APPENDIX E

UNIVERSITY OF WASHINGTON – COLLEGE OF FOREST RESOURCES

The 2007 Washington State Forestland Database

Final Report

Luke W. Rogers and Andrew G. Cooke

3/24/2009

Prepared under contract for the USDA Forest Service

Executive Summary

Beginning with the passage of Washington State House Bill 2091, otherwise known as the Salmon Recovery Act (1998), the State has had an interest in quantifying the numbers, acres and other characteristics of small forest landowners (SFLO) and their lands. The Washington State Forestland Database was developed to provide a comprehensive platform for understanding the spatial characteristics of all private forestland ownership in the state, including family forests. The Database is an ArcGIS 9.2 Geodatabase and designed for use in Microsoft Access or any ESRI ArcGIS product.

The Washington State Forestland Database combines land ownership, land use and assessment information with physical characteristics of the land to develop economic, social and environmental metrics about the forest land base. The spatially-explicit information in the database allows for analysis at the watershed, county and state level. This high-resolution dataset can produce maps, statistics and models at multiple scales. Over time it will become a comprehensive platform for understanding how forest land ownership and land use is changing, thereby enabling new science and research to inform public policy analysis, debate and action.

Three primary products were developed: the Washington State Forestland Database, statistics on the numbers and acres of forestland parcels and maps of the distribution and extent of private forestlands. Statistics derived from the Database reveal that 215 thousand small forest landowners own 5.7 million acres of forestland, half of the 11.6 million acres of private forestland in the state. Over 89 thousand of those small forest landowners have ownerships greater than 10 acres and 55 thousand own more than 20 acres. The maps of the distribution of forestlands in the State of Washington show that small forest landowner properties, often adjacent to suburban and exurban lands, provide a critical buffer between upland industrial forestlands and lowland residential areas.

To map and quantify the location and features of forestlands, parcel data and assessor's attributes from the state's 39 counties were collected and normalized into a common statewide format. In counties where no GIS parcel data exists, GIS "pseudo-parcels" were developed from assessor's legal descriptions. The three million individual parcels in the normalized database were then compared to forestland cover maps developed from Landsat satellite imagery as part of the National Land Cover Dataset. In addition to the land-cover assessments, assessor's tax-rolls were used to identify forested land uses as well as participation in forestland tax programs. Forest land parcels as small as 1 acre were included in the database.

Owner names, categories and style of forest management were classified into five "owner type categories": government, corporate, tribal, conservation and other private. Using owner type and number of acres, parcels were classified into management types: industrial or small forest land owner. By use of the Landscape Management System, the management regimes and the physical characteristics of the property, including site index, forest type and regulatory buffers, were modeled to develop a financial profile for each forest parcel. In addition, multiple physical and political characteristics were computed for each parcel such as distance to development, proximity to roads, distance from a designated Urban Growth Area and contiguous ownership area.

Table of Contents

Executive Summary 106
Table of Contents 107
List of Figures 109
List of Tables 109
Acknowledgements 110
Introduction and Background 111
Project Overview 112
Methodology 112
  Creating a Statewide Parcel Database 112
    Parcels Working Group 112
    Data Collection and Normalization 114
    Products 118
    Caveats 119
  Identifying Forestlands 120
    Determining Forest Acres 120
  Physical Characteristics 120
    East/West 120
    Buffers 121
    WRIA 123
    WAU 123
    Streams 123
    Proximity 123
  Economic Analysis 124
    Owner Classes 124
    Management Types 124
    Modeling forest growth 127
    Risk of conversion 133
Results 135
  Tabular/GIS comparison 135
    Purpose 135
    Methods 136
    Results 139
    Discussion 141
  Summary statistics 142
    Washington State Private Forestland Acres by Management Type 142
    Washington Small Forest Land Owners Acreages by Size Class 142
  Product descriptions 143
    Database 143
    Statistics 143
    Maps 143
Discussion 143
Limitations 144
Additional Data Needs 145
Conclusions 146
Works Cited 146
Appendix A: Attributes in the 2007 Washington State Parcel Database 149

Product Description 149
Database Design 149
Attributes 149
Parcels Table 149
Organizations Table 150
TaxRoll Table 150
Land Use Table 152
TaxRollHasNames Table 153
Names Table 153
NormalizedNames Table 154
Appendix B: Attributes in the 2007 Washington State Forestland Database 155
Product description 155
Database Design 155
Attributes 157
Land Use 157
Ownership Classification 157
Management Type 157
Physical Attributes 158
Economic Attributes 162
Appendix C: GIS Datasets Used 164
Appendix D: Statistics 166
Appendix E: Maps 169
Appendix F: Land Use Codes in the Forestland Database 177

List of Figures

Figure 1: County Participation in the Washington State Forestland Database. 115
Figure 2: Entity Relationship Diagram of the 2007 Washington State Parcel Database. 119
Figure 3: Parcel Data Availability for Washington State. 136
Figure 4: GIS Parcels for Lewis County. 137
Figure 5: Pseudo-Parcels for Lewis County. 137
Figure 6: GIS Parcels around Wildwood and Vader, Lewis County. 138
Figure 7: Pseudo-Parcels around Wildwood and Vader, Lewis County. 138
Figure 8: Washington State Private Forestland Ownership Acres by Management Type 142
Figure 9: Washington Small Forest Land Owner Acreage by Size Class 142
Figure 10: Washington State Parcel Database Entity Relationship Diagram 149
Figure 11: Washington State Forestland Database Entity Relationship Diagram. 156
Figure 12: Private Forests and Public Lands in Washington State. 169
Figure 13: Washington Small Forest Land Owners and Forest Cover. 170
Figure 14: The Percent of County Area Owned by Small Forest Land Owners. 171
Figure 15: The Number of Small Forest Land Owner Parcels per County. 172
Figure 16: Small Forest Land Owner Density, Counties. 173
Figure 17: The Percent of WAU Area Owned by Small Forest Land Owners. 174
Figure 18: The Number of Small Forest Land Owner Parcels per WAU. 175
Figure 19: Small Forest Land Owner Density, WAUs. 176

List of Tables

Table 1: Parcels Working Group Participants. 114
Table 2: Sample State, Federal and Private Applications. 114
Table 3: Wetland Buffer Distances 122
Table 4: Stream and Body of Water Buffer Distances. 122
Table 5: Site index, SDI Max, and rotation length for site class and ownership in Western Washington. 127
Table 6: Simplified harvest by buffer zone for western Washington. 128
Table 7: Site/owner class scenarios for western Washington. 128
Table 8: Site index, SDI Max, and rotation length for site class and ownerships in Eastern Washington. 129
Table 9: Simplified harvest by buffer zone for eastern Washington. 130
Table 10: Site/owner class scenarios for eastern Washington. 131
Table 11: Uneven-aged scenarios for Eastern Washington. 132
Table 12: Acres and Percent of County in Forestland Ownership by Owner Class. 139
Table 13: Acres and Percent of Ownership in Buffers by Management Type. 140
Table 14: Length of Streams in Feet. 140
Table 15: Length of Streams in Feet for SFLO Parcels and Percent of Total. 140
Table 16: Length of Streams in Feet for Industrial Parcels and Percent of Total. 141
Table 17: Length of Streams in Feet for all Private Parcels and Percent of Total. 141
Table 18: Forestland Database primary/foreign key relationships for thematic mapping. 155

Acknowledgements

Luke Rogers	Principal Investigator
Andrew Cooke	Research Consultant
Ara Erickson	Research Consultant
James McCarter, Ph. D.	Research Scientist

The Family Forest Foundation and the Washington State Farm Forestry Association advocated for funds to develop a database of family forestlands in Washington State, resulting in a 2006 federal budget allocation of $500,000 for a "private landowner database." This allocation culminated in a USDA Forest Service contract with the Rural Technology Initiative to create the Washington State Forestland Database. This project could not have been completed without their combined efforts. We would like to thank the FFF and the WFFA for their unrelenting efforts to help quantify and better understand the interactions between policy and science and for their continued support of a project that has benefits far beyond their parcels of forestland.

In addition, David Jennings at the Washington State Department of Health has been an advocate and supporter of the Washington State Parcel Database, the foundation upon which the Forestland Database was constructed. The Department of Health allocated $210,000 to RTI to continue development of the Parcel Database and ensure its long-term success and availability. We thank David for his work in co-chairing the Parcels Working Group and for championing a statewide cadastre at our State agencies.

Much of the success in assembling the first versions of both the Parcel and Forestland Databases can be attributed to the hard work of RTI staff Ara Erickson (now with the Cascade Land Conservancy) and Steve Stinson of the Family Forest Foundation. Ara's relentless commitment to deadlines, eternally optimistic outlook and cheerful demeanor were critical to developing sustainable and trusting relationships with the counties. Steve Stinson's tireless pursuit of good science, his willingness to track down even the most obscure detail to ensure accurate statistics from the Database and the Family Forest Foundation's support of this project will have enduring value for our State.

We thank Brad Coston for his support of both hardware and software on the servers needed to manage, store, backup and process data for this project. We thank Matthew McLaughlin for his help in sifting through tens of thousands of records in the database to validate methods and ensure accuracy. We thank Brian Boyle, Gordon Bradley, Alicia Robbins, Bob Rose and members of our Technical Review Committee for sharing their knowledge and thoughtful advice about assumptions and methods.

Lastly, and most importantly, we thank the county assessors, their GIS staff and the Washington State Association of County Assessors for their participation in both the Parcel and Forestland Database projects. Without the diligent work of our county assessors, their appraisers and their GIS personnel we could not have developed such a comprehensive platform to quantify and improve understanding of our State's natural resource lands. The data counties assemble and maintain is a critical resource for the State and we appreciate their willingness to share their data and knowledge.

Introduction and Background

Beginning with the passage of Washington State House Bill 2091, otherwise known as the Salmon Recovery Act, the State has had an interest in quantifying the numbers, acres and other characteristics of small forest landowners (SFLO) and their lands. In 2001, the Rural Technology Initiative (RTI) began this work by assembling the Washington State Department of Natural Resources Small Forest Landowner Database from county tax records to create the first spatially explicit database of family forest parcel information. At the time, very few of Washington's counties had Geographic Information Systems (GIS), making spatial location of the parcels problematic and labor-intensive. Legal description information from the county assessors was used to geo-locate each individual parcel from the tabular tax records to a specific township, range and section. Although this information was very coarse, it presented us for the first time with a picture of the unique spatial distribution and geographic relevance of family forests in Washington State.

Since 2001 most counties have acquired GIS capability and are managing parcel boundaries and tax rolls digitally. The continued development of county assessor's GIS-based tax rolls brings new opportunities to refine and reevaluate family forestland metrics in the state. In 2005 a partnership of The Family Forest Foundation and the Washington State Farm Forestry Association was successful in advocating for funds to develop a database of family forestlands in Washington State and in the Federal Government's 2006 budget $500,000 was allocated for a "private landowner database in Washington State." Based on their experience with quantifying the forest land base in Washington State and their knowledge of county GIS parcel data the Rural Technology Initiative at the University of Washington's College of Forest Resources was awarded a contract from the US Forest Service to develop a Washington State Forestland Database.

The development of the Washington State Forestland Database consists of six primary components: collection of county GIS parcel data and associated assessor tax rolls from Washington's 39 counties; normalization of acquired data into a single statewide parcel database; analysis and integration of physical and political features; determination of landowner class and type; modeling forest management opportunity and economics; and developing and documenting products for use by others. By repeating this process annually or as funding allows researchers also hope to be able to analyze trends over time. Recognizing that federal appropriations and state budget allocations are an unreliable source of funding researchers chose to seek partnerships with state and federal agencies that would benefit from a Washington State Parcel Database and in collaboration with dozens of partners created and now co-chair the Washington State Parcels Working Group.

The Forestland Database is an extensive platform for understanding the changing forest land base and implications for the economy, ecology, wildlife and citizens of Washington State. By combining information on natural resources, environmental and land use regulations, and land ownership, scientists and policy analysts can gain insight into the complex interactions between public and private objectives. Over time, the database will enable researchers to detect changes in the forest land base and perhaps quantify the effectiveness of policy decisions.

Project Overview

To map and quantify the location and features of forestlands in the state of Washington data parcel data and assessor's attributes from the state's 39 counties was collected and normalized into a common statewide format. The three million parcels in the normalized database were then compared to forestland cover maps developed from Landsat satellite imagery as part of the National Land Cover Dataset. In addition to the land-cover assessments, assessor's tax-rolls were used to identify forested land-uses and participation in forestland tax programs. Using this method forest land parcels as small as 1 acre were included in the analysis.

To differentiate the types of owners and their style of forest management owner names were classified into five owner type categories: government, corporate, tribal, conservation, and other private. Using owner type and number of acres parcels were classified into management types: industrial or small forest land owner. Based on surveys done for the Future of Washington's Forests Report (Lippke, et al. 2007) industrial and small forest land owners manage their lands at different intensities. Using the Landscape Management System the management regimes and the physical characteristics of the property like site index, forest type and regulatory buffers were modeled to develop a financial profile for each forest parcel. By comparing the financial profile of individual parcels with the county assessor's appraised market values for the properties a relative risk of conversion metric was developed. In addition, multiple physical and political characteristics were computed for each parcel such as distance to development, proximity to roads, near an urban growth area, and contiguous ownership area.

Using the Washington State Parcel Database statistics on the number of owners, private forestland acres, forested riparian areas, risk of conversion and other metrics were tabulated. Maps showing the spatial extent and distribution of industrial and small forest land owners around the state were developed and thematic maps of the densities and quantities of these ownerships were produced. The database, statistics and maps quantify in exquisite detail the current forestland ownership patterns in the State and provide a platform for quantifying forestland change in the future.

Methodology

Creating a Statewide Parcel Database

The Washington State Forestland Database is built upon county assessor GIS parcels and related tax roll information. To create a foundation for the Forestland Database the concept of a Washington State Parcel Database was presented to interested parties and the Parcels Working Group was established.

Parcels Working Group

In October 2006 a group of federal, state, tribal, non-profit and local government participants came together to explore whether there was interest in and a willingness to pursue the development and coordination of a statewide parcel framework dataset that would be accessible to various participating agencies. As a substantial portion of the Washington State Forestland Database would be built from county parcel data, researchers actively participated in the meeting and the principal investigator, Luke Rogers, along with a representative from the Washington State Department of Health, David Jennings, were unanimously appointed to co-chair the newly formed Washington State Parcels Working Group.

Participation and leadership in the Working Group has potential long-term benefits for the Washington State Forestland Database project.

Early in the project researchers recognized that utilizing federal funds as a seed to develop a long-term program would have enduring value for understanding forestland conversion, ownership and conservation trends. However, the collection, normalization and assembly of a statewide parcel database is costly. An opportunity existed to reduce government redundancy, increase efficiency, reduce taxpayer's burden and provide a well documented, common dataset for use by government partners by producing a single statewide parcel database annually and sharing it among government. Previously, many individual state and federal agencies were periodically contacting counties to acquire parcel data. License agreements with counties were often restrictive and did not allow for sharing of parcel data or derivative products. Therefore, each agency was collecting and maintaining parcel data independently inflating the cost to taxpayers.

By helping establish the Parcels Working Group and collaborating with dozens of state and federal agencies researchers hope to: 1) reduce redundancy and increase timeliness and quality of statewide parcel data, 2) provide a common platform for land ownership related questions in Washington State, 3) leverage limited federal funds to develop a Washington State Parcel Database program, 4) share the normalized parcel data and derivative projects among government users. Over time researchers hope the cost of producing the Washington State Parcel Database can be distributed among the many state and federal government agencies benefiting from the use of the normalized statewide data. As the most expensive component of, and foundation for, the Washington State Forestland Database the cost of analyzing forestland trends over time can be significantly reduced by working collaboratively with the Parcels Working Group.

Accomplishments for the Parcels Working Group from October 2006 through December 2008 include:

- Conducted a parcel data "consumer survey"
- Conducted a parcel data "use case" assessment
- Developed a "Statement of Intent" about how we intend to interact with the Counties
- Fostered a open, collaborative and positive working environment between state, federal and local participants
- Developed a comprehensive website about the project documenting every phase of the effort
- Developed and released the 2007 Washington State Parcel Database to Working Group partners
- Identified opportunities to enhance the existing Public Records law in the State of Washington with respect to parcel data, "commercial use" and a "list of names"
- Held fifteen Parcels Working Group meetings in Olympia

Table 1: Parcels Working Group Participants.

Group	Participants
Local	Adams, Asotin, Benton, Chelan, Clallam, Clark, Columbia, Cowlitz, Douglas, Ferry, Franklin, Garfield, Grant, Grays Harbor, Island, Jefferson, King, Kitsap, Kittitas, Klickitat, Lincoln, Mason, Okanogan, Pacific, Pend Oreille, Pierce, San Juan, Skagit, Skamania, Snohomish, Spokane, Stevens, Thurston, Wahkiakum, Walla Walla, Whatcom, Whitman, WA Association of Counties
State	Community Trade and Economic Development, Health, Office of Financial Management, Natural Resources, Fish and Wildlife, Social and Health Services, Transportation, Revenue, Ecology, Inter Agency Committee, Information Services, Secretary of State, Information Services Board, Geographic Information Technology Committee, Washington Geographic Information Council, Emergency Management Division, State Patrol, Conservation Commission, Archeological and Historic Preservation, Legislative staff
Federal	US Geological Survey, Bureau of Land Management, Federal Geographic Data Committee, Environmental Protection Agency, United States Forest Service, US Bureau of Reclamation, Federal Emergency Management Agency, Department of Homeland Security
University	University of Washington
Tribal	Quinault Indian Nation, Northwest Indian Fisheries Commission
Non-Profit	Family Forest Foundation, Washington Farm Forestry Association

Table 2: Sample State, Federal and Private Applications.

Topic	Agency and Application
Climate Change	Ecology - Forest carbon accounting WSU Energy - Biomass and bio-fuel assessment UW - Land use forecasting impacts
Environmental	Ecology - Water quality monitoring Natural Resources - Salmon recovery prioritization Ecology - Resource land conversion Health - Well head protection and notification
Emergency Management	Emergency Management - Vulnerable populations Office of the Insurance Commissioner - Damage assessments Military - Critical infrastructure State Patrol - aviation guidance
Business Development	Facility location Market assessments Real estate
Social and Health Services	Association of Sheriffs and Police Chiefs - Sex offenders & school zones Social and Health Servies - Foster parent prioritization

Data Collection and Normalization

Collect Data from Counties

In the summer of 2007, the 39 counties in Washington State were contacted about providing parcel data to the Washington State Parcel Database. There were varying levels of interest and participation from individual counties. A key goal of the project was to not require special effort from counties in terms of

the data they provide the database, but rather to take their current data as is. As a result county data was provided in many formats, with non-standardized attributes and attribute names.

