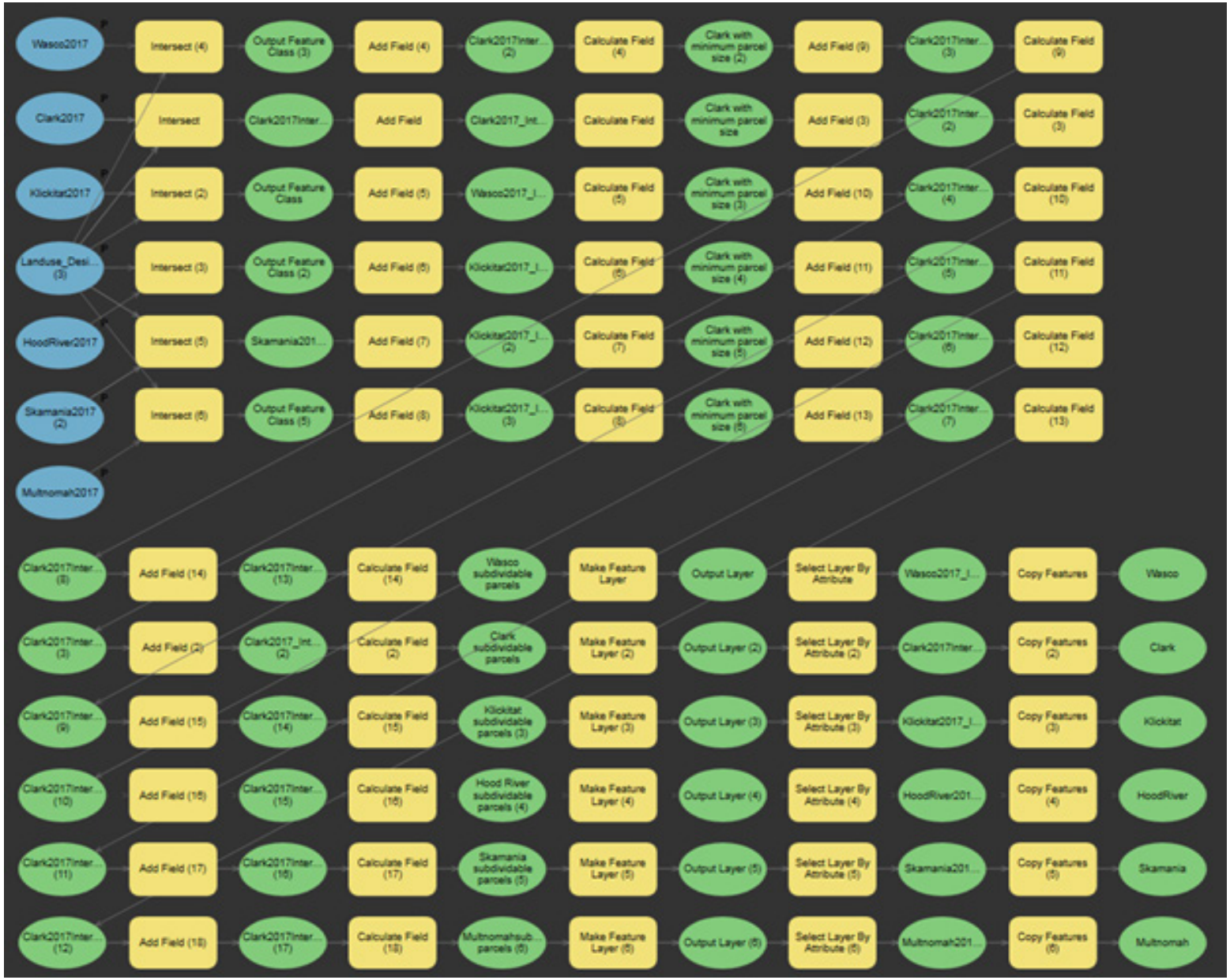
Appendix 1: Vacant Land Model in ArcGIS ModelBuilder