To aid the data collection process a website was designed to store information on county contacts, how to acquire data, phone and email conversions, and the data itself. The public facing portion of that website can be found on the web at http://depts.washington.edu/wagis/projects/parcels/producers/. Initially researchers contacted counties in August of 2007 via email and then followed up with phone calls and/or additional emails on approximately one month intervals. The bulk of the parcel data and assessor attributes were collected from September to December 2007. A few counties required additional help to extract data from their back-end systems. Wahkiakum County for example had no way to digitally extract data from their legacy database system. Working with the county assessor and a contracted consultant we designed and implemented a data extraction program that regularly exports the tax roll for public records requests and for use in other applications.

Ultimately data from all but 1 of Washington's 39 counties was acquired for use in the Washington State Forestland Database (Figure 1). However, many counties still do not have GIS-based tax rolls and were only able to provide tabular tax rolls with legal description information such as Township, Range and Section which could be referenced back to the public land survey system.

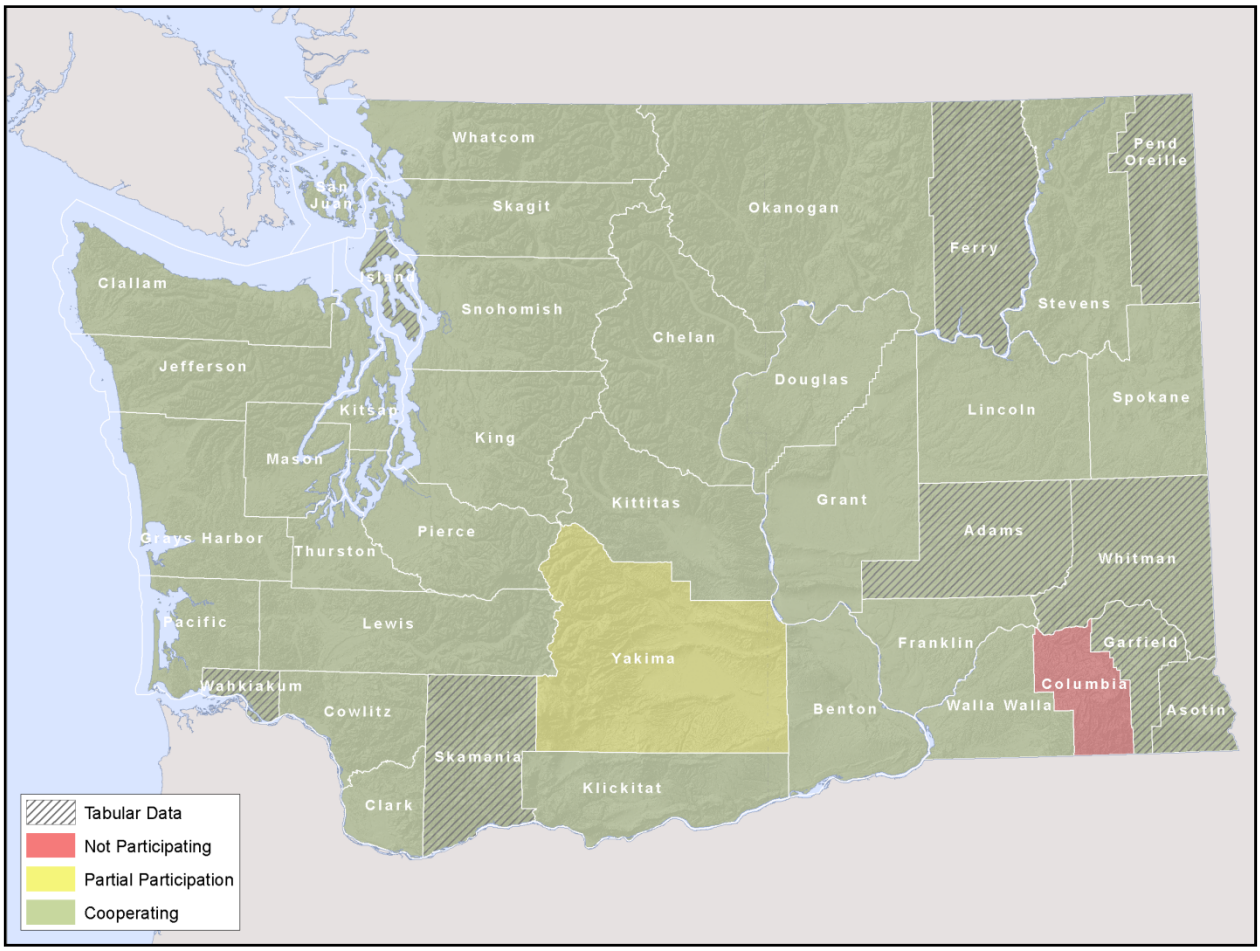

Figure 1: County Participation in the Washington State Forestland Database.

List of Attributes

The first step in normalizing the county data was to develop a set of standard attributes. All told, there were 1982 different attributes provided by the counties. These were rigorously examined to find common attributes. Due to differences in naming practices from county to county, the 1982 attributes could be reduced to 150 common attributes. To determine which attributes would be present in the Washington State Parcel Database, two decision rules were used. Firstly, if an attribute was present in 80% of the counties, then it was included. Secondly, all market and taxable value information, regardless of the number of counties using a particular attribute, was included.

Development of Pseudo-Parcels

The second step in normalizing the data was to create placeholder polygons for counties that did not have GIS parcel data. Using either the legal description information or the assessor's parcel identification number which is most often a concatenation of Township, Range and Section, a program was written to place representative parcels within approximately the same geographic area. Using the section polygons of the Public Land Survey System (PLS) data from the Washington State Department of Natural Resources each parcel was geographically located. For parcels that were not able to be located due to missing or incomplete legal descriptions and/or parcel ID numbers that were not based on PLS locations parcel polygons were located in the most accurate geographic area possible. For example, in Island County properties located in Oak Harbor had non-PLS based parcel id numbers. For those parcels the Office of Financial Management Cities layer (Washington State Department of Transportation 2007) was used to define the extents of the Oak Harbor area and each parcel was randomly located within the city boundary. Many parcels in Skamania County had no spatially identifying information and were randomly located within the county. So, depending on the county different spatial accuracies exist for individual parcels. A test of the relative accuracy of using these pseudo-parcels for generation of statewide statistics is evaluated in the results section.

FME Used to Transform Data

The third step in normalizing the data was to convert the data from the various formats provided by the county to a standardized GIS database format. The software, Feature Manipulation Engine (FME), produced by Safe Software, was used for this purpose. It is an Extract, Translate, and Load (ETL) program for GIS data. A data normalization program was created for each county which read in the original data, renamed and normalized the attributes, and deleted unwanted attributes. Many of the attribute translations were straightforward such as extracting house number, street, city, state and zip code information from a single address field. Other attributes like land use required more complex translation tables to convert county specific land use codes into a normalized statewide standard. The FME software also performed several spatial comparisons described below to address errors identified in the data.

Correcting Errors in the Data, QA/QC

While processing and normalizing the data for each county to a standardized statewide dataset, five possible procedures could have been applied: Removing Duplicate Parcels, Flattening Stacked Parcels, Creating Multipart Parcels, Removing Duplicate Names, and Removing Duplicate Tax Rolls.

The data for each county was tested to see whether or not these five procedures were applied. For each of these procedures applied in a county, one test parcel to which a process was applied was selected and tested to ensure the procedure was applied correctly.

A parcel to which none of the procedures was applied was also tested to make sure all of the normalized attributes in the original data were correctly transferred to the final dataset. It is therefore possible that six data quality tests were performed for each county.

The following five Procedures were performed in order on the data for each county in FME.

1. Removing Duplicate Parcels

   There are two or more polygons representing a single parcel in the original data. They have the same geometry and identical attribute information. These are assumed to be multiple copies of the same parcel, and so duplicates are removed leaving a single polygon and single set of attribute information in the final database. A duplicate field was created in the database recording how many duplicates of each parcel were in the original data.

2. Flattening Stacked Parcels

   There are two or more polygons representing a parcel in the original data, however, while sharing the same geometry, they have different attributes. These are assumed to be multiple owners for the same parcel. The polygon only needs to be in the final database a single time, but all original attribute information for the different owners needs to be retained. A stack field was created in the database recording how many stacked polygons there were in the original data for each parcel.

3. Creating Multipart Parcels

   There are two or more polygons in the original data with different geometries but identical attribute information. It is assumed that these parcels are all owned by the same owner. The original polygons are all retained as a single, multipart polygon, but duplicate versions of the attributes are removed. Only a single copy of the attribute information is needed in the final database. A multipart field was created in the database recording how many parcels were aggregated into each multipart polygon.

4. Removing Duplicate Tax Rolls

   Two or more parcels in a county have identical tax roll attributes. These attributes only need to be in the final database a single time. A duplicate tax roll field was created in the database recording how many of the original parcels shared each set of tax roll attributes.

5. Removing Duplicate Names

   Two or more parcels in a county have the same name attributes in the original data. These attributes only need to be in the final database a single time. A duplicate name field was created in the database recording how many of the original parcels shared each set of name attributes.

Products

Final Attributes and Database Format

The Washington State Parcel Database is made up of seven related tables, as presented in Figure 2. The attributes in each table are described in Appendix A: Attributes in the 2007 Washington State Parcel Database. Not all attributes are collected by each data providing organization, and therefore not all attributes are available for all parcels.

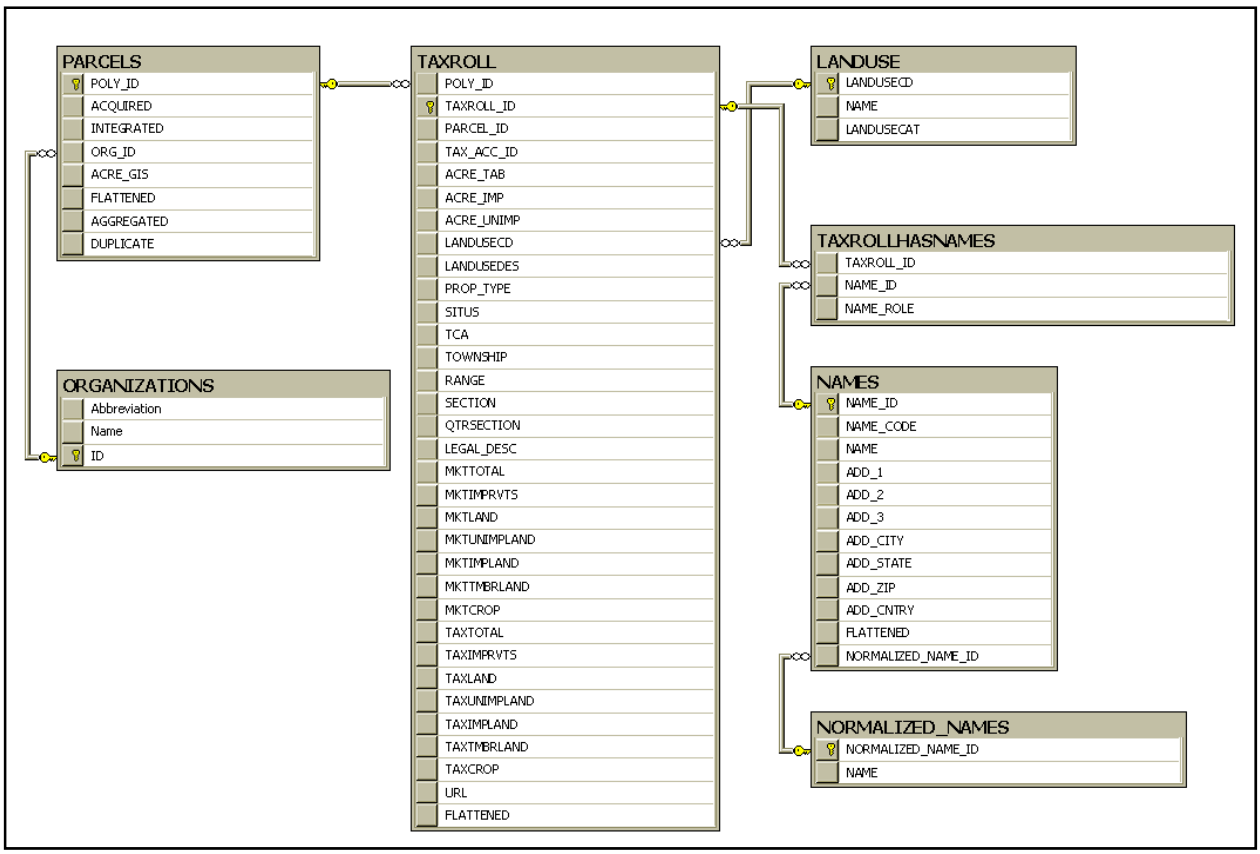

Figure 2: Entity Relationship Diagram of the 2007 Washington State Parcel Database.

Caveats

While the Washington State Parcel Database has extraordinary utility in many applications there are some notable caveats that must accompany its use. The primary purpose for which assessors develop GIS-based parcel data is for the equitable taxation of property values. Many assessors utilize Computer Assisted Mass Appraisal (CAMA) systems that rely on both spatial and tabular information to appraise and assess property tax. For these systems to operate effectively only a reasonable representation of the true location and size of individual properties is required. The spatial accuracy of these GIS-based systems is variable between counties and even within counties with many parcels represented hundreds of feet from their true location. For this reason many assessors refer to these GIS-based parcels as "cartoon" representations and state that they are not accurate or reliable for spatial analysis.

Anecdotal experience using these cartoon representations of parcels has demonstrated that most are within tens of feet of their true location, especially in more populated areas. However, considerable variability exists and caution using these data is warranted. For statewide analyses the use of these data for generating statistics and maps of general ownership patterns, land use and appraisal values is appropriate. At the sub-county level the use of the Washington State Parcel Database for evaluating individual properties or groups of properties can only hint at the true on-the-ground conditions and is no substitute for field visits or conversations with individual county assessor's offices.

The transformation of the original county assessor's data into the normalized Washington State Parcel Database further blurs the accuracy and precision of the spatial geometry and attributes of these cartoon representations. The spatial geometry of the original parcels is transformed, attributes are normalized using translation tables, and other attributes are eliminated entirely. Many of the pseudo-parcels are spatially represented far from their true location and given the random nature in which these pseudo-parcels are created many overlap one-another making spatial analyses difficult and error prone.

Identifying Forestlands

Determining Forest Acres

The 2007 Washington State Forestland Database is a subset of the 2007 Washington State Parcel Database. A parcel must meet acreage and forest cover requirements in order to be included in the Forestland Database. Forestland parcels were identified using both forest cover information and land use information.

Forest Cover from Satellite Imagery

The first method is based on satellite imagery collected and processed by the Multi-Resolution Land Characteristics Consortium. The MRLC (http://www.mrlc.gov/) "is a group of federal agencies who first joined together in 1993 to purchase Landsat 5 imagery for the conterminous U.S. and to develop a land cover dataset called the National Land Cover Dataset (http://landcover.usgs.gov/natllandcover.php). In 1999, a second-generation MRLC consortium was formed to purchase three dates of Landsat 7 imagery for the entire United States and to coordinate the production of a comprehensive land cover database for the nation called the National Land Cover Database (NLCD 2001)." From the NLCD 2001 data, three classes, 41, 42, and 43, Deciduous Forest, Evergreen Forest, and Mixed Forest respectively, were used to create a presence/absence forest dataset. If a pixel was in one of these three classes, it was classified as forest, if it was not, it was classified as non-forest. This presence/absence information was used to measure the acreage of forest cover (NLCD Forest Acres) in each parcel. Using this method, a Forestland parcel must be at least one acre in size, and must contain at least one-half acre of forest.

Assessor Land-use Codes

A second method used to determine Forestland examined whether or not each parcel was enrolled in a forestland tax program. County Assessors assign parcels in these programs a land use code of 87, 88, 92 or 95. Parcels in these programs have requirements for how their forests are managed. It can be assumed that even if there is not forest cover present on this parcel in the satellite imagery, that the entire parcel is being managed as forest as is therefore included in the Database. The Forest Acres attribute for parcels in forest tax programs is equivalent to the parcel acreage, rather than the NLCD forest cover acres.

Physical Characteristics

East/West

For the purposes of this database, every parcel in the state is considered to be on either the east or west side of the Cascade Crest. The Washington Department of Natural Resources forest management rules, as described in the Washington Forest Practices Rules and Regulations (Forest Practice Rules 2009),

differ for each side of the State. It is therefore necessary to determine the side of the State in which each parcel lies in order to model stream buffers, and forest growth.

The DNR maintains an east west dividing line for the State and a State boundary line. By combining these two boundaries, a polygon was created for both the east and west sides of the State. All but 2 of the 39 counties are entirely on one side of the Cascade Crest. The parcels in these counties can be automatically assigned to the east or west side. Skamania and Yakima counties cross the Cascade Crest. Each parcel centroid in these two counties was compared to these east and west polygons to determine the side of the State in which they are located.

Buffers

Background

The Washington Department of Natural Resources forest management rules, as described in the Washington Forest Practices Rules and Regulations (Forest Practice Rules 2009), that trees be left around streams, bodies of water, and wetlands under certain conditions during harvest activities for ecological purposes. Whether or not these water features contain suitable fish habitat, whether or not they have water year round, the productivity of the soil around a water feature, the location of the water feature in the State, and other factors influence where trees cannot be harvested. These remaining tree buffers affect timber harvest planning, and the revenue available to a land owner from a particular harvest for a given piece of land.

It is possible with available GIS data maintained by the Washington Department of Natural Resources to model buffers[1] around water features for each parcel in the State. These buffer models are required in order to estimate the economic viability of each parcel when managed as forest.

Preparation

The size of the State of Washington necessitates breaking up the process of developing water feature buffers into smaller pieces. Because buffers are located on hydrological features, logical sub-units of the state in which to work are Watershed Administrative Units (WAU). WAU boundaries were established under WAC 222-22-020, and their GIS data were developed and are maintained by the Washington Department of Natural Resources. There are 846 WAUs in the State. Buffers were calculated for each WAU in the State, one at a time, then combined to produce statewide coverage.

WAUs are located exclusively in either western or eastern Washington. The east/west location of each WAU is determined by whether or not the East or West polygons contain the centroid of the WAU.

Wetlands Processing

Wetlands buffers are dependent on the classification and size of each wetland feature (Table 3). Definitions of Wetland types are found in WAC 222-16-035. The size and classification of each wetland in the Washington Department of Natural Resources Forest Practices Wetlands data set were determined, and buffer polygons created.

[1] Buffers are polygons surrounding at a specified distance, but not including, a feature of interest.

Table 3: Wetland Buffer Distances

Size	Classification	Buffer width
> 5 acres	A	100 ft
<= 5 acres	A	50 ft
> 5 acres	B	50 ft
<= 5 acres and > 0.5 acres	B	25 ft
other		n/a

Stream and Water Body Processing

Stream and body of water buffers are dependent on the water feature type, the site class of the water feature location, and location of the water feature within the state (Table 4).

Water feature types are defined in WAC 222-16-034 and fall into four main categories: S, shoreline; F, fish-habitat; Np, non-fish habitat, perennial; Ns, non-fish habitat, seasonal. Type F and S water features are required to have three buffers, a core, inner, and outer. Type Np water features are required to have a buffer as well. All other non-wetland water features do not have buffer requirements.

The water feature type, site class (WAC 222-16-10), and location within the State of each stream segment and body of water in the Washington Department of Natural Resources Washington State Watercourse (WC) Hydrography and Washington State Water Body (WBWS) data sets were determined, and buffer polygons created.

Table 4: Stream and Body of Water Buffer Distances.

SITECLASS	CORE BUFFER DISTANCE	INNER BUFFER DISTANCE	OUTER BUFFER DISTANCE	DISTANCE FOR TYPE N STREAMS	LOCATION
1	50	150	200	50	West
2	50	138	170	50	West
3	50	105	140	50	West
4	50	83	110	50	West
5	50	68	90	50	West
6	50	68	90	50	West
7	50	68	90	50	West
8	50	68	90	50	West
9	50	68	90	50	West
no data	50	68	90	50	West
1	30	100	130	50	East
2	30	100	110	50	East
3	30	100	0	50	East
4	30	100	0	50	East
5	30	100	0	50	East
6	30	100	0	50	East
7	30	100	0	50	East
8	30	100	0	50	East
9	30	100	0	50	East
no data	30	100	0	50	East

Final Processing

The buffer polygons for all water features for all WAUs were combined to create a statewide buffer data set.

Caveats

Washington State Forest Practice Rules for riparian buffers are complex, even for professional foresters and geomorphologists on site. The DNR waterbody, watercourse and wetlands GIS layers are known to have inaccurate spatial locations and frequent omissions of smaller streams and wetlands (Mouton 2005). Combined with the spatial uncertainty of the assessor parcel data and the variable options land owners have in buffering non-fish streams and there is considerable error in using the buffer analysis for site-specific modeling. However, aggregating statistics on the acres of riparian buffers on different owner types and management styles to the watershed, county or state level mitigates parcel specific errors.

WRIA

For the purposes of this database, every parcel in the state is considered to be located within a single WRIA. WRIA (Water Resource Inventory Areas) data and boundaries were created and are maintained by the Washington Department of Ecology. There are 62 WRIAs in the State. While parcels may cross WRIA boundaries, they are assigned to a single WRIA by the location of the parcel centroids. Each parcel's centroid will be located within a single WRIA.

WAU

For the purposes of this database, every parcel in the state is considered to be located within a single WAU. WAU (Watershed Administrative Unit) data and boundaries were created and are maintained by the Washington Department of Natural Resources. There are 846 WAUs in the State. While parcels may cross WAU boundaries, they are assigned to a single WAU by the location of the parcel centroids. Each parcel's centroid will be located within a single WAU.

Streams

The total length of stream and the length of different Forest Practices stream types (S, F, N, U, X) on each parcel were computed for this database. Forest Practice stream types are defined in WAC 222-16-030, as shoreline (S), fish habitat (F), non-fish habitat (N), unknown (U), and not meeting the definition of a typed water (X). Stream data was created and is maintained by the Washington Department of Natural Resources.

Not all stream segments in the DNR's watercourses dataset were considered. The watercourses dataset maintains line segments through bodies of water. These are not truly streams, and therefore should not be considered. Artificial connectors which act as streams in man-made environments, but are not streams should also not be considered. Watercourses with values of 10, 21, or 99 (Single-line representing a watercourse segment, Watercourse line within a double banked stream polygonal watercourse, Unknown or Unclassified) in the WC_LN_TYPE_CD field were used, while values of 5, 20, 30 (Artificial connector, Watercourse line within a polygonal water body, Watercourse segment coincident with a water body perimeter) were excluded.

Proximity

The way each parcel relates to different features of the physical landscape around it likely has an effect on its viability as a managed forest. To explore this issue, six proximity metrics were measured for each parcel in the forestland database: proximity to development, proximity to urban growth areas, proximity to roads, proximity to designated forest lands, proximity to federal lands, and proximity to Washington

Department of Natural Resources managed Timberlands. More information about these proximity attributes can be found in Appendix B: Attributes in the 2007 Washington State Forestland Database Each was calculated using the same methodology. A centroid was calculated inside of each parcel. Distance measurements were made using the centroids, rather than parcel boundaries. Distances are measured straight-line and not via a network route. Distances were calculated using the ArcGIS Near tool.

Economic Analysis

Owner Classes

Another attribute central to the database is the type of owner for each property. The type of owner affects forest management style, which in turn affects their economics and conversion risk. The owner class was determined by examining the owner name for each parcel, comparing it to a categorized, exhaustive list of names, and placing the parcel into a category. The owner class can be: Government, Corporate, Tribal, Conservation, Other Private.

- Government: An owner class field describing whether or not a parcel has Government ownership.
- Corporate: An owner class field describing whether or not a parcel has corporate ownership.
- Tribal: An owner class field describing whether or not a parcel has Tribal ownership.
- Conservation: An owner class field describing whether or not a parcel has conservation ownership.
- Other Private: An owner class field describing whether or not a parcel is Private ownership, but not one of the above categories.

Management Types

Through previous studies performed by the Rural Technology Initiative, it has been shown that industrial and small forest landowners (SFLO) manage their forests differently (Lippke, et al. 2007). In order to accurately model the economics (Internal Rate of Return and Forest Value) of each forest parcel, the management method needs to be known.

There are two separate concepts of what defines a small forest landowner, one based on productivity, and one based on ownership size. Washington State created a definition in RCW 76.09.450, which is based on productivity of the owner. The database attribute WA_TYPE is used to represent this definition of small forest landowner.

The term Non-Industrial Private Forestland (NIPF) is often used interchangeably with small forest land owner and is based on ownership size. There is not a single definition for this confusing term. There are two Forest Service Definitions. Smith et al. define nonindustrial private as, "An ownership class of private lands where the owner does not operate wood-using plants"(Smith, et al. 2003). Gray et al. define forest industry lands as, "Lands owned by companies that grow timber for industrial use. Includes companies both with and without wood processing plants," and other private lands as, “private lands not owned by forest industry. Native American lands, farmer-owned lands, and miscellaneous private lands are included”(Gray, Veneklase and Rhodes 2005). In Washington State, before the Salmon Recovery Act defined the term small forest landowner, nonindustrial forests and woodlands were defined as, "suburban acreages and rural lands supporting or capable of supporting trees and other flora and fauna associated with a forest ecosystem, comprised of total individual land ownerships of less than

five thousand acres and not directly associated with wood processing or handling facilities," in RCW 76.13.010. Finally, in Washington Department of Natural Resource Timber Harvest Reports through the year 2002, private land owners were broken down into two categories Private Large, and Private Small. Private Small was defined as, "Non-industrial companies and individuals not operating wood-using plants and having statewide holdings totaling less than 1,000 acres,"(Washington State Timber Harvest Reports 2009). However, the Washington Department of Revenue, the source of the Timber Harvest Report data, has now moved to using the term Small Harvester, which is defined as, "A harvester who harvests timber from privately or publicly owned forest land in an amount not exceeding two million board feet in a calendar year" in both WAC 458-40-610 and RCW 84.33.035.

Currently, no reliable method exists to determine which owners harvest less than two million board feet in a calendar year. The Washington State Department of Revenue does collect information on “Small Harvesters” which is self reported by timber harvesters however the Revenue database cannot be directly linked to parcels in the Forestland Database. A proxy for the 2 million board foot harvest limitation was developed to identify SFLO ownerships based on acreage and location in the state.

Using yield curves[2], modeled stocking densities, and volume equations on the Westside an estimated 40 thousand board feet (Mbf) per acre can be harvested on a 50 year cycle (the average modeled rotation length for both industrial and SFLO lands) on site III ground. Harvest restrictions due to buffers were assumed to be 20% of the landscape. Using Westside growth curves (McArdle, Meyer and Bruce 1949) for high site III ground yields were assumed to be 50 Mbf per acre in 50 years, only 80% of which is harvestable.

$$2{,}000{,}000\ bf \Big/ \left[\frac{40{,}000\ \frac{bf}{acre}}{50\ years}\right] = 2{,}500\ acres$$

On the Eastside an estimated 4 thousand board feet per acre can be harvested on a 20 year cutting cycle on site IV ground. This assumes a 45% volume removal and corresponds to a 75+ year understory regeneration scenario producing 9 MBF.

$$2{,}000{,}000\ bf \Big/ \left[\frac{4{,}004\ \frac{bf}{acre}}{20\ years}\right] = 9{,}990\ acres$$

Using these growth and harvest assumptions for Westside and Eastside forests acreage proxies for the Washington State small forest landowner 2 million board foot definitions were set at 2,500 and 9,990 acres respectively.

The Washington State Forestland Database is primarily interested in identifying small forest landowner parcels using the State SFLO definition. However an attempt to identify NIPF parcels was also made. Because of the lack of clarity about the definition of NIPF, the database uses the RCW 76.13.010 definition of, "total individual land ownerships of less than five thousand acres and not directly associated with wood processing or handling facilities". The database attribute WA_NIPF is used to represent this definition of small forest landowner.

[2] Westside assumptions use (King 1966) yield curves for Douglas-fir (base age 50). Eastside assumptions use (Cochran 1979) yield curves for Douglas-fir (base age 50); (Barrett 1978) yield curves for Ponderosa pine (base age 100); and (Alexander, Tackle and Dahms 1967) yield curves for Lodgepole pine (base age 100)

Washington Small Forest Land Owner

This forestland management type uses an acreage proxy for the Washington State Small Forest Landowner (SFLO) definition as defined in RCW 76.09.450 (harvesting no more than an average of 2 million board feet of timber per year). While the Forestland Database has parcels down to 1 acre in size, the Database's SFLO definition requires the smallest properties to be at least 2 acres in size (tract acres) with a minimum of 1 acre of forest cover. Parcels with forested land uses as defined by county assessors were classified as SFLO up to the acreage limits regardless of minimum size cutoffs (land uses 87, 88, 92 and 95, see Appendix F: Land Use Codes in the Washington State Forestland Database).

Values: SFLO, Industrial, Tribal SFLO, or NULL.

- SFLO: A parcel that meets the Washington State Small Forest Landowner definition as defined in RCW 76.09.450 (harvesting no more than an average of 2 million board feet of timber per year). This is estimated by determining the number of acres in management an owner would need to meet this level of productivity. On the west side of the state, an owner would need 2500 acres, and on the eastside 9990 acres. A parcel whose owner owns less than 2500 acres on the west side of the state, or a parcel whose owner owns less than 9990 acres on the east side of the state would qualify. The parcel owner must also be non-corporate and non-government.
- INDUSTRIAL: A parcel that does not meet the Washington State Small Forest Landowner definition as defined in RCW 76.09.450 (harvesting no more than an average of 2 million board feet of timber per year). This is estimated by determining the number of acres in management an owner would need to meet this level of productivity. On the west side of the state, an owner would need 2500 acres, and on the eastside 9990 acres. A parcel whose owner owns at least 2500 acres on the west side of the state, or a parcel whose owner owns at least 9990 acres on the east side of the state would qualify. The parcel owner must also be corporate and non-government.
- TRIBAL_SFLO: A parcel that meets the Washington State Small Forest Landowner definition as defined in RCW 76.09.450 (harvesting no more than an average of 2 million board feet of timber per year). This is estimated by determining the number of acres in management an owner would need to meet this level of productivity. On the west side of the state, an owner would need 2500 acres, and on the eastside 9990 acres. A parcel whose owner owns less than 2500 acres on the west side of the state, or a parcel whose owner owns less than 9990 acres on the east side of the state would qualify. The parcel owner must also be tribal, non-corporate, and non-government.

Washington Non-Industrial Private Forest Land Owner

The management type using the NIPF definition, "total individual land ownerships of less than 5000 acres and not directly associated with wood processing or handling facilities".

Values: NIPF, Industrial, or Null.

- NIPF: A parcel that meets NIPF definition, "total individual land ownerships of less than 5000 acres and not directly associated with wood processing or handling facilities", and does not have a corporate or government owner.
- INDUSTRIAL: A parcel that does not meet the NIPF definition, "total individual land ownerships of less than 5000 acres and not directly associated with wood processing or handling facilities", meaning the parcel owner owns more than 5000 acres in the State. The parcel also has a corporate owner, and is non-government.

Modeling forest growth

Growth simulations were preformed to represent forested lands in the state of Washington. Five site classes were used for eastern and western Washington. In addition two general ownership classes were simulated (Industrial and Non-Industrial Private). Each of the site class and ownership class simulations was then matched to parcel information on the state landscape.

Each ownership class/site class also had separate simulations to represent the different forest activities allowed in the buffers of Forest and Fish. Initial simulations assumed a maximum removal as allowed by the Forest and Fish rules.

Modeling Assumptions and Details

The FVS growth model was used for all simulations. Western Washington simulations were run using the Pacific Northwest Coast variant of FVS and used the Olympic NF equations (FVS location code 609) and an elevation of 300 feet. All stands were modeling with the same location parameters except for the variation is site index. Maximum SDI values were reduced to 600 (from the default of 950) according to the maximum value suggested for Douglas-for by (Long, McCarter and Jack 1988) and (Reineke 1933).

Westside Simulations

The Table 5 shows the site index, SDI Max and rotation length for each ownership site class for Western Washington. The rotation lengths and intermediate treatments represent a management intensity level associated with each site class.

Table 5: Site index, SDI Max, and rotation length for site class and ownership in Western Washington.

	Owner Class	Site Class	Site Index[3]	SDI Max	Rotation
Westside	Industrial	S1	145	600	35
		S2	125	600	40
		S3	105	600	45
		S4	85	600	45
		S5	65	600	50
	NIPF	S1	135	600	45
		S2	115	600	50
		S3	100	600	55
		S4	80	600	60
		S5	60	600	65

[3] Westside simulations use (King 1966) site index for Douglas-fir (base age 50).

For each site class and ownership 5 separate simulations were run for upland stands and each buffer zone according to Forest and Fish rules. A simplified description of the harvest options by buffer is presented in Table 6.

Table 6: Simplified harvest by buffer zone for western Washington.

Riparian/Wetland Management Zone	Treatment
Upland	Site/owner class specific scenario
Core	No harvest
Inner	Leave > 57 TPA, thin from below, regeneration simulated
Outer	Leave 20 TPA > 12", regeneration simulated
Wetland	Leave 75 TPA > 6", regeneration simulated

Each site class and ownership also has a unique scenario and combination of treatments designed to represent different management intensities across the site and ownership classes. These are summarized in

Table 7. The Industrial S1 management intensity represents management that includes improved stock and no thinning treatments on a short rotation. Industrial S2 and S3 contain a single commercial thinning. Only the NIPF S2 management intensity includes a commercial thinning.

Table 7: Site/owner class scenarios for western Washington.

Owner Class	Rotation	Regeneration[4] (TPA DF)	Intermediate Treatments	Final Harvest
Industrial S1	35	590	None	Leave 5 TPA @ 35
Industrial S2	40	590	PCT to 275 TPA @ 15	Leave 5 TPA @ 40
Industrial S3	45	590	PCT to 275 TPA @ 15	Leave 5 TPA @ 45
Industrial S4	45	590	None	Leave 5 TPA @ 45
Industrial S5	50	590	None	Leave 5 TPA @ 50
NIPF S1	45	590	PCT to 275 TPA @ 15	Leave 5 TPA @ 45
NIPF S2	50	590	None	Leave 5 TPA @ 50
NIPF S3	55	590	None	Leave 5 TPA @ 55
NIPF S4	60	590	None	Leave 5 TPA @ 60
NIPF S5	65	590	None	Leave 5 TPA @ 65

Eastside Simulations

Eastern Washington was divided into three zones that were as defined in the WA Forest Practices Rules: Ponderosa Pine type (0-2500 ft), Mixed conifer type (2501-5000 ft), and high elevation type (>5000 ft). Each zone was represented by a different species: Ponderosa pine type = PP; Mixed conifer type = DF; and high elevation type = LP.

[4] Regeneration for DF was developed to produce a simulation that was compatible with an unmanaged stand development from the (McArdle, Meyer and Bruce 1949) yield tables. A simulation exercise was done to determine a starting point for the simulation that would track through the yield tables and agree in density, diameter, and volume.

Table 8: Site index, SDI Max, and rotation length for site class and ownerships in Eastern Washington.

Zone	Owner Class	Site Class	Site Index[5]	SDI Max	Rotation
Eastside - PP	Industrial	S1	130	600	75
		S2	120	600	75
		S3	110	600	75
		S4	100	600	75
		S5	90	600	75
	NIPF	S1	120	600	75
		S2	110	600	75
		S3	100	600	75
		S4	90	600	75
		S5	80	600	75
Eastside – DF	Industrial	S1	110	600	75
		S2	100	600	75
		S3	90	600	75
		S4	80	600	75
		S5	70	600	75
	NIPF	S1	100	600	75
		S2	90	600	75
		S3	80	600	75
		S4	70	600	75
		S5	60	600	75
Eastside – LP	Industrial	S1	90	700	65
		S2	80	700	65
		S3	70	700	65
		S4	60	700	65
		S5	50	700	65
	NIPF	S1	80	700	75
		S2	70	700	75
		S3	60	700	75
		S4	50	700	75
		S5	40	700	75

The eastern Washington simulations were run using the East Cascades variant of FVS and used different locations for each of the three zones simulated: PP (Wenatchee - 617), DF (Okanogan - 608), and LP (Okanogan - 608).

[5] Eastside simulations use (Cochran 1979) site index for Douglas-fir (base age 50); (Barrett 1978) site index for Ponderosa pine (base age 100); and (Alexander, Tackle and Dahms 1967) site index for Lodgepole pine (base age 100)

Table 8 presents the site index, SDI Max, and rotation length for the site classes and ownerships in Eastern Washington.

For zone, each site class, and ownership 5 separate simulations were run for upland stands and each buffer zone according to Forest and Fish rules. A simplified description of the harvest options by buffer is presented in Table 9.

Table 9: Simplified harvest by buffer zone for eastern Washington.

Riparian/Wetland Management Zone	Zone	Criteria	Treatment
Upland			Site/owner class specific scenario
Core			No harvest
Inner	PP	BA > 110	Leave 50 TPA > 10”
		BA < 60 and TPA >100	Leave 100 TPA > 6”
		Otherwise	Leave 100 TPA
	DF	BA > 150, 130, 110	Leave 50 TPA > 10”
		BA < 150 and TPA > 120	Leave 120 TPA > 6”
		Otherwise	Leave 100 TPA
	LP		Leave 58 TPA > 12”
Outer	PP		Leave 10 TPA, regen 400 PP
	DF		Leave 15 TPA, regen 400 DF
	LP		Leave 20 TPA, regen 400 LP
Wetland	PP		Leave 75 TPA > 4”, regen 200 PP
	DF		Leave 75 TPA > 4”, regen 200 DF
	LP		Leave 75 TPA > 4”, regen 200 LP

Table 10 presents the scenarios used for even-aged management in Eastern Washington.