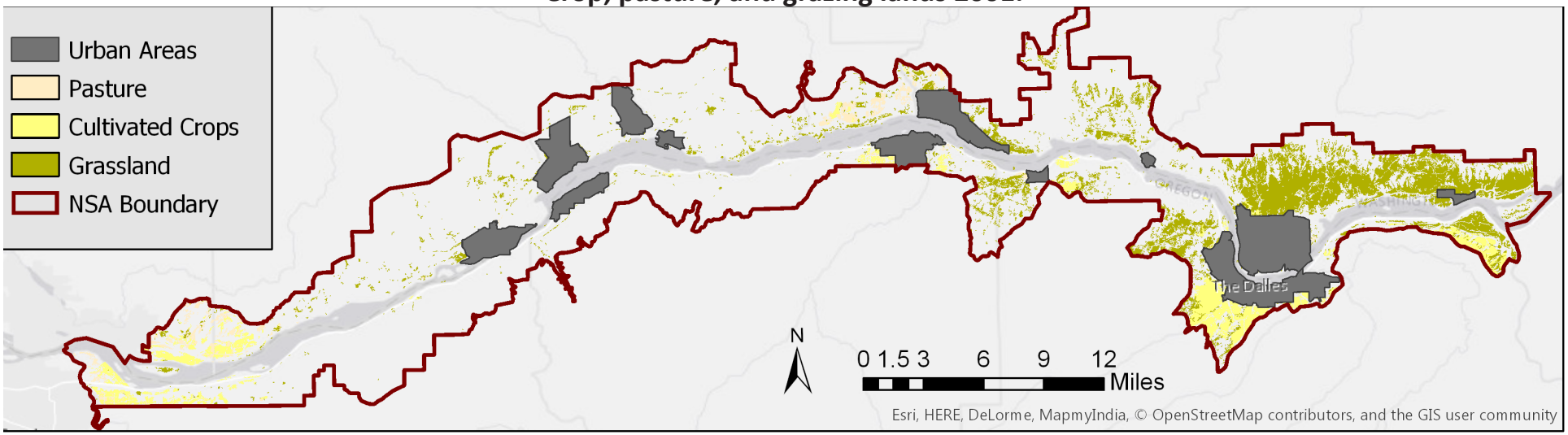


Appendix 2: Dividable Land Model in ArcGIS ModelBuilder

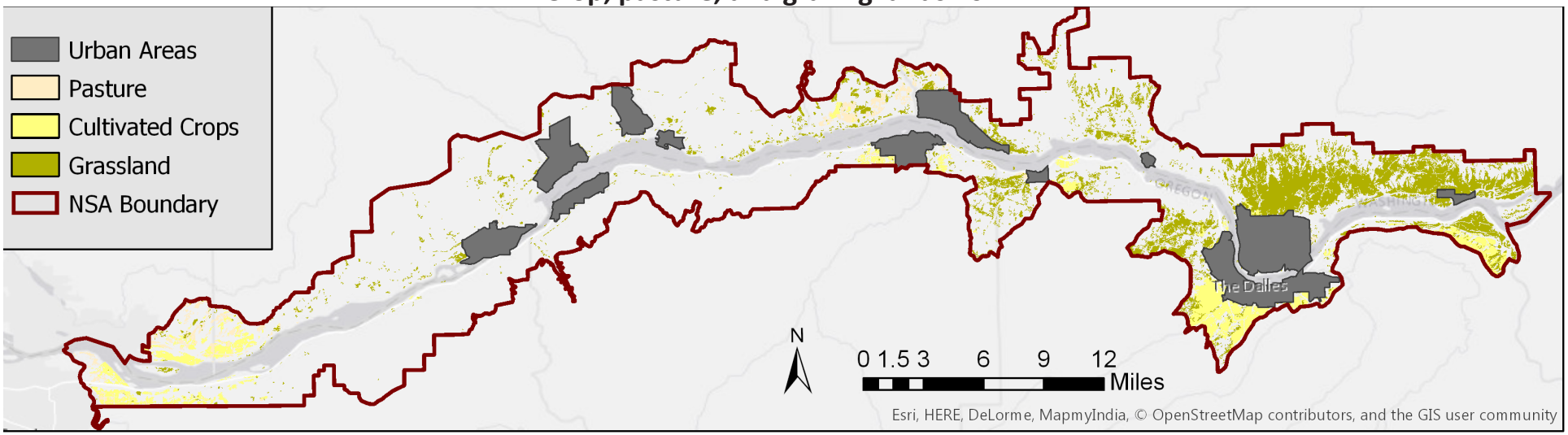


Appendix 3: Change in Crop, Pasture, and Grazing Lands 2001-2011

Crop, pasture, and grazing lands 2001.