Table 10: Site/owner class scenarios for eastern Washington.

	Owner Class	Rotation	Regeneration[6] (TPA DF)	Intermediate Treatments	Final Harvest
Ponderosa Pine	Industrial S1	75	400	Leave 250 TPA @ 25 Leave 175 TPA @ 50	Leave 5 TPA @ 75
	Industrial S2	75	400	Leave 250 TPA @ 25 Leave 175 TPA @ 50	Leave 5 TPA @ 75
	Industrial S3	75	400	Leave 175 TPA @ 50	Leave 5 TPA @ 75
	Industrial S4	75	400	Leave 175 TPA @ 50	Leave 5 TPA @ 75
	Industrial S5	75	400	Leave 175 TPA @ 50	Leave 5 TPA @ 75
	NIPF S1	75	400	Leave 175 TPA @ 50	Leave 5 TPA @ 75
	NIPF S2	75	400	None	Leave 5 TPA @ 75
	NIPF S3	75	400	None	Leave 5 TPA @ 75
	NIPF S4	75	400	None	Leave 5 TPA @ 75
	NIPF S5	75	400	None	Leave 5 TPA @ 75
Mixed Conifer	Industrial S1	75	400	Leave 175 TPA @ 50	Leave 5 TPA @ 75
	Industrial S2	75	400	Leave 175 TPA @ 50	Leave 5 TPA @ 75
	Industrial S3	75	400	Leave 175 TPA @ 50	Leave 5 TPA @ 75
	Industrial S4	75	400	Leave 175 TPA @ 50	Leave 5 TPA @ 75
	Industrial S5	75	400	Leave 175 TPA @ 50	Leave 5 TPA @ 75
	NIPF S1	75	400	Leave 175 TPA @ 50	Leave 5 TPA @ 75
	NIPF S2	75	400	Leave 175 TPA @ 50	Leave 5 TPA @ 75
	NIPF S3	75	400	Leave 175 TPA @ 50	Leave 5 TPA @ 75
	NIPF S4	75	400	Leave 175 TPA @ 50	Leave 5 TPA @ 75
	NIPF S5	75	400	Leave 175 TPA @ 50	Leave 5 TPA @ 75
High elevation	Industrial S1	65	800	None	Leave 5 TPA @ 65
	Industrial S2	65	800	None	Leave 5 TPA @ 65
	Industrial S3	65	800	None	Leave 5 TPA @ 65
	Industrial S4	65	800	None	Leave 5 TPA @ 65
	Industrial S5	65	800	None	Leave 5 TPA @ 65
	NIPF S1	65	800	None	Leave 5 TPA @ 75
	NIPF S2	65	800	None	Leave 5 TPA @ 75
	NIPF S3	65	800	None	Leave 5 TPA @ 75
	NIPF S4	65	800	None	Leave 5 TPA @ 75
	NIPF S5	65	800	None	Leave 5 TPA @ 75

[6] Regeneration eastern Washington was set at 400 TPA for each species.

Eastside Un-even aged Simulations

The initial even-aged simulations for Eastern Washington were felt to be inadequate because they did not represent the types of management that is actually happening. A series of uneven-aged simulations were developed to address that concern.

A series of simulations were done to investigate an initial starting condition that would results in a somewhat even flow of volume from each upland stand over multiple 20 year cutting cycles. These simulations were started in the past to achieve a mature stand in 2000 for the first 20 year cycle or a limited harvest of a buffer for the PP and Mixed Conifer (DF) zones.

Table 11: Uneven-aged scenarios for Eastern Washington.

	Owner Class	Regeneration[7] (TPA)	Intermediate Treatments (2000, 2020…)	Final Harvest
Ponderosa Pine	Industrial S1	400	Thin to SDI 330	Regen 150 TPA
	Industrial S2	400	Thin to SDI 300 (2000),330	Regen 200 TPA
	Industrial S3	400	Thin to SDI 300 (2000), 330	Regen 200 TPA
	Industrial S4	400	Thin to SDI 330	Regen 200 TPA
	Industrial S5	400	Thin to SDI 330	Regen 200 TPA
	NIPF S1	400	Thin to SDI 330	Regen 200 TPA
	NIPF S2	400	Thin to SDI 330	Regen 200 TPA
	NIPF S3	400	Thin to SDI 330	Regen 200 TPA
	NIPF S4	400	Thin to SDI 330	Regen 200 TPA
	NIPF S5	400	Thin to SDI 330	Regen 200 TPA
Mixed Conifer (DF)	Industrial S1	400	Thin to SDI 330	Regen 200 TPA
	Industrial S2	400	Thin to SDI 300	Regen 200 TPA
	Industrial S3	400	Thin to SDI 350-375	Regen 200 TPA
	Industrial S4	400	Thin to SDI 300	Regen 200 TPA
	Industrial S5	400	Thin to SDI 300-315	Regen 200 TPA
	NIPF S1	400	Thin to SDI 330	Regen 200 TPA
	NIPF S2	400	Thin to SDI 330	Regen 200 TPA
	NIPF S3	400	Thin to SDI 300-330	Regen 200 TPA
	NIPF S4	400	Thin to SDI 330	Regen 200 TPA
	NIPF S5	400	Thin to SDI 330	Regen 200 TPA

The Industrial S2 and S2 management intensities required a slightly heavier thinning in 2000 to balance the volume yields. Several of the Mixed Conifer management intensities (Industrial S3, S5 and NIPF S3) required variation in the thinning intensity to balance the volume yields.

[7] Regeneration in Eastern Washington was set at 400 TPA for each species.

Risk of conversion

Using the parcel-based Washington State Forest Land Database to extract real estate values, acreages, improvement values and land uses for forested areas in Washington, maps were produced of the privately-owned areas at highest risk of conversion, based on a series of assumptions on forest growth, management intensity and appraised market values. The base assumption is that parcels with the largest difference between the real estate value (REV) and the working forest value (WFV) are likely candidates for conversion. Working forest value is the sum of the forest value (FV) in the buffers and upland areas. The real estate value (REV) is the market value assigned to each parcel by the county assessor. The forest value (FV) is the land value plus the added economic value of any standing timber (the total economic value of the forest).

The forest value was calculated using five site classes for eastern and western Washington with cost assumptions from the recently produced timber supply study based on owner type (industrial/non-industrial). Modeled management scenarios within riparian buffers are based on findings from the timber supply study and allocated by owner type since it is known that riparian areas are being managed differently by industrial and non-industrial owners. Both WFV and REV are calculated and mapped for each parcel, and the output is a map of forested parcels with the differential between WFV and REV normalized to a per acre basis. Parcels with a high REV relative to WFV can be considered likely candidates for conversion whereas parcels with a high WFV relative to REV can be considered unlikely candidates for conversion.

Process

- Calculate all forested acres (_A)
    - Forest acres are different than parcel size, since a landowner could have a 100-acre parcel and only 50-acres are forested. Forest acres are based on an intersection with forest cover data or as available from assessor land use information.
    - Calculated upland acres (UA)
    - Calculated acres in riparian management zones (RMA) and wetland management zones (WMA) on forested parcels
        - As much is possible, acreage in riparian management zones (RMZ) and wetland management zones (WMZ) were determined as defined in state forest practice rules, Chapter 22-30, Timber Harvesting.
        - Using DNR's soil site class layer, and stream type (F, S, Np, Ns) or wetland type (A, B) the acreage included in each type of RMZ and WMZ by parcel was calculated.
        - There are three riparian management acreages per parcel: core, inner and outer (RMA_c, RMA_i, and RMA_o), and one wetland management acreage: WMA
- Calculate Land Value (SEV)
    - This figure, also known as bare land value, land expectation value (LEV), or soil expectation value (SEV), estimates the economic value of the land alone based on its ability to generate income through the production of timber through an infinite number

of rotations including planting costs, thinning costs, harvest revenue and administrative costs.

- $SEV = \frac{-P(1+i)^r \pm M_t(1+i)^{(r-t)} + H_r}{(1+i)^r - 1} - \frac{a}{i}$
- Where:
  - P = planting cost
  - M_t = mid-rotation cash flow in year t (PCT cost or thinning revenue)
  - H_r = net harvest revenue at rotation year r
  - a = annual overhead cost
  - i = target rate of return (assume 5%)

- Calculate Forest Value (FV_x)
  - Forest value is land value plus the added economic value of any standing timber (the total economic value of the forest). Since current forest values for each parcel are unknown, assume an average at midpoint of rotation (or immediately post-harvest for uneven aged stands).
  - $FV_{evenaged} = \frac{\pm M_t}{(1+i)^t} + \frac{H_r}{(1+i)^r} - a\left[\frac{(1+i)^r - 1}{i(1+i)^r}\right] + \frac{SEV}{(1+i)^r}$
  - $FV_{unevenaged} = \frac{H_r - a\left[\frac{(1+i)^c - 1}{i}\right]}{(1+i)^c - 1}$
  - Where:
    - M_t = mid-rotation cash flow in year t (PCT cost or thinning revenue)
    - H_r = net revenue from harvest of existing timber at year r (end of current rotation or cutting cycle)
    - c = number of years in the uneven aged cutting cycle
    - SEV = bare land value
    - a = annual overhead cost
    - i = target rate of return
  - Forest value is calculated per acre for each combination of site index, owner type, and forest area (upland, buffer)
- Determine Real Estate Value (REV)
  - Using Washington State Forest Land Database, determine total market value (real estate value) for each parcel.
- Calculate Working Forest Value (WFV)
  - Working forest value is the forest value for each parcel which is the sum of the forest value in the buffers and the uplands
  -
  - $WFV = (RMA_c\ RMA_c \times FV_c) + (RMA_i \times FV_i) + (RMA_o FV_c + RMA_i \times FV_i + RMA_o \times FV_o + WMA \times FV_w + UA \times FV_u$Where:
    - RMA_c = core riparian management zone acres
    - RMA_i = inner riparian management zone acres
    - RMA_o = outer riparian management zone acres
    - WMA = wetland management zone acres
    - UA = upland acres

        - FV_c = forest value per acre in the core riparian management zone
        - FV_i = forest value per acre in the inner riparian management zone
        - FV_o = forest value per acre in the outer riparian management zone
        - FV_w = forest value per acre in the wetland management zone
        - FV_u = forest value per acre in the upland area
- Calculate conversion risk (CR) as the difference between WFV and REV.
    - CR = REV – WFV

Discussion

The use of county assessor appraisal values as a proxy for the market value of forestland is feasible on parcels not in the Designated Forest Land (DFL) tax program. Parcels in the DFL program are not required to be appraised for fair market value and therefore a conversion risk cannot be calculated. A brief attempt was made to correlate market values to physical characteristics of the DFL lands, like proximity to roads, urban growth areas or development however no statistically significant predictors were found. Others have shown that the development of market value predictors from physical characteristics can be done and therefore more work should be done in this area. An attempt was also made to correlate recent sales activity to DFL lands to generate a market value however the sales information was too coarse and had artifacts from multi-parcel sales that made correlation difficult.

For the non-DFL lands the calculated conversion risk follows conventional wisdom: smaller parcels closer to urban growth areas, major transportation corridors or high-amenity areas like the Puget Sound have a much higher risk of conversion compared to larger rural properties.

Results

Tabular/GIS comparison

Purpose

GIS-based parcel geometry is currently unavailable for 10 of the 39 counties in Washington State (Figure 1). However, nine of these 10 counties have tabular parcel data with a legal description for each parcel. The legal description will place each parcel within a Township, Range and Section in Washington's Public Land Survey System framework. Each Section is a one mile by one mile square. Using available information, it is possible to place each parcel within one square mile of its actual location even without GIS-based data.

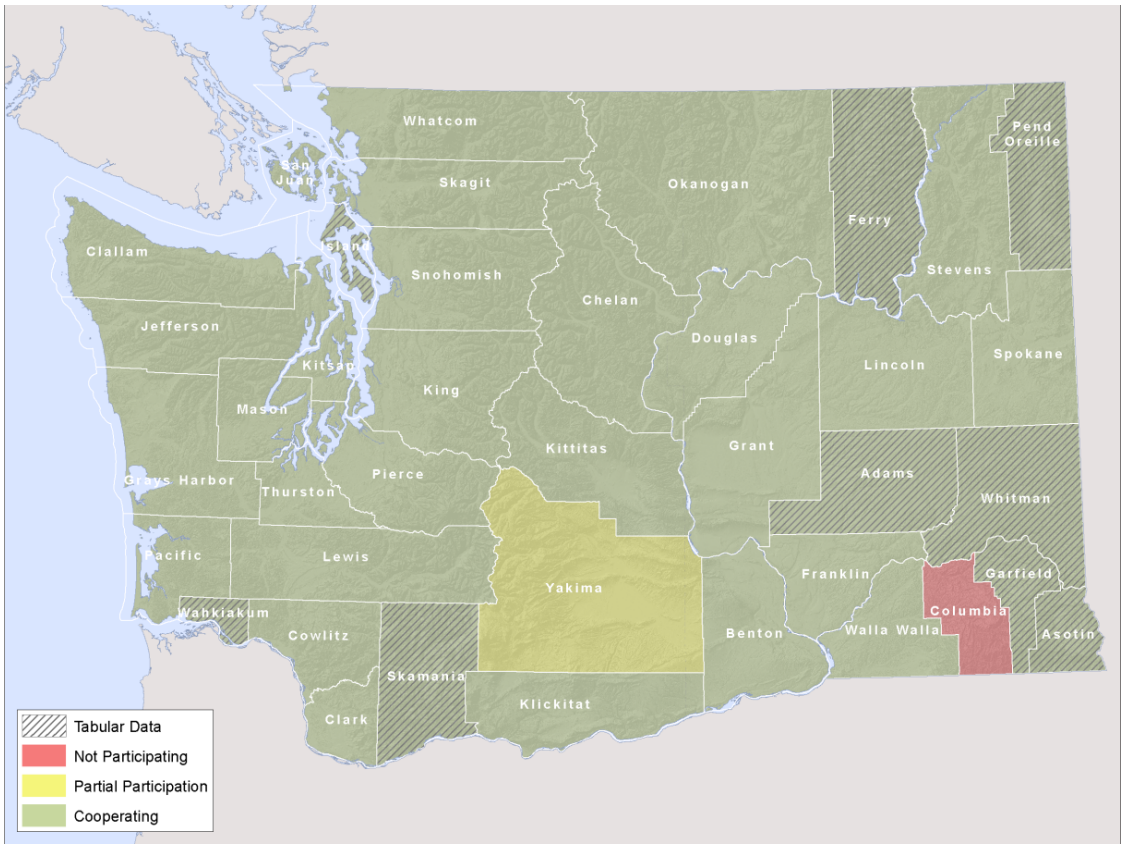

Figure 3: Parcel Data Availability for Washington State.

For this database project, a method was developed to use the acreage and legal description in the Assessor's data to estimate the location for each parcel when true geometry was unavailable. These estimated locations are referred to from here on as Pseudo-Parcels. In a worst-case scenario, a Pseudo-Parcel could be up to 1.4 miles from its real-world location. Clearly this introduces complications when attempting to develop attributes for a particular parcel such as distances to certain features, whether or not streams are present, and the amount of Forest Practice stream buffers. It is of interest to know whether or not the spatial inaccuracy inherent in this process has a significant effect on these and other attributes when looking at a larger area, such as an entire county. To this end, a test was undertaken to determine the extent to which using Pseudo-Parcels affects spatial attributes.

Methods

Lewis County was selected as a sample county for this test because of its large forest area, and the availability of existing GIS parcel geometry. A Pseudo-Parcel dataset (Figures 3 and 5) was developed using the legal description and acreage information provided by the county. This Pseudo-Parcel GIS data was compared to the true GIS data (Figures 2 and 4) by performing the spatial analysis on both data sets and calculating statistics.

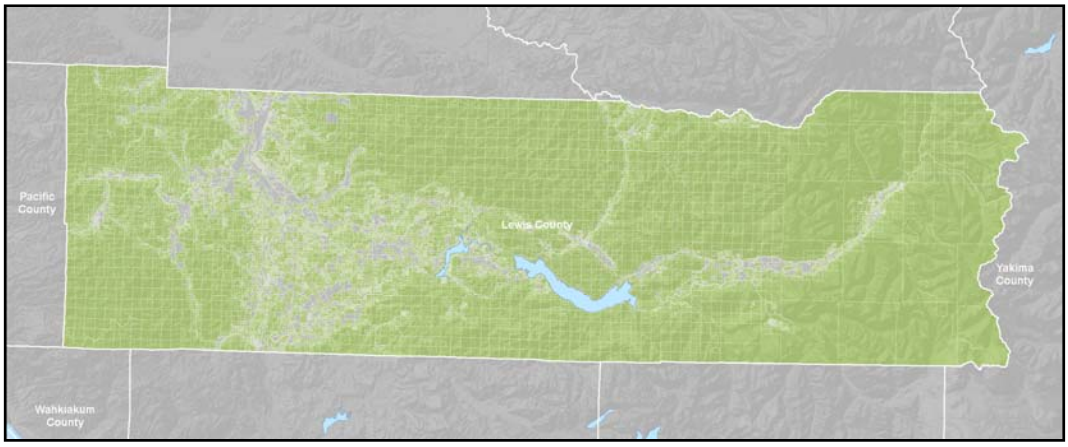

Figure 4: GIS Parcels for Lewis County.

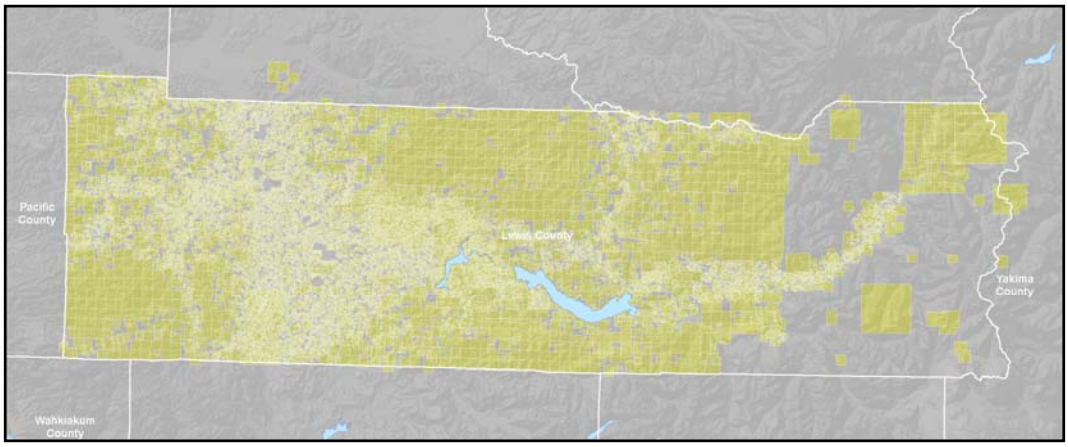

Figure 5: Pseudo-Parcels for Lewis County.

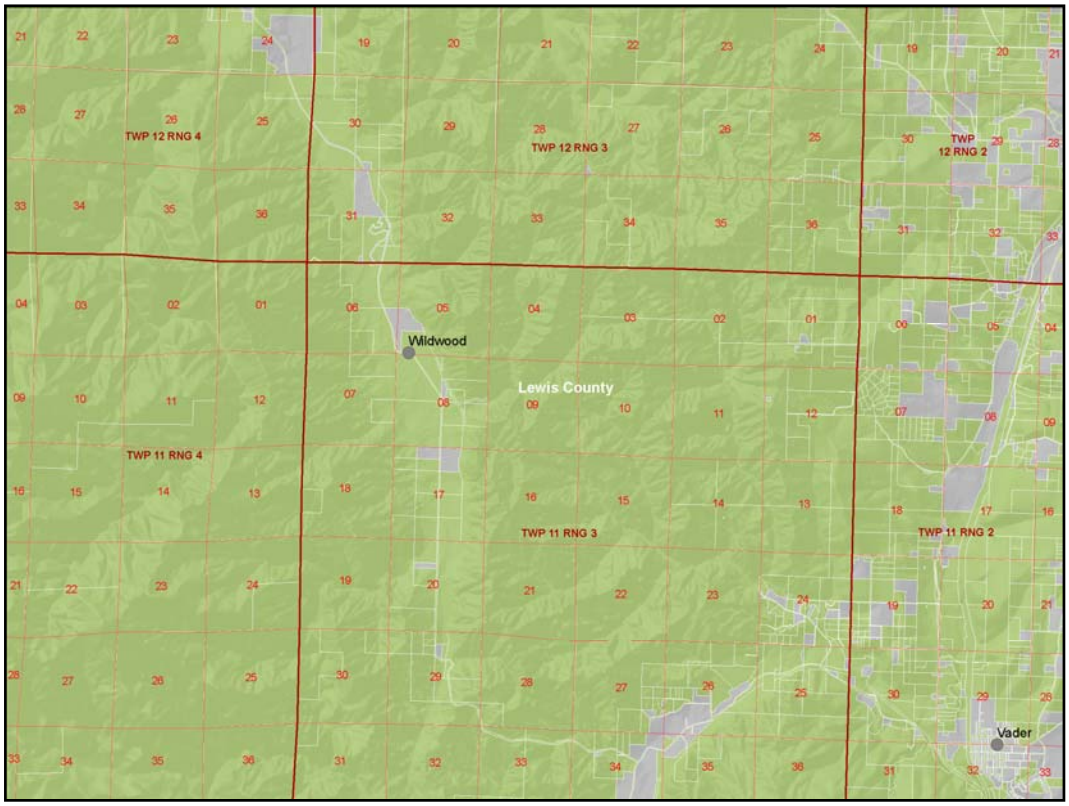

Figure 6: GIS Parcels around Wildwood and Vader, Lewis County.

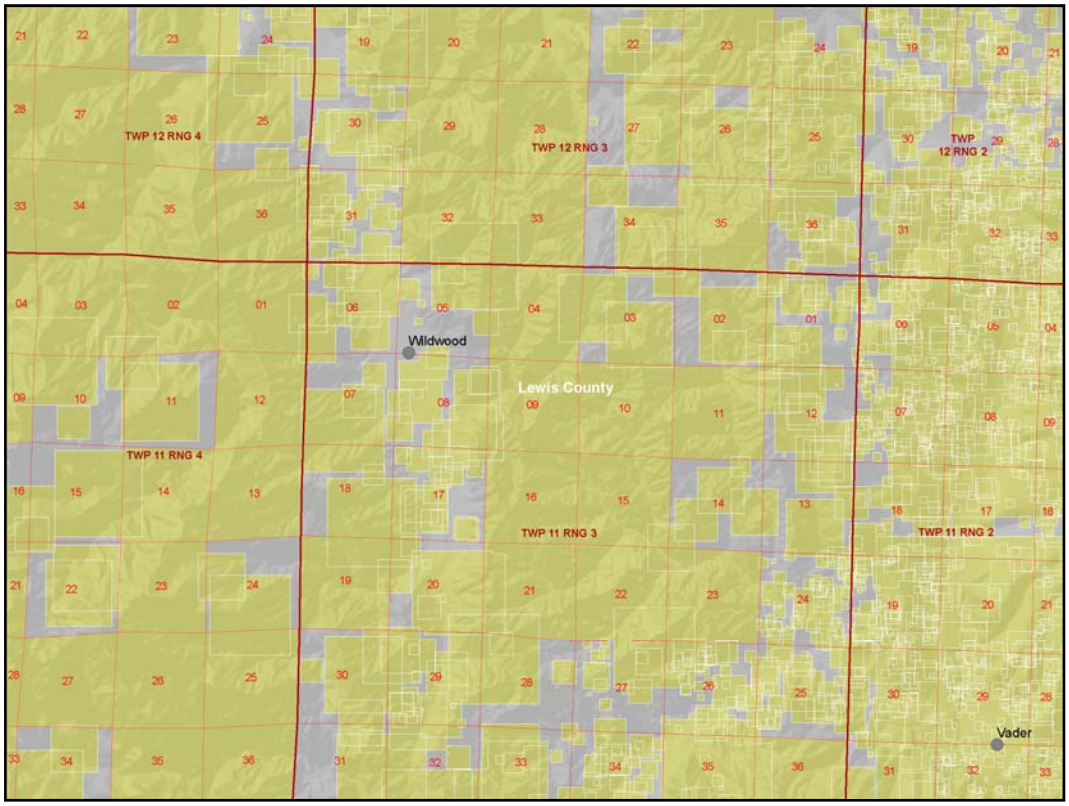

Figure 7: Pseudo-Parcels around Wildwood and Vader, Lewis County.

Results

The first comparison performed on the two parcel datasets was to compare the acreage of each owner class (Corporate, Tribal, Conservation, and Other Private) for the entire county (Table 12). Since these classes are based on the owner names, they should be more or less identical.

Table 12: Acres and Percent of County in Forestland Ownership by Owner Class.

Acres	County	Corporate	Tribal	Conservation	Other private	Total private
GIS Parcels	1,558,511	553,147 (35%)	198 (0%)	221 (0%)	300,382 (19%)	853,949 (55%)
Psuedo-Parcels	1,558,511	597,883 (38%)	248 (0%)	248 (0%)	365,783 (23%)	964,162 (62%)

It is immediately obvious, that the acreage of each owner class is not the same for the GIS parcels and the Pseudo-Parcels. There is an increase of 110,213 total private acres for the Pseudo-Parcels.

It was realized as a result of this test that the way the Pseudo-Parcel creation methodology handles missing acreage and legal description values in the Assessor's data could be improved. The method will be improved in the next version of the database.

It was also realized that this comparison is somewhat inappropriate. By using the County Assessor's parcel acreage, this comparison is a test of the data quality not a test of the accuracy of the Pseudo-Parcel creation methodology. It accurately represents the method used for counties without GIS data, but errors in the data provided by the county outweigh differences due to methodology. If the true GIS acres had been used to create the Pseudo-Parcels for this test, the comparison performed here would have been direct and more appropriate.

A second test compared the acreage of Forest Practice buffers around wetlands and streams (Table 13) for two different management types (Small Forest Land Owners, and Industrial) and for all private parcels for the two parcel datasets. Again the acreages for the Pseudo-Parcels are larger than those for the GIS Parcels. However, both the Buffer Acres and the Total Parcel Acres are higher for the Pseudo-Parcels, so the percentage of land in each buffer type is nearly identical between the Pseudo and GIS Parcels.

Table 13: Acres and Percent of Ownership in Buffers by Management Type.

	Owner type	Parcel acres	Buffer acres	Core acres	Inner acres	Outer acres	Wetland acres
GIS Parcels	SFLO	177,443	30,200 (17%)	17,367 (10%)	6,813 (4%)	3,365 (2%)	2,655 (1%)
	Industrial	604,026	124,757 (21%)	96,411 (16%)	17,969 (3%)	8,361 (1%)	2,015 (0%)
	All Private	781,470	154,957 (20%)	113,778 (15%)	24,783 (3%)	11,726 (2%)	4,670 (1%)
Psuedo-Parcels	SFLO	324,732	55,480 (17%)	31,346 (10%)	12,745 (4%)	6,181 (2%)	5,208 (2%)
	Industrial	639,431	132,088 (21%)	100,176 (16%)	20,114 (3%)	9,378 (1%)	2,419 (0%)
	All Private	964,162	187,568 (19%)	131,522 (14%)	32,859 (3%)	15,559 (2%)	7,627 (1%)

The third comparison made was between the lengths of streams in different Forest Practice Stream classifications in both the Pseudo and GIS parcel datasets. Table 14 presents the total length of all streams in the different classifications for the entirety of Lewis County.

Table 14: Length of Streams in Feet.

	Stream length	Type F length	Type S length	Type N length	Type U length
Lewis County	80,998,624	13,902,900	4,444,579	5,1743,207	10,907,938

Table 15 presents the length and percentage of each stream type that occurs on Small Forest Land Owner Parcels. For example, there are 1,920,545 feet of Type N streams on SFLO GIS Parcels in Lewis County, which means that 18% of Type N streams in Lewis County occur on SFLO ownership in the GIS Parcels dataset.

Table 15: Length of Streams in Feet for SFLO Parcels and Percent of Total.

		Stream length	Type F length	Type S length	Type N length	Type U length
GIS Parcels	Acres	10,812,029	3,166,779	1,040,320	4,684,385	1,920,545
	(%)	(13%)	(23%)	(23%)	(9%)	(18%)
Psuedo-Parcels	Acres	14,446,145	3,851,957	1,493,446	6,519,663	2,581,079
	(%)	(18%)	(28%)	(34%)	(13%)	(24%)

Table 16 presents the length and percentage of each stream type that occurs on Industrial Ownership. For example, there are 6,163,523 feet of Type F streams on Industrial Pseudo-Parcels in Lewis County, which means that 44% of Type F streams in Lewis County occur on Industrial ownership in the Pseudo-Parcels dataset.

Table 16: Length of Streams in Feet for Industrial Parcels and Percent of Total.

		Stream length	Type F length	Type S length	Type N length	Type U length
GIS Parcels	Acres	43,106,515	5,526,150	1,633,302	30,302,838	5,644,226
	(%)	(53%)	(40%)	(37%)	(59%)	(52%)
Psuedo-Parcels	Acres	44,684,186	6,163,523	1,566,970	31,141,579	5,812,114
	(%)	(55%)	(44%)	(35%)	(60%)	(53%)

Table 17 presents the length and percentage of each stream type that occurs on Private Ownership. For example, there are 8,692,928 feet of Type F streams on Private GIS Parcels in Lewis County, which means that 63% of Type F streams in Lewis County occur on Private ownership in the GIS Parcels dataset.

Table 17: Length of Streams in Feet for all Private Parcels and Percent of Total.

		Stream length	Type F length	Type S length	Type N length	Type U length
GIS Parcels	Acres	53,918,544	8,692,928	2,673,622	34,987,223	7,564,771
	(%)	(67%)	(63%)	(60%)	(68%)	(69%)
Psuedo-Parcels	Acres	59,130,331	10,015,481	3,060,417	37,661,241	8,393,193
	(%)	(73%)	(72%)	(69%)	(73%)	(77%)

Discussion

The acreage overestimation that occurred when creating Pseudo-Parcels is understood, and will be addressed in the next version of the database. Since both total acreages and acreages of buffers are overestimated, the relative proportion of these acreages is still valuable, and is very close to the proportions seen in the GIS Parcels.

The acreage overestimation disproportionately affects SFLO ownership. It takes more small parcels to fill an entire square mile section, and it is possible for small parcels to have larger distances between their estimated and true locations within a section. Small parcels tend to occur in urban areas, and SFLO parcels tend to be smaller and closer to urban areas. In Lewis County, the estimated locations for small parcels often placed them outside of their true urban locations and inside of forest cover. The result is that many non-forest parcels in the GIS Parcels became forested SFLO parcels in the Pseudo-Parcel dataset. Industrial parcels are typically larger taking up all or high percentages of a section, and are typically located farther from urban areas. Distances between true and estimated parcel locations will be smaller, and there will be less movement from urban to forested locations for Industrial ownerships.

Summary statistics

The Washington State Forestland Database contains an extraordinary amount of information on the location, physical and political characteristics of forestland ownerships. The focus of this report is not to provide a comprehensive list of statistics or figures from the database but instead to document its various features and how it was created. Included below are a few statistics to demonstrate the capability of the database. Additional statistics by county can be found in Appendix D: Statistics. A detailed and extensive quantification of Washington's forest land base will be the subject of subsequent papers and publications.

Washington State Private Forestland Acres by Management Type

The 11.6 million acres of private forestland in Washington State is split nearly evenly between larger industrial owners and smaller family forest landowners (or SFLO) as shown in Figure 8.

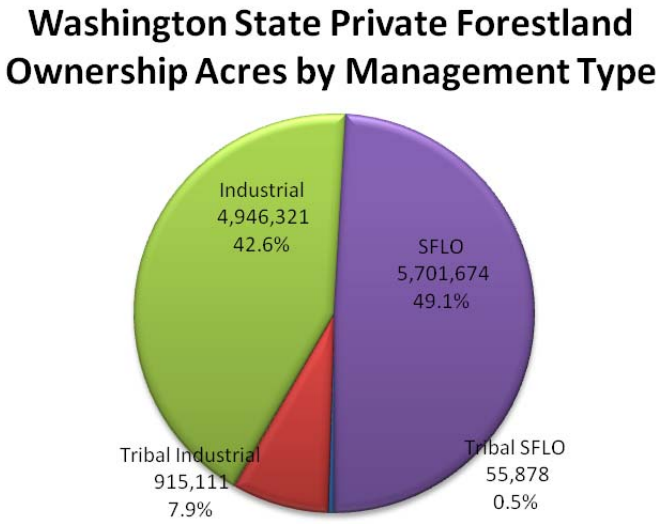

Figure 8: Washington State Private Forestland Ownership Acres by Management Type

Washington Small Forest Land Owners Acreages by Size Class

The Washington State Forestland Database can be used to quantify acres and owners by size class as in

Table 9. Parcel Acres includes the non-forest portions of parcels whereas Forested Acres includes only the forested portions of those parcels.

Size Class	# Parcels	# Owners	Parcel Acres	Forested Acres
<20	173,212	159,585	1,031,388	699,017
20-100	65,156	41,927	1,422,349	950,824
100-1000	34,927	12,418	2,032,996	1,143,292
1000-5000	8,741	1,058	997,956	382,256
5000+	1,162	98	216,971	59,982
Total	**283,198**	**215,043**	**5,701,661**	**3,235,372**

Figure 9: Washington Small Forest Land Owner Acreage by Size Class

Product descriptions

The result of this research is three primary products: the Washington State Forestland Database, statistics on the numbers and acres of forestland parcels, and maps of the distribution and extent of private forestlands. The analysis and compilation of these statistics and the publication of maps will be the subject of future work.

Database

Components of the Washington State Forestland Database have been exported to an ESRI Personal Geodatabase for generating statistics and maps. This database can be used in Microsoft Access or with any ESRI ArcGIS product. The database consists of the Forestland table, and WRIA, WAU and County Feature Classes that can be used for mapping. Technical, political and legal considerations prohibit individual parcel boundaries and personal information from distribution in the Washington State Forestland Database product. Organizations and individuals needing more detailed sub-WAU maps will need to contact researchers to discuss possibilities for collaboration. Information on how to access the Washington State Forestland Database can be found on the project website. Technical information about the attributes and structure of the database can be found in Appendix B: Attributes in the 2007 Washington State Forestland Database.

Statistics

An Excel spreadsheet with statistics on the numbers, acres and locations of private forestlands in Washington State is available on the project website. Sample state and county statistics can be found in the appendix. Additional statistics will be the subject of future work.

Maps

A few sample map graphics from the Washington State Forestland Database are included in the appendix. Higher-resolution printable maps and graphics for presentations are currently under development and will be available on the project website. Requests for additional maps and graphics can be sent to Luke Rogers: lwrogers@u.washington.edu.

Discussion

The Forestland Database is a powerful and flexible tool. There are several immediate possibilities for use, and certainly more will become apparent over time. The primary objective of the Database is to increase the understanding of forest ownership types, locations and relationships to other physical and political features. The platform that has been developed, while complex, is efficient to use and can quickly enumerate and visualize various statistics about forestland ownership.

As the database is updated with new information from counties researchers will be able to analyze land use change and parcelization (subdivisions of parcels). Using county assessor land use information any changes in the land use of parcels, particularly from a forested use to a non-forested use will indicate forestland conversion allowing explicit quantification. By developing an archive of land use change and parcelization over time land use change forecast models can be developed.

Potential applications of the Forestland Database are:

- Economic implications of forest policy
- Identification of property improvements for fire and flood risk mitigation
- Identification of eligible ownerships for salmon habitat and stream improvement
- Bio-fuel feedstock assessments
- Carbon accounting when combined with forest inventory

Limitations

There are many known limitations of the Washington State Forestland Database and while most have been detailed previously it is prudent to review the most critical of those here to ensure appropriate use of the database and its derivative products.

- Spatial accuracy: Each county assessor maintains their GIS and tax-roll information to different standards of both format and accuracy. While many counties appear to have highly accurate parcel geometry many do not and the digital representations of parcels in their data can only be considered "cartoons". When combined with the myriad datasets that were used to quantify forestland ownership significant errors are almost certainly introduced and are extraordinarily difficult to quantify. However, when data is aggregated at the county, regional or state scale, these errors are likely small.
- Pseudo-Parcels: Many counties do not have GIS based parcel information and were not able to provide spatially explicit information for this project. In these counties, actual parcel locations were approximated using legal description information. The potential errors associated with using this information for spatial overlays are large and a validation test was run to determine the magnitude of this error. Caution must be exercised when using these pseudo-parcels for local spatial analysis.
- Designated Forest Lands (DFL): According to WAC 458-40-530, the Washington Department of Revenue is responsible for determining current designated forestland values for County assessors. The Department of Revenue uses timber species, site index, and operability class to make these determinations. Therefore, County Assessor data does not contain accurate, current market value for properties in the DFL program. The risk of conversion figure in the database is therefore only calculated for parcels not enrolled in the DFL program where suitable market values exist.
- Forest Inventory: Modeling forest values for each parcel assumes bare ground. There is no current inventory information used in this database. Clearly current inventory on a parcel will affect the financial analysis and future work will attempt to utilize remotely sensed inventory assessments to improve the quality of the economic analysis.
- Ownership Information: Ownership data is collected individually by each County, and is often incomplete, as assessors are mainly concerned with equitable assessments and the collection of taxes. There is no statewide owner ID available and no straightforward method to integrate owners across the State, which makes determining total statewide ownership for each owner

difficult. The result is that the number of owners stated in the statistics is overestimated for each owner that has property in more than one county. The net result of this overestimation however is presumed to be minor if not completely inconsequential.