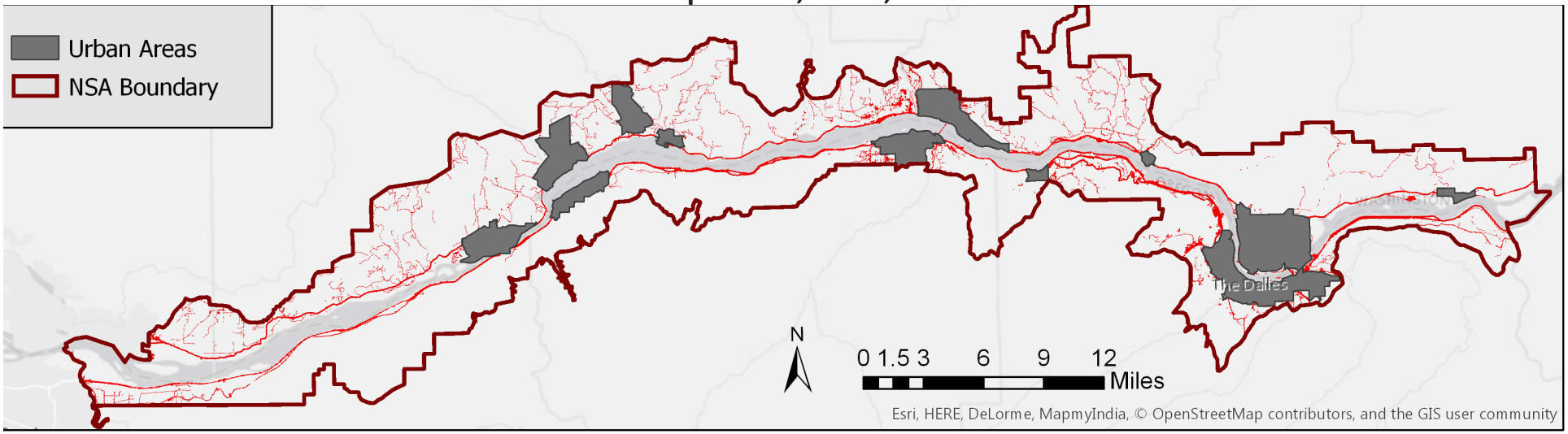


Crop, pasture, and grazing lands 2011.

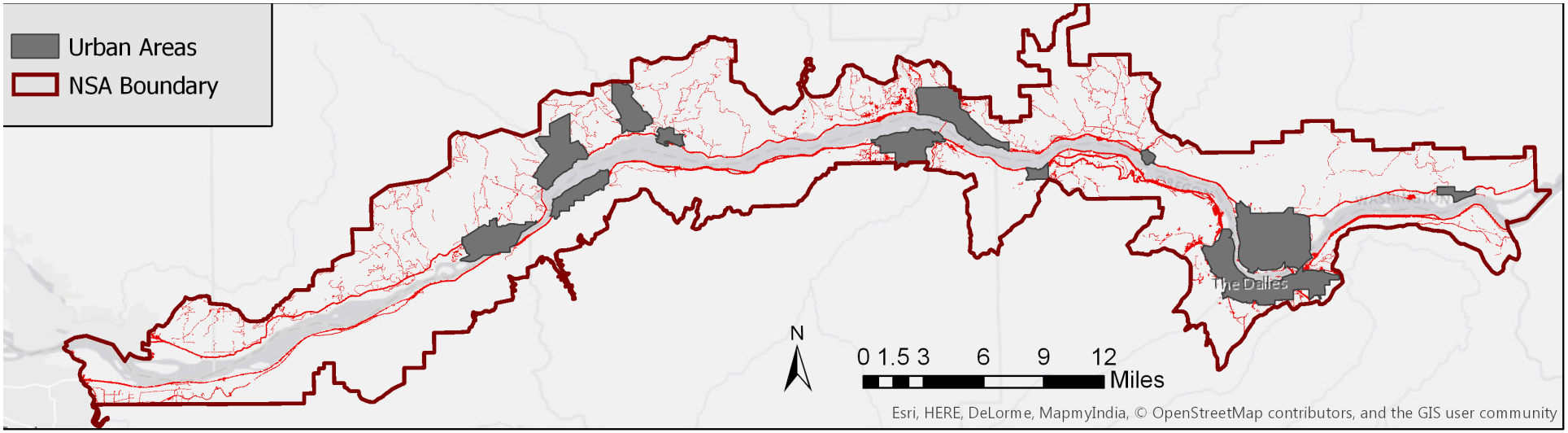


Appendix 4: Change in Developed Lands 2001-2011

Developed land, in red, 2001.