- Forest Cover: In addition to land use information forest cover from the National Land Cover Dataset (NLCD) was used to identify forested parcels. The most recent NLCD data available for this analysis was from 2001 which includes satellite imagery from a variety of dates. The collected parcel data has dates around October 2007. The difference in dates between the land cover data and the assessor's information is a source of error. It is likely that some parcels identified from forest cover as forestland have been converted to non-forest uses and others have been re-forested. The net effect of this temporal misalignment is unknown.

Additional Data Needs

Additional data sources have been identified that can be added to the database to increase its functionality however few of these datasets have been compiled at the statewide level.

- Urban Growth Areas, Zoning, Comprehensive Plans and Critical Areas: The State and many Counties have created and maintain additional GIS data that affect how individual parcels can be used and developed. Counties create and maintain zoning, comprehensive plans, and critical areas data sets. The Washington Department of Community, Trade & Economic Development maintains a statewide Urban Growth Area Boundary dataset.
- Conservation Status: There are several State programs with forest conservation goals, such as the Forest Riparian Easement Program (FREP), and non-Governmental organizations such as the Cascade Land Conservancy and The Nature Conservancy with conservation easements, ownership, or development rights. Identification of these "protected" lands in the database would help provide context for priorities.
- Designated Forest Land Assessments: A market value assessment process for DFL lands should be developed based on recent market activity, proximity to other appraised lands and amenities or a combination of factors. A brief attempt was made to correlate sales, adjacent lands and proximity to amenities however no statistically significant factors were identified. A more rigorous approach would likely yield an appropriate method for modeling DFL highest-and-best-use appraisals.
- LIDAR-derived Forest Inventory Estimates: The current economic model for forest investment return is based on bare ground growth simulations. Economic profiles of individual ownerships could be more accurately quantified with knowledge of current forest inventories. While the acquisition of plot-level inventory data for the state is not feasible, research suggests that reasonably accurate volume estimates can be developed from aerial LiDAR flights. With high-resolution LiDAR data it is also possible to infer metrics on stand structure, a key component for modeling wildlife habitat and other biological systems.

Conclusions

The Washington State Forestland Database combines land ownership, land use and assessment information with physical characteristics of the land to develop economic, social and environmental metrics about the forest land base. The spatially explicit information in the database allows for analysis at the watershed, county and state level. This high-resolution dataset can be used to produce maps, statistics and models at multiple scales and when combined with additional datasets becomes a powerful tool for analyzing natural resource lands.

Statistics and maps on the numbers of parcels, acres and owners of forestland in the State of Washington are presented here as a basic example of the kinds of information that can be summarized and visualized using the Forestland Database. Future research at the Rural Technology Initiative will provide additional quantification and maps of the forest land base and by incorporating new data from counties forestland change will be measured. Over time the Washington State Forestland Database will become a comprehensive platform for understanding how forest land ownership and land use is changing enabling new science, research and informed policy to emerge.

Works Cited

Alexander, R.R., D. Tackle, and W.G. Dahms. *Site indexes for Lodgepole pine, with corrections for stand density: Methodology.* Research Paper RM-29, Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station, 1967.

Barrett, J.W. *Height Growth and Site Index Curves for Managed, Even-aged Stands of Ponderosa Pine in the Pacific Northwest.* Research Paper PNW-232, Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station, 1978.

Cochran, P.H. *Site Index and Height Growth Curves for Managed, Even-aged stands of Douglas-fir East of the Cascades in Oregon and Washington.* Research Paper PNW-251, Portland, OR: U.S.Department of Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station, 1979.

Forest Practice Rules. 2009. http://www.dnr.wa.gov/BusinessPermits/Topics/ForestPracticesRules/Pages/fp_rules.aspx (accessed February 10, 2009).

Gray, Andrew N., Charles F. Veneklase, and Robert D. Rhodes. *Timber resource statistics for nonnational forest land in western Washington, 2001.* Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station, 2005.

King, James E. *Site index curves for Douglas-fir in the Pacific Northwest.* Paper 8, Centralia, WA: Weyerhaeuser Company, Forestry Research Center, 1966.

Lippke, B., L. Mason, K. Zobrist, K. Ceder, E. Oneil, and J. McCarter. *Timber Supply and Forest Structure.* In The Future of Washington's Forests and Forestry Industries, Final Report, July 2007. Prepared for the

Washington Department of Natural Resources, Seattle, WA: University of Washington, College of Forest Resources, 2007, 2-123.

Long, J.N., J.B. McCarter, and S.B. Jack. "A modified density management diagram for coastal Douglas-fir." *Western Journal of Applied Forestry* 3, no. 3 (1988): 88-89.

McArdle, R.E., W.H. Meyer, and D. Bruce. *The yield of Douglas fir in the Pacific Northwest.* Technical Bulletin 201, U.S. Department of Agriculture, 1949.

Mouton, Adam. *Generating stream maps using LiDAR derived digital elevation models and 10-m USGS DEM.* Thesis (M.S.), University of Washington, 2005.

Multi-Resolution Land Characteristics Consortium (MRLC). "National Land Cover Database Zone 01 Land Cover Layer (NLCD 2001)." *National Land Cover Database.* [raster digital data]. September 2003. http://www.mrlc.gov/multizone_download.php?zone=1 (accessed February 15, 2008).

Reineke, L. H. "Perfecting a stand-density index for even-aged forests." *Journal of Agriculture Research* 46 (1933): 627-638.

Smith, W. Brad, Patrick D. Miles, John S. Vissage, and Scott A. Pugh. *Forest Resources of the United States, 2002.* St. Paul, MN: U.S. Department of Agriculture, Forest Service, North Central Research Station, 2003.

Straka, T. J., and S. H. Bullard. "Land Expectation Value Calculation in Timberland Valuation." *The Appraisal Journal*, 1996: 399-405.

Washington Department of Ecology. "Water Resource Inventory Areas of Washington (WRIA)." *Ecology's Spatial Datasets.* [vector digital data]. May 2000. http://www.ecy.wa.gov/services/gis/data/data.htm (accessed May 1, 2008).

Washington Department of Natural Resources. "Cadastre DNR Managed Land Parcels." *Available GIS Data.* [vector digital data]. April 2007. http://fortress.wa.gov/dnr/app1/dataweb/dmmatrix.html (accessed May 1, 2008).

—. "County." *Available GIS Data.* Unknown. http://fortress.wa.gov/dnr/app1/dataweb/dmmatrix.html (accessed August 8, 2008).

—. "County." *Available GIS Data.* [vector digital data]. Unknown. http://fortress.wa.gov/dnr/app1/dataweb/dmmatrix.html (accessed August 8, 2008).

—. "East/West Dividing Line." *Forest Practices GIS Spatial Data Sets.* [vector digital data]. October 2002. http://dnr.wa.gov/BusinessPermits/Topics/ForestPracticesApplications/Pages/fp_gis_spatial_data.aspx (accessed May 30, 2008).

—. "Forest Practices Wetlands." *Forest Practices GIS Spatial Data Sets.* [vector digital data]. December 2007.

http://dnr.wa.gov/BusinessPermits/Topics/ForestPracticesApplications/Pages/fp_gis_spatial_data.aspx (accessed May 22, 2008).

—. "NDMPL (Washington State Non-DNR Major Public Lands)." *Available GIS Data.* [vector digital data]. October 2007. http://fortress.wa.gov/dnr/app1/dataweb/dmmatrix.html (accessed May 1, 2008).

—. "Site Class." *Forest Practices GIS Spatial Data Sets.* [vector digital data]. August 2001. http://dnr.wa.gov/BusinessPermits/Topics/ForestPracticesApplications/Pages/fp_gis_spatial_data.aspx (accessed May 1, 2008).

—. "Transportation (Statewide)." *Available GIS Data.* [vector digital data]. April 2008. http://fortress.wa.gov/dnr/app1/dataweb/dmmatrix.html (accessed May 1, 2008).

—. "Washington State Water Body (WBWS) Hydrography." *Available GIS Data.* [vector digital data]. April 2008. http://fortress.wa.gov/dnr/app1/dataweb/dmmatrix.html (accessed May 1, 2008).

—. "Washington State Watercourse (WC) Hydrography." *Available GIS Data.* [vector digital data]. April 2008. http://fortress.wa.gov/dnr/app1/dataweb/dmmatrix.html (accessed May 1, 2008).

—. "Watershed Administrative Units (WAU)." *Forest Practices GIS Spatial Data Sets.* [vector digital data]. April 2006. http://dnr.wa.gov/BusinessPermits/Topics/ForestPracticesApplications/Pages/fp_gis_spatial_data.aspx (accessed May 1, 2008).

Washington State Department of Community, Trade & Economic Development / Washington Department of Ecology. "Urban Growth Area Boundaries." [vector digital data]. January 2008. Acquired via email from Sam Wentz samw@cted.wa.gov (accessed October 1, 2008).

Washington State Department of Transportation. "City Limits of Washington State." *WSDOT GeoData Distribution Catalog.* [vector digital data]. November 2007. http://www.wsdot.wa.gov/mapsdata/GeoDataCatalog/ (accessed February 14, 2008).

Washington State Timber Harvest Reports. 2009. http://www.dnr.wa.gov/BusinessPermits/Topics/Budget/Pages/washington_state_timber_harvest.aspx (accessed February 10, 2009).

Appendix A: Attributes in the 2007 Washington State Parcel Database

Product Description

The 2007 Washington State Parcel Database is designed to be flexible and therefore carries with it some additional overhead that demands thoughtful use. The database is designed with three primary components: the Parcels feature class, the TaxRoll table and the Names table. Additionally there is a TaxRollHasNames table which is necessary to handle the many-to-many relationships between owners and the taxroll (a single parcel may have multiple owners and a single owner may have multiple parcels). The relationship of the tables can be seen in Figure 10.

Database Design

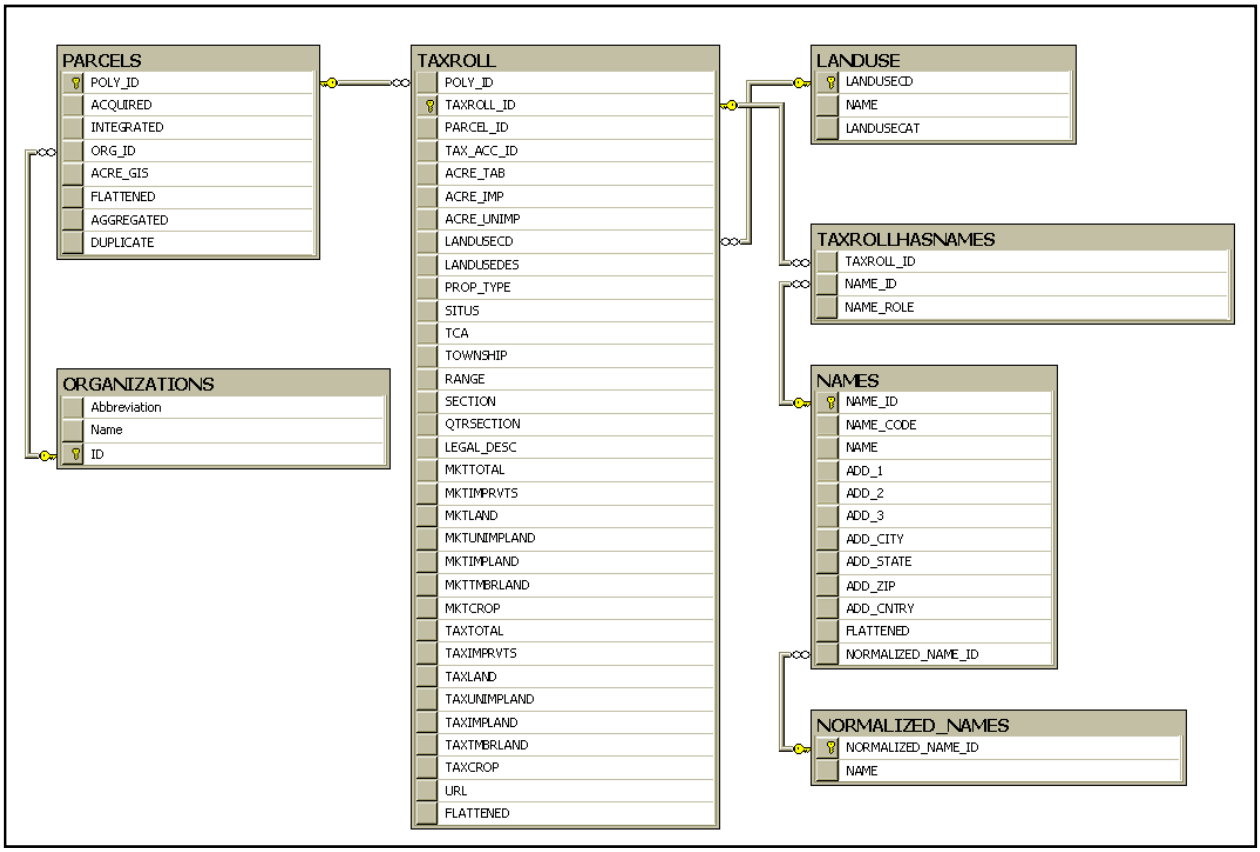

Figure 10: Washington State Parcel Database Entity Relationship Diagram

Attributes

The name and SQL Server data type are followed by the description. Not all attributes are collected by each data providing organization, and therefore not all attributes are available for all parcels.

Parcels Table

POLY_ID (nvarchar 16): The unique identifier for each parcel created by FME in the data normalization process.

ACQUIRED (datetime): The date the data was acquired from the county or agency.

INTEGRATED (datetime): The date the data was normalized using FME.

ORG_ID (smallint): The unique identification number for each data providing organization. Counties are numbered one through 39, while State and Federal Agencies are 40 and greater.

ACRE_GIS (numeric 38,8): The acreage of each parcel, calculated in the GIS software. It is based on the geometry of the GIS parcels provided by each county.

FLATTENED (smallint): The number of stacked parcels in the original data that were combined to make each parcel in the database. See the section, "Correcting Errors in the Data, QA/QC", for a discussion of Stacked Parcels.

AGGREGATED (smallint): The number of parcels in the original data that were combined to make each multipart polygon parcel. See the section, "Correcting Errors in the Data, QA/QC", for a discussion of Multipart Parcels.

DUPLICATE (smallint): The number of duplicate parcels in the original data combined to make each parcel in the database. See the section, "Correcting Errors in the Data, QA/QC", for a discussion of Duplicate Parcels.

Organizations Table

ABBREVIATION (nvarchar 15): An abbreviation of the organization name.

NAME (nvarchar 100): The name of the organization which developed and is responsible for the data.

ID (smallint): The unique identification number for each data providing organization. Counties are numbered one through 39, while State and Federal Agencies are 40 and greater.

TaxRoll Table

POLY_ID (nvarchar 16): The unique identifier for each parcel created by FME in the data normalization process. Used to relate this table to the Parcels Table.

TAXROLL_ID (nvarchar 16): The unique identifier for each tax roll created by FME in the data normalization process.

PARCEL_ID (nvarchar 50): The unique parcel identification number created by the data providing organization.

TAX_ACC_ID (nvarchar 50): The unique taxpayer identification number for each parcel created by each data providing organization.

ACRE_TAB (numeric 38, 8): The total acreage of each parcel as measured by the data providing organization.

ACRE_IMP (numeric 38, 8): The acreage of improved land on each parcel as measured by the data providing organization.

ACRE_UNIMP (numeric 38, 8): The acreage of unimproved land on each parcel as measured by the data providing organization.

LANDUSECD (smallint): The land use code of each parcel as determined by the Assessor at the data providing organization. The values provided by each organization were normalized to fit the Washington State 'Standard two-digit land use code' values as defined in WAC 458-53-30. Values range from 1 to 99.

LANDUSEDES (nvarchar 100): The description of the land use of each parcel as determined by the Assessor at the data providing organization.

PROP_TYPE (nvarchar 100): A general land use classification used differently by each data providing organization, usually including broad categories such as commercial, residential, farm, etc.

SITUS (nvarchar 255): The address of each parcel for legal purposes as produced by the data providing organization.

TCA (nvarchar 50): The tax code area for each parcel as defined in WAC 458-19-005: " 'Tax code area' means a geographical area made up of a unique mix of one or more taxing districts, which is established for the purpose of properly calculating, collecting, and distributing taxes. Only one tax code area will have the same combination of taxing districts, with limited exceptions."

TOWNSHIP (nvarchar 10): The Public Land Survey System Township in which the parcel is located.

RANGE (nvarchar 10): The Public Land Survey System Range in which the parcel is located.

SECTION (nvarchar 10): The Public Land Survey System Section in which the parcel is located.

QTRSECTION (nvarchar 10): The Public Land Survey System Quarter Section in which the parcel is located.

LEGAL_DESC (nvarchar 255): The legal description of the property boundaries for each parcel, as produced by the data providing organization.

MKTTOTAL (int): The total market value of each parcel, as determined by the Assessor at the data providing organization.

MKTIMPRVTS (int): The market value of the improvements on each parcel, as determined by the Assessor at the data providing organization.

MKTLAND (int): The market value of the land for each parcel, as determined by the Assessor at the data providing organization.

MKTUNIMPLAND (int): The market value of the unimproved land for each parcel, as determined by the Assessor at the data providing organization.

MKTIMPLAND (int): The market value of the improved land for each parcel, as determined by the Assessor at the data providing organization.

MKTTMBRLAND (int): The market value of the timber land for each parcel, as determined by the Assessor at the data providing organization.

MKTCROP (int): The market value of the crop for each parcel, as determined by the Assessor at the data providing organization.

TAXTOTAL (int): The total taxable value of each parcel, as determined by the Assessor at the data providing organization.

TAXIMPRVTS (int): The taxable value of the improvements on each parcel, as determined by the Assessor at the data providing organization.

TAXLAND (int): The taxable value of the land for each parcel, as determined by the Assessor at the data providing organization.

TAXUNIMPLAND (int): The taxable value of the unimproved land for each parcel, as determined by the Assessor at the data providing organization.

TAXIMPLAND (int): The taxable value of the improved land for each parcel, as determined by the Assessor at the data providing organization.

TAXTMBRLAND (int): The taxable value of the timber land for each parcel, as determined by the Assessor at the data providing organization.

TAXCROP (int): The taxable value of the crop for each parcel, as determined by the Assessor at the data providing organization.

URL (nvarchar 255): The address of the website providing tax information for each parcel.

FLATTENED (smallint): The number of duplicate tax rolls in the original data for each tax roll in the database. Calculated as part of the data normalization process in FME. See the section, "Correcting Errors in the Data, QA/QC", for a discussion of Flattened Tax Rolls.

Land Use Table

LANDUSECD (smallint): The land use code of each parcel as determined by the Assessor at the data providing organization. The values provided by each organization were normalized to fit the Washington State 'Standard two-digit land use code' values as defined in WAC 458-53-30. Values range from 1 to 99. It is a numeric representation of the land use name. Used to relate this table to the Parcels Table.

NAME (nvarchar 100): The name of the land use for each parcel as determined by the Assessor at the data providing organization. The values provided by each organization were normalized to fit the Washington State 'Standard two-digit land use code' values as defined in WAC 458-53-30.

LANDUSECAT (nvarchar 44): The land use category of each parcel as determined by the Assessor at the data providing organization. The values provided by each organization were normalized to fit the

Washington State 'Standard two-digit land use code' values as defined in WAC 458-53-30. There are eight land use categories: residential; manufacturing; transportation, communication, and utilities; trade; services; cultural, entertainment, and recreational; resource production and extraction; undeveloped land and water areas.

TaxRollHasNames Table

TAXROLL_ID (nvarchar 16): The unique identifier for each tax roll created by FME in the data normalization process. Used to relate this table to the Parcels Table.

NAME_ID (nvarchar 16): The unique identifier for each name created by FME in the data normalization process. Used to relate this table to the Names Table.

NAME_ROLE (nvarchar 10): Who the name attributes belong to. Data providing organizations could maintain taxpayer names, owner names, or both.

Names Table

NAME_ID (nvarchar 16): The unique identifier for each name created by FME in the data normalization process.

NAME_CODE (nvarchar 50): Some data providing organizations distribute data with names and parcels in separate tables. The name code is the key relating the original data tables from the data providing organization. It is conceptually the same as the NAME_ID.

NAME (nvarchar 255): The owner or taxpayer's Name as created by the data providing organization.

ADD_1 (nvarchar 255): The owner or taxpayer's Address as created by the data providing organization.

ADD_2 (nvarchar 255): The owner or taxpayer's Address as created by the data providing organization.

ADD_3 (nvarchar 255): The owner or taxpayer's Address as created by the data providing organization.

ADD_CITY (nvarchar 50): The owner or taxpayer's City as created by the data providing organization.

ADD_STATE (nvarchar 50): The owner or taxpayer's State as created by the data providing organization.

ADD_ZIP (nvarchar 50): The owner or taxpayer's Zip Code as created by the data providing organization.

ACC_CNTRY (nvarchar 50): The owner or taxpayer's Country as created by the data providing organization.

FLATTENED (smallint): The number of duplicate names in the original data for each name in the database. Calculated as part of the data normalization process in FME. See the section, "Correcting Errors in the Data, QA/QC", for a discussion of Flattened Names.

NORMALIZED_NAME_ID (int): The unique identifier for each normalized name created by FME in the data normalization process. Used to relate this table to the Normalized Names Table.

NormalizedNames Table

NORMALIZED_NAME_ID (int): The unique identifier for each normalized name created by FME in the data normalization process. Used to relate this table to the Names Table.

NORMALIZED_NAME (nvarchar 255): There are times when the same owner or taxpayer name appears in a County's data spelled differently. This is a consistent version of each name for identifying ownerships across the state. Due to time and resource constraints this functionality has not been implemented.

Appendix B: Attributes in the 2007 Washington State Forestland Database

Product description

The 2007 Washington State Forestland Database is an ArcGIS 9.3 Personal Geodatabase that can be accessed using any of the programs in the ESRI ArcGIS product suite or using Microsoft Access. The spatial components of the database are not accessible via MS Access.

Database Design

The database consists of four separate features: the Forestland table and the County, WRIA and WAU feature classes for thematic mapping (Figure 11). Each of the three feature classes can be joined or related to the Forestland table (Table 18).

Table 18: Forestland Database primary/foreign key relationships for thematic mapping.

From	To
Forestland_2007.COUNTY_ID	County_2007.JURDSG
Forestland_2007.WRIA_NR	WRIA_2007.WRIA_NR
Forestland_2007.WAU_CD	WAU_2007.WAU_CD

To create thematic maps using the Forestland Database summary statistics must first be run on the data. For example to create a map of the percent of each WRIA that is owned by Small Forest Landowners a new "make table" query must be run to make the table that will be joined to the WRIA feature class for mapping. The query in Microsoft Access would be:

```
SELECT Forestland_2007.WRIA_NR, Sum([Forestland_2007].[GIS_ACRES]/[WRIA_2007].[WRIA_ACRES])
AS PERCENT_SFLO INTO WRIA_Percent_SFLO
FROM Forestland_2007 INNER JOIN WRIA ON Forestland_2007.WRIA_NR = WRIA_2007.WRIA_NR
WHERE (((Forestland_2007.WA_SFLO)="SFLO"))
GROUP BY Forestland_2007.WRIA_NR;
```

The newly created "WRIA_Percent_SFLO" table can then be joined to the WRIA feature class for thematic mapping in ArcGIS.

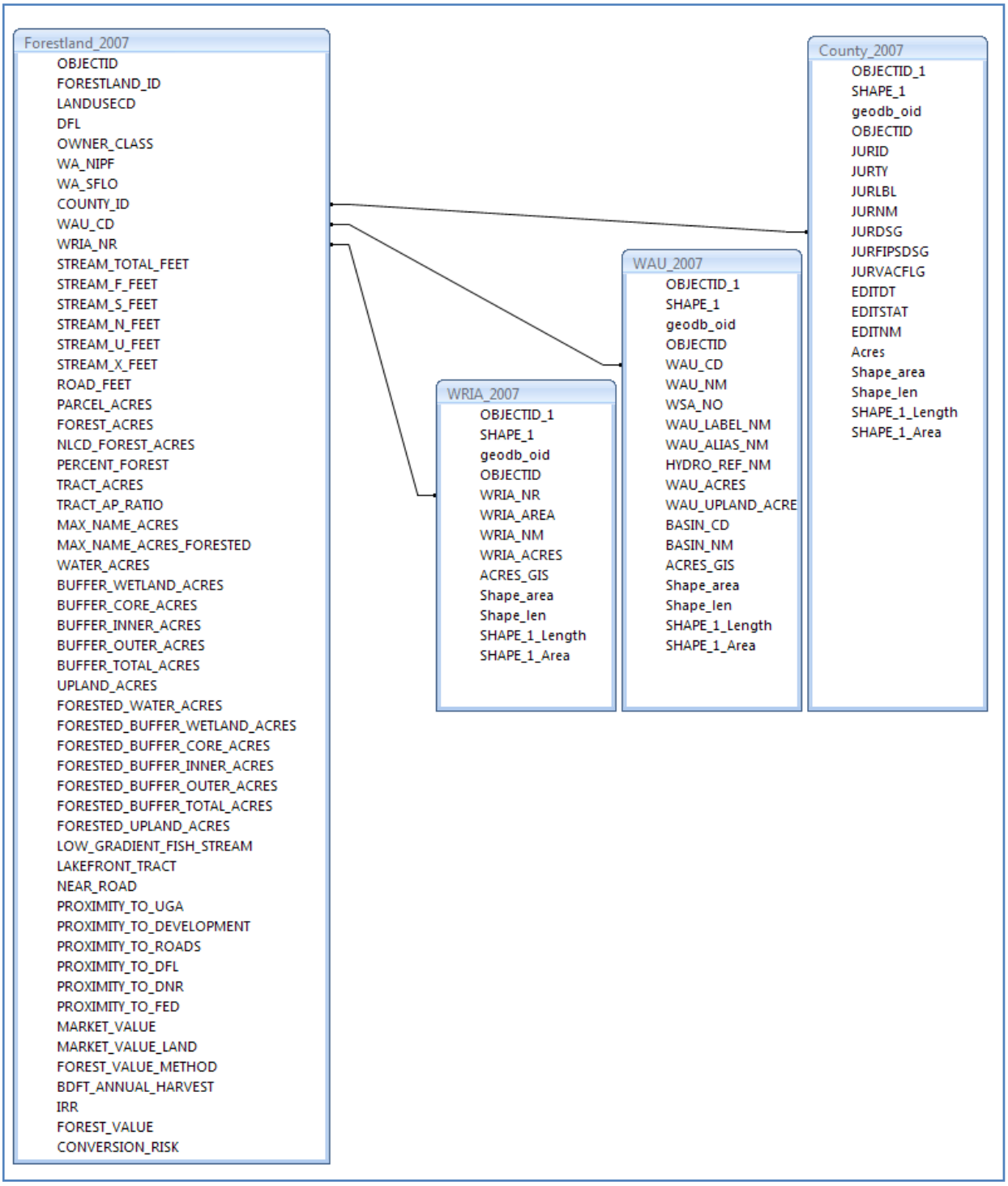

Figure 11: Washington State Forestland Database Entity Relationship Diagram.

Attributes

Datasets referenced with superscripts are described in Appendix C: GIS Datasets Used.

FORESTLAND_ID: The unique identifier for each parcel created in the data export process. Each identifier is a 128 bit GUID (globally unique identifier) represented as a 38 character string.

Land Use

LANDUSECD: The land use as assessed by each County Assessor. County values were normalized to fit the Washington State 'Standard two-digit land use code' values as defined in WAC 458-53-30. Values range from 1 to 99.

DFL: Whether or not each parcel is enrolled in the Designated Forestland Tax Program. This is determined by its land use code. A land use code value of 87 or 88 indicates that the parcel is participating in the program. Values: 1 or Null.

Ownership Classification

OWNER_CLASS: The type of owner for each property. This was determined by examining the owner name for each parcel, comparing it to a categorized, exhaustive list of names, and placing the parcel into a category. Values: Government, Corporate, Tribal, Conservation, Other Private.

Management Type

WA_NIPF: The management type using the NIPF definition, "total individual land ownerships of less than 5000 acres and not directly associated with wood processing or handling facilities". Values: NIPF, Industrial, or Null.

> **NIPF:** A parcel that meets NIPF definition, "total individual land ownerships of less than 5000 acres and not directly associated with wood processing or handling facilities", and does not have a corporate or government owner.
>
> **Industrial:** A parcel that does not meet the NIPF definition, "total individual land ownerships of less than 5000 acres and not directly associated with wood processing or handling facilities", meaning the parcel owner owns more than 5000 acres in the State. The parcel also has a corporate owner, and is non-government.

WA_SFLO: The management type using the Washington State Small Forest Landowner definition as defined in RCW 76.09.450 (harvesting no more than an average of 2 million board feet of timber per year). Values: SFLO, Industrial, Tribal_SFLO, or NULL. While the Forestland Database has parcels down to 1 acre in size, the Database's SFLO definition requires the smallest properties to be at least 2 acres in size (tract acres) with a minimum of 1 acre of forest cover. Parcels with forested land uses as defined by county assessors were classified as SFLO up to the acreage limits regardless of minimum size cutoffs (land uses 87, 88, 92 and 95, see Appendix F: Land Use Codes in the Washington State Forestland Database).

> **SFLO:** A parcel that meets the Washington State Small Forest Landowner definition as defined in RCW 76.09.450 (harvesting no more than an average of 2 million board feet of timber per year).

This is estimated by determining the number of acres in management an owner would need to meet this level of productivity. On the west side of the state, an owner would need 2500 acres, and on the eastside 9990 acres. A parcel whose owner owns less than 2500 acres on the west side of the state, or a parcel whose owner owns less than 9990 acres on the east side of the state would qualify. The parcel owner must also be non-corporate and non-government.

Industrial: A parcel that does not meet the Washington State Small Forest Landowner definition as defined in RCW 76.09.450 (harvesting no more than an average of 2 million board feet of timber per year). This is estimated by determining the number of acres in management an owner would need to meet this level of productivity. On the west side of the state, an owner would need 2500 acres, and on the eastside 9990 acres. A parcel whose owner owns at least 2500 acres on the west side of the state, or a parcel whose owner owns at least 9990 acres on the east side of the state would qualify. The parcel owner must also be corporate and non-government.

Tribal_SFLO: A parcel that meets the Washington State Small Forest Landowner definition as defined in RCW 76.09.450 (harvesting no more than an average of 2 million board feet of timber per year). This is estimated by determining the number of acres in management an owner would need to meet this level of productivity. On the west side of the state, an owner would need 2500 acres, and on the eastside 9990 acres. A parcel whose owner owns less than 2500 acres on the west side of the state, or a parcel whose owner owns less than 9990 acres on the east side of the state would qualify. The parcel owner must also be tribal, non-corporate, and non-government.

Physical Attributes

COUNTY_ID: The ID number of the County in which each parcel is located. The county boundary dataset was created by the Washington Department of Natural Resources[1].

WAU_CD: The ID number of the WAU (Watershed Administrative Unit) in which each parcel is located. The WAU dataset was created by the Washington Department of Natural Resources[2].

WRIA_NR: The ID number of the WRIA (Water Resource Inventory Area) in which each parcel is located. The WRIA dataset was created by the Washington State Department of Ecology[3].

STREAM _TOTAL_FEET: The total length in feet of all watercourses on a parcel. The watercourse data was created by the Washington Department of Natural Resources[4].

STREAM_F_FEET: The total length in feet of all type F watercourses on a parcel. The type F designation is a DNR Forest Practices Fish Habitat Water Type Code, implemented for Western Washington March 1, 2005, and for Eastern Washington March 1, 2006. It is used in conjunction with WAC 222-16-030 and 222-16-031 and the Washington Forest Practices Board Manual. The watercourse data was created by the Washington Department of Natural Resources[4].

STREAM_S_FEET: The total length in feet of all type S watercourses on a parcel. The type S designation is a DNR Forest Practices Fish Habitat Water Type Code, implemented for Western Washington March 1, 2005, and for Eastern Washington March 1, 2006. It is used in conjunction with WAC 222-16-030 and 222-16-031 and the Washington Forest Practices Board Manual. The watercourse data was created by the Washington Department of Natural Resources[4].

STREAM_N_FEET: The total length in feet of all type N watercourses on a parcel. The type N designation is a DNR Forest Practices Fish Habitat Water Type Code, implemented for Western Washington March 1, 2005, and for Eastern Washington March 1, 2006. It is used in conjunction with WAC 222-16-030 and 222-16-031 and the Washington Forest Practices Board Manual. The watercourse data was created by the Washington Department of Natural Resources[4].

STREAM_U_FEET: The total length in feet of all type U watercourses on a parcel. The type U designation is a DNR Forest Practices Fish Habitat Water Type Code, implemented for Western Washington March 1, 2005, and for Eastern Washington March 1, 2006. It is used in conjunction with WAC 222-16-030 and 222-16-031 and the Washington Forest Practices Board Manual. The watercourse data was created by the Washington Department of Natural Resources[4].

STREAM_X_FEET: The total length in feet of all type X watercourses on a parcel. The type X designation is a DNR Forest Practices Fish Habitat Water Type Code, implemented for Western Washington March 1, 2005, and for Eastern Washington March 1, 2006. It is used in conjunction with WAC 222-16-030 and 222-16-031 and the Washington Forest Practices Board Manual. The watercourse data was created by the Washington Department of Natural Resources[4].

ROAD_FEET: The total length in feet of all roads on a parcel. The road data was created by the Washington Department of Natural Resources[5].

PARCEL_ACRES: The total acreage calculated by the GIS software for the geometry of each parcel.

FOREST_ACRES: The total acreage of forest on each parcel. This was calculated in one of two ways:

1) Using the NLCD Forest/Non-Forest dataset[6]. The NLCD data was intersected with the parcel geometry to determine the amount of forest within each parcel.
2) Using the parcel land use code. It is assumed that if a parcel is in a designated forestland tax program, that the entire acreage is managed as forest even if some portion of the parcel is non-forest in the NLCD dataset. The full parcel acreage is considered to be forest in this scenario.

NLCD_FOREST_ACRES: The acres of forest using only the NLCD Forest/Non-Forest dataset[6]. This eliminates the second method used to calculate **FOREST_ACRES** above, and does not consider enrollment in a designated forestland tax program.

PERCENT_FOREST: The percentage of the total acreage that is Forest for each parcel. This is calculated by dividing the **FOREST_ACRES** by the **PARCEL_ACRES**.

TRACT_ACRES: Contiguous properties owned by the same owner are called a tract. A tract can be a single parcel. This is the acreage of the tract in which a parcel is a member.

TRACT_AP_RATIO: A measurement of the "parcelization" of ownership tracts (contiguous properties owned by the same owner). It is the sum of the areas of parcels in a tract divided by the sum of the perimeters of parcels in a tract. Values: 2 to 5772.

MAX_NAME_ACRES: A best attempt to determine ownership acres, the total acreage owned by the owner of each parcel within that parcel's county. Counties may use either taxpayer or owners for each parcel, so this attribute could not be named Ownership Acres. Each parcel may also have more than one owner. The total acreage owned in the county is calculated for each owner of a parcel, and the largest total acreage of the multiple owners is used.

MAX_NAME_ACRES_FORESTED: The same as **MAX_NAME_ACRES**, but for acres of forest, not parcel acres.

WATER_ACRES: The total acreage of each parcel that is water (waterbodies or wetlands). This attribute was derived using the Washington Department of Natural Resources waterbodies[7] and wetlands[8] datasets.

BUFFER_WETLAND_ACRES: The total acreage of each parcel that is in wetland buffers. This attribute was calculated using the Washington Department of Natural Resources wetlands[8] and Site Class[9] datasets, and using the Forest Practices Riparian Management Zone rules as defined in WAC 222-30.

BUFFER_CORE_ACRES: The total acreage of each parcel that is in core buffers. This attribute was calculated using the Washington Department of Natural Resources waterbodies[7], watercourses[4], east/west dividing line[10], and Site Class[9] datasets, and using the Forest Practices Riparian Management Zone rules as defined in WAC 222-30.

BUFFER_INNER_ACRES: The total acreage of each parcel that is in inner buffers. This attribute was calculated using the Washington Department of Natural Resources waterbodies[7], watercourses[4], east/west dividing line[10], and Site Class[9] datasets, and using the Forest Practices Riparian Management Zone rules as defined in WAC 222-30.

BUFFER_OUTER_ACRES: The total acreage of each parcel that is in outer buffers. This attribute was calculated using the Washington Department of Natural Resources waterbodies[7], watercourses[4], east/west dividing line[10], and Site Class9 datasets, and using the Forest Practices Riparian Management Zone rules as defined in WAC 222-30.

BUFFER_TOTAL_ACRES: The total acreage of each parcel that is in any type of Forest Practices buffer. This is calculated by summing the core, inner, outer, and wetland buffer acreages.

UPLAND_ACRES: The total acreage of each parcel that is not water or Forest Practice buffer.

FORESTED_WATER_ACRES: The total acreage of each parcel that is both water, as defined in **WATER_ACRES** above, and forest, as defined in **FOREST_ACRES** above.