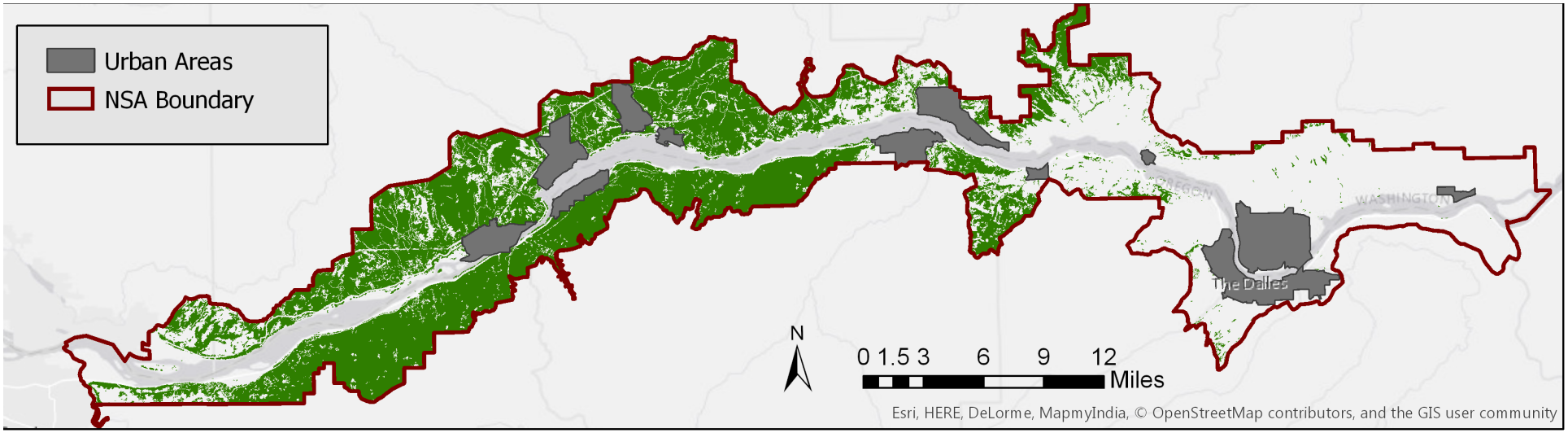
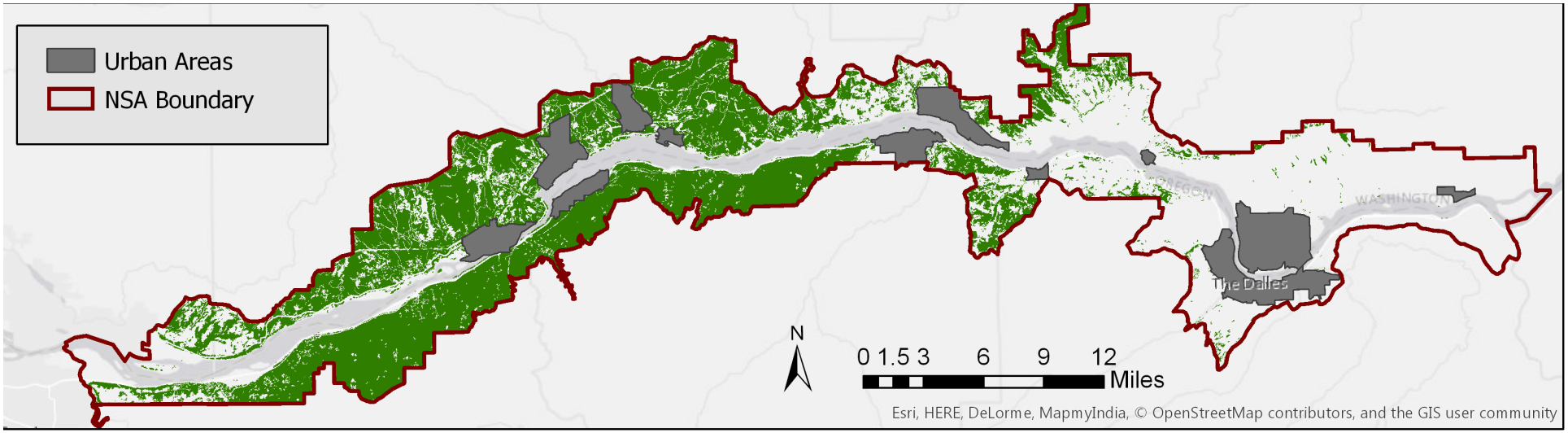


Developed land, in red, 2011.



Appendix 5: Change in Forest Lands 2001-2011

Forest lands in the NSA 2001.



Forest lands in the NSA 2011.