FORESTED_BUFFER_WETLAND_ACRES: The total acreage of each parcel that is both wetland buffer, as defined in **BUFFER_WETLAND_ACRES** above, and forest, as defined in **FOREST_ACRES** above.

FORESTED_BUFFER_CORE_ACRES: The total acreage of each parcel that is both core buffer, as defined in **BUFFER_CORE_ACRES** above, and forest, as defined in **FOREST_ACRES** above.

FORESTED_BUFFER_INNER_ACRES: The total acreage of each parcel that is both inner buffer, as defined in **BUFFER_INNER_ACRES** above, and forest, as defined in **FOREST_ACRES** above.

FORESTED_BUFFER_OUTER_ACRES: The total acreage of each parcel that is both outer buffer, as defined in **BUFFER_OUTER_ACRES** above, and forest, as defined in **FOREST_ACRES** above.

FORESTED_BUFFER_TOTAL_ACRES: The sum of the forested core, inner, outer, and wetland buffers.

FORESTED_UPLAND_ACRES: The total acreage of each parcel that is both upland, as defined in **UPLAND_ACRES** above, and forest, as defined in **FOREST_ACRES** above.

LOW_GRADIENT_FISH_STREAM: Parcels with a Forest Practices type S watercourse or Water Body from the DNR hydro datasets present. The type S designation is a DNR Forest Practices Fish Habitat Water Type Code, implemented for Western Washington March 1, 2005, and for Eastern Washington March 1, 2006. It is used in conjunction with WAC 222-16-030 and 222-16-031 and the Washington Forest Practices Board Manual. The watercourse and Water Body datasets were created by the Washington Department of Natural Resources[4], [7]. Values: 1 or NULL.

LAKEFRONT_TRACT: Parcels that are within a half mile of a ten acre or larger lake in the Washington Department of Natural Resources Water Body[7] dataset, and are part of a tract (contiguous properties owned by the same owner) that intersects these lakes. Values: 1 or NULL.

NEAR_ROAD: Parcels that are 600 feet or less from a major road. Major roads were selected from the Washington Department of Natural Resources transportation dataset[5] that were: primary highway/all-weather/hard surface, secondary highway/ all-weather/ hard surface, light-duty road/ all-weather/ improved surface. Values: 1 or NULL.

PROXIMITY_TO_UGA: The distance of each parcel to urban growth areas likely has an effect on its viability as a managed forest. Therefore the straight-line distance in miles from each parcel to the nearest urban growth area was measured. The urban growth area boundary dataset[11] was created and is maintained by the Washington Department of Community, Trade & Economic Development (CTED). Values: 0 to 73 miles.

PROXIMITY_TO_DEVELOPMENT: The distance of each parcel to developed land uses likely has an effect on its viability as a managed forest. Therefore the straight-line distance in miles was measured from each parcel to the nearest parcel with a developed land use code. Developed land uses are those with

an assessed land use code less than 80. The land use is assessed by each County Assessor. County values were normalized to fit the Washington State 'Standard two-digit land use code' values as defined in WAC 458-53-30. Land use code values range from 1 to 99.
Values: 0 to 28 miles.

PROXIMITY_TO_ROADS: The straight-line distance in miles from each parcel to the nearest major road. Major roads were selected from the Washington Department of Natural Resources transportation dataset[5] that were: primary highway/all-weather/hard surface, secondary highway/ all-weather/ hard surface, light-duty road/ all-weather/ improved surface. Values: 0 to 19 miles.

PROXIMITY_TO_DFL: The straight-line distance in miles from each parcel to the nearest designated forestland parcel Designated Forestlands are identified by their Land Use Code: 87 (not presently assigned [formerly classified forest land under chapter 84.33 RCW]) or 88 (designated forest land under chapter 84.33 RCW). Values: 0 to 56 miles.

PROXIMITY_TO_DNR: The straight-line distance in miles from each parcel to the nearest Washington Department of Natural Resources managed timberland. The managed timberland data were created by the Washington Department of Natural Resources in the DNR Managed Land Parcels dataset[12]. Values: 0 to 37 miles.

PROXIMITY_TO_FED: The straight-line distance in miles from each parcel to the nearest Federal ownership. This could include the US Forest Service, US Fish & Wildlife Service, US Federal Service, US Bureau of Reclamation, US Bureau of Land Management, National Park Service, or other (excludes Department of Defense and Department of Energy). Federal ownership data were created by the Washington Department of Natural Resources in the Washington State Non-DNR Major Public Lands dataset[13]. Values: 0 to 30 miles.

Economic Attributes

MARKET_VALUE: The value of each parcel (land and improvements) on the market today, as assessed by each County Assessor. Designated Forest Lands are not assessed. A market value was not directly available for all counties depending on how each Assessor collects data. For some counties market values were derived through some combination of the market value of improvements, market value of improved land, market value of unimproved land, and market value of timberland. For some counties, market values were not available. Values: $0 to $1,219,546,100.

MARKET_VALUE_LAND: The value (land only) of each parcel on the market today, as assessed by each County Assessor. Designated Forest Lands are not assessed. Values: $0 to $609,896,900.

FOREST_VALUE_METHOD: The method used to quantify the amount of forest cover on an individual parcel for calculation of the FOREST_VALUE. Parcels with forested land use codes of 87, 88, 92 and 95 were classified as completely forested as any non-forested portions as detected by the NLCD land cover were assumed to be planted and in reproduction. Parcels with non-forest land use codes were assumed to have forest only on the portions of the parcel as detected by NLCD land cover data and no reproduction was assumed. Values: Entire Parcel; Forest Cover Only.

BDFT_ANNUAL_HARVEST: The average annual productivity (final harvest / rotation length) for each parcel in board feet, based on a modeled forest management scenario of site class, buffers, wetlands, location and management type. Values: 0 to 106,523,366.

IRR: The yield on investment per parcel, based on a modeled forest management scenario. Values: 0% to 15.28%.

FOREST_VALUE: The net present value of a modeled forest management scenario for each parcel (the soil expectation value at a five percent discount rate). Values: -$9,873,830 to $429,748,962.

CONVERSION_RISK: An estimate of how likely each parcel is to change from forest to non-forest use. The difference between per acre Market Value and per acre Forest Value for each parcel. Values: -$4795 to $26,690,335 per acre.

Appendix C: GIS Datasets Used

1. Washington Department of Natural Resources. "County." *Available GIS Data.* [vector digital data]. Unknown. http://fortress.wa.gov/dnr/app1/dataweb/dmmatrix.html (accessed August 8, 2008).
2. Washington Department of Natural Resources. "Watershed Administrative Units (WAU)." *Forest Practices GIS Spatial Data Sets.* [vector digital data]. April 2006. http://dnr.wa.gov/BusinessPermits/Topics/ForestPracticesApplications/Pages/fp_gis_spatial_data.aspx (accessed May 1, 2008).
3. Washington Department of Ecology. "Water Resource Inventory Areas of Washington (WRIA)." *Ecology's Spatial Datasets.* [vector digital data]. May 2000. http://www.ecy.wa.gov/services/gis/data/data.htm (accessed May 1, 2008).
4. Washington Department of Natural Resources. "Washington State Watercourse (WC) Hydrography." *Available GIS Data.* [vector digital data]. April 2008. http://fortress.wa.gov/dnr/app1/dataweb/dmmatrix.html (accessed May 1, 2008).
5. Washington Department of Natural Resources. "Transportation (Statewide)." *Available GIS Data.* [vector digital data]. April 2008. http://fortress.wa.gov/dnr/app1/dataweb/dmmatrix.html (accessed May 1, 2008).
6. Multi-Resolution Land Characteristics Consortium (MRLC). "National Land Cover Database Zone 01 Land Cover Layer (NLCD 2001)." *National Land Cover Database.* [raster digital data]. September 2003. http://www.mrlc.gov/multizone_download.php?zone=1 (accessed February 15, 2008).
7. Washington Department of Natural Resources. "Washington State Water Body (WBWS) Hydrography." *Available GIS Data.* [vector digital data]. April 2008. http://fortress.wa.gov/dnr/app1/dataweb/dmmatrix.html (accessed May 1, 2008).
8. Washington Department of Natural Resources. "Forest Practices Wetlands." *Forest Practices GIS Spatial Data Sets.* [vector digital data]. December 2007. http://dnr.wa.gov/BusinessPermits/Topics/ForestPracticesApplications/Pages/fp_gis_spatial_data.aspx (accessed May 22, 2008).
9. Washington Department of Natural Resources. "Site Class." *Forest Practices GIS Spatial Data Sets.* [vector digital data]. August 2001. http://dnr.wa.gov/BusinessPermits/Topics/ForestPracticesApplications/Pages/fp_gis_spatial_data.aspx (accessed May 1, 2008).
10. Washington Department of Natural Resources. "East/West Dividing Line." *Forest Practices GIS Spatial Data Sets.* [vector digital data]. October 2002. http://dnr.wa.gov/BusinessPermits/Topics/ForestPracticesApplications/Pages/fp_gis_spatial_data.aspx (accessed May 30, 2008).
11. Washington State Department of Community, Trade & Economic Development / Washington Department of Ecology. "Urban Growth Area Boundaries." [vector digital data]. January 2008. Acquired via email from Sam Wentz samw@cted.wa.gov (accessed October 1, 2008).

12. Washington Department of Natural Resources. “Cadastre DNR Managed Land Parcels.” *Available GIS Data.* [vector digital data]. April 2007. http://fortress.wa.gov/dnr/app1/dataweb/dmmatrix.html (accessed May 1, 2008).

13. Washington Department of Natural Resources. “NDMPL (Washington State Non-DNR Major Public Lands).” *Available GIS Data.* [vector digital data]. October 2007. http://fortress.wa.gov/dnr/app1/dataweb/dmmatrix.html (accessed May 1, 2008).

14. Washington State Department of Transportation. "City Limits of Washington State." *WSDOT GeoData Distribution Catalog.* [vector digital data]. November 2007. http://www.wsdot.wa.gov/mapsdata/GeoDataCatalog/ (accessed February 14, 2008).

Appendix D: Statistics

Sample statistics by County from the Washington State Parcel Database

Washington State Forestland Parcel Acres by Owner Type and County					
County	**Industrial**	**SFLO**	**Tribal Industrial**	**Tribal SFLO**	**County Total**
Adams	3,759	28,004			**31,763**
Asotin	39,794	134,658		994	**175,445**
Benton	1,284	9,383			**10,667**
Chelan	60,260	127,220			**187,480**
Clallam	261,485	81,337	3,896	1,084	**347,803**
Clark	42,016	128,761			**170,777**
Cowlitz	418,491	124,499		16	**543,006**
Douglas	11,698	116,208		296	**128,203**
Ferry	126,367	183,298	56,628	5,272	**371,564**
Franklin	2,338	30,060			**32,397**
Garfield		161,413			**161,413**
Grant	3,393	6,867			**10,260**
Grays Harbor	555,518	134,700	41,382	15,646	**747,246**
Island	299	76,239			**76,537**
Jefferson	141,068	62,378		96	**203,542**
King	237,371	171,150		1,823	**410,344**
Kitsap	24,376	116,703	10,429	1,279	**152,788**
Kittitas	181,472	104,607		30	**286,109**
Klickitat	225,848	273,961	75,766	156	**575,730**
Lewis	604,033	248,426		198	**852,658**
Lincoln	14,889	216,230		72	**231,190**
Mason	229,339	101,326		3,126	**333,790**
Okanogan	33,468	439,367	29,014	1,857	**503,705**
Pacific	381,005	70,023		137	**451,166**
Pend Oreille	86,020	110,447		1,004	**197,471**
Pierce	235,462	180,364		312	**416,139**
San Juan		76,378			**76,378**
Skagit	191,991	118,523		1,522	**312,036**
Skamania	81,905	33,497			**115,402**
Snohomish	92,235	216,846		10,219	**319,300**
Spokane	39,021	527,052			**566,073**
Stevens	303,898	623,554		2,891	**930,344**
Thurston	94,966	163,911		1,196	**260,073**
Wahkiakum	91,195	28,640			**119,835**
Walla Walla	2,991	79,567			**82,558**
Whatcom	89,203	138,678		3,709	**231,590**
Whitman		199,304			**199,304**
Yakima	37,861	58,084	697,995	2,944	**796,884**
State Total	**4,946,321**	**5,701,661**	**915,111**	**55,878**	**11,618,971**

Washington State Small Forest Landowner Acres and Owners by County						
County	# Parcels	# Owners	Parcel Acres	Avg Tract Acres	Forest Acres	Avg % Forest
Adams	99	67	28,004	734	525	4%
Asotin	1,696	600	135,651	299	48,126	52%
Benton	42	35	9,383	1,139	105	8%
Chelan	3,937	2,717	127,220	80	65,295	62%
Clallam	8,315	5,644	82,422	30	66,020	76%
Clark	11,719	11,711	128,761	23	76,708	62%
Cowlitz	10,229	7,416	124,514	28	97,013	73%
Douglas	1,104	774	116,505	304	14,129	35%
Ferry	4,631	2,744	188,570	59	128,003	69%
Franklin	179	124	30,060	1,157	732	5%
Garfield	1,339	700	161,413	175	28,551	43%
Grant	49	41	6,867	462	207	8%
Grays Harbor	5,856	4,141	150,347	38	113,935	67%
Island	9,695	7,913	76,239	9	56,394	78%
Jefferson	4,936	3,610	62,474	21	51,125	79%
King	19,533	16,455	172,973	21	116,476	70%
Kitsap	19,590	16,093	117,982	22	93,172	79%
Kittitas	4,063	2,632	104,637	131	58,497	68%
Klickitat	5,023	3,379	274,117	221	98,185	56%
Lewis	13,792	9,224	248,624	48	178,516	70%
Lincoln	2,037	1,212	216,301	384	43,962	39%
Mason	10,179	7,059	104,452	23	86,209	79%
Okanogan	10,981	5,997	441,224	310	181,859	55%
Pacific	3,022	1,941	70,161	49	56,087	70%
Pend Oreille	5,448	3,739	111,450	26	82,902	80%
Pierce	19,199	15,424	180,676	19	124,264	72%
San Juan	6,660	4,814	76,378	44	56,938	77%
Skagit	8,910	6,200	120,045	38	86,858	72%
Skamania	2,221	1,650	33,497	18	24,660	73%
Snohomish	22,816	22,783	227,065	26	156,568	69%
Spokane	21,430	16,378	527,052	60	241,483	61%
Stevens	18,020	10,818	626,445	115	546,273	81%
Thurston	12,804	10,135	165,108	34	103,652	67%
Wahkiakum	1,139	732	28,640	30	23,495	80%
Walla Walla	994	587	79,567	400	24,230	44%
Whatcom	9,733	7,503	142,387	37	85,519	66%
Whitman	1,933	1,782	199,304	109	22,777	22%
Yakima	934	531	61,027	248	33,460	59%
Total	**284,287**	**215,305**	**5,757,539**	**183**	**3,272,908**	**59%**

Appendix E: Maps

Private Forests and Public Lands in Washington State

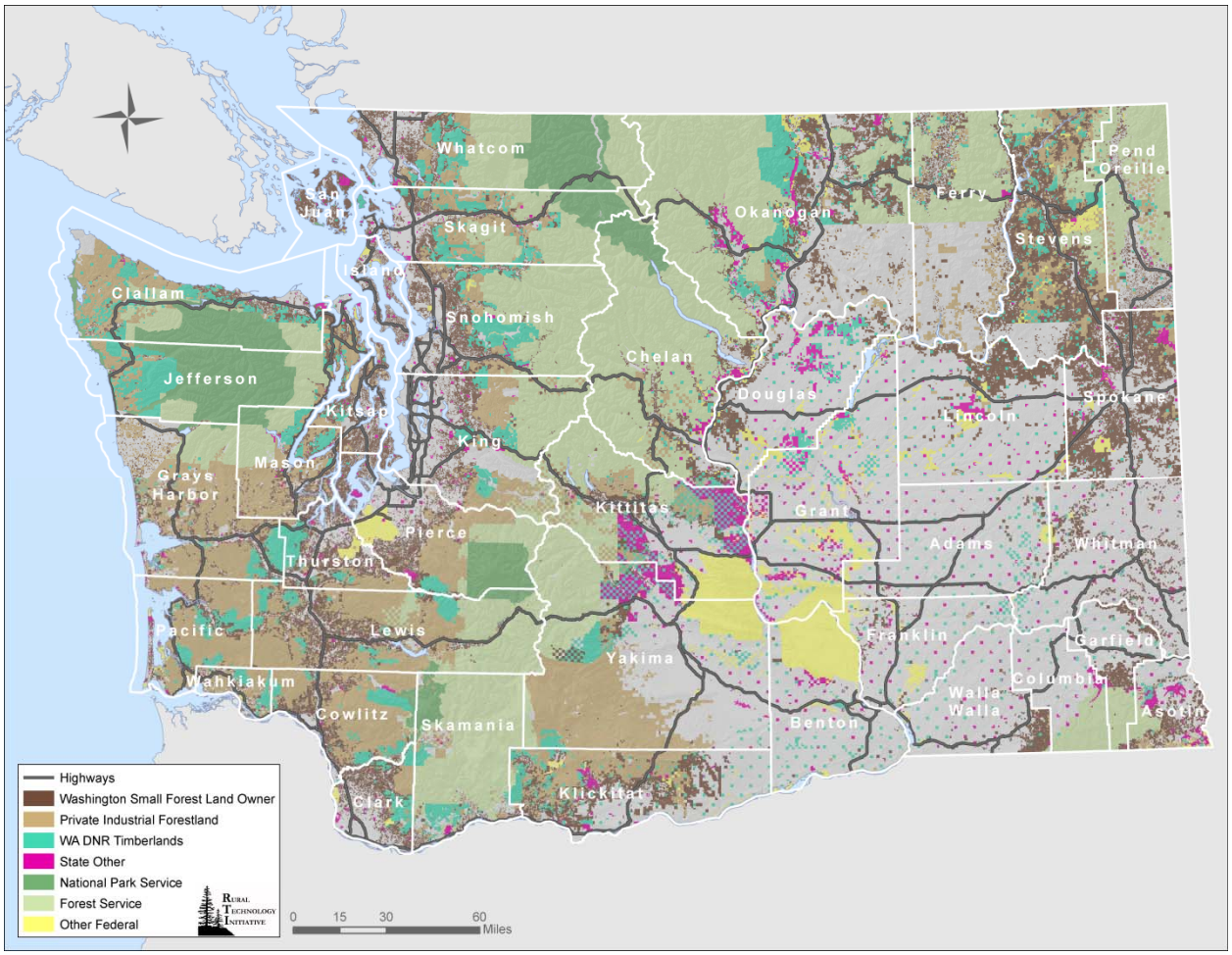

Figure 12: Private Forests and Public Lands in Washington State.

The Washington State Forestland Database demonstrates the spatial relationship between private industrial owners, small forest land owners, and public lands throughout the state.

Washington Small Forest Land Owners and Forest Cover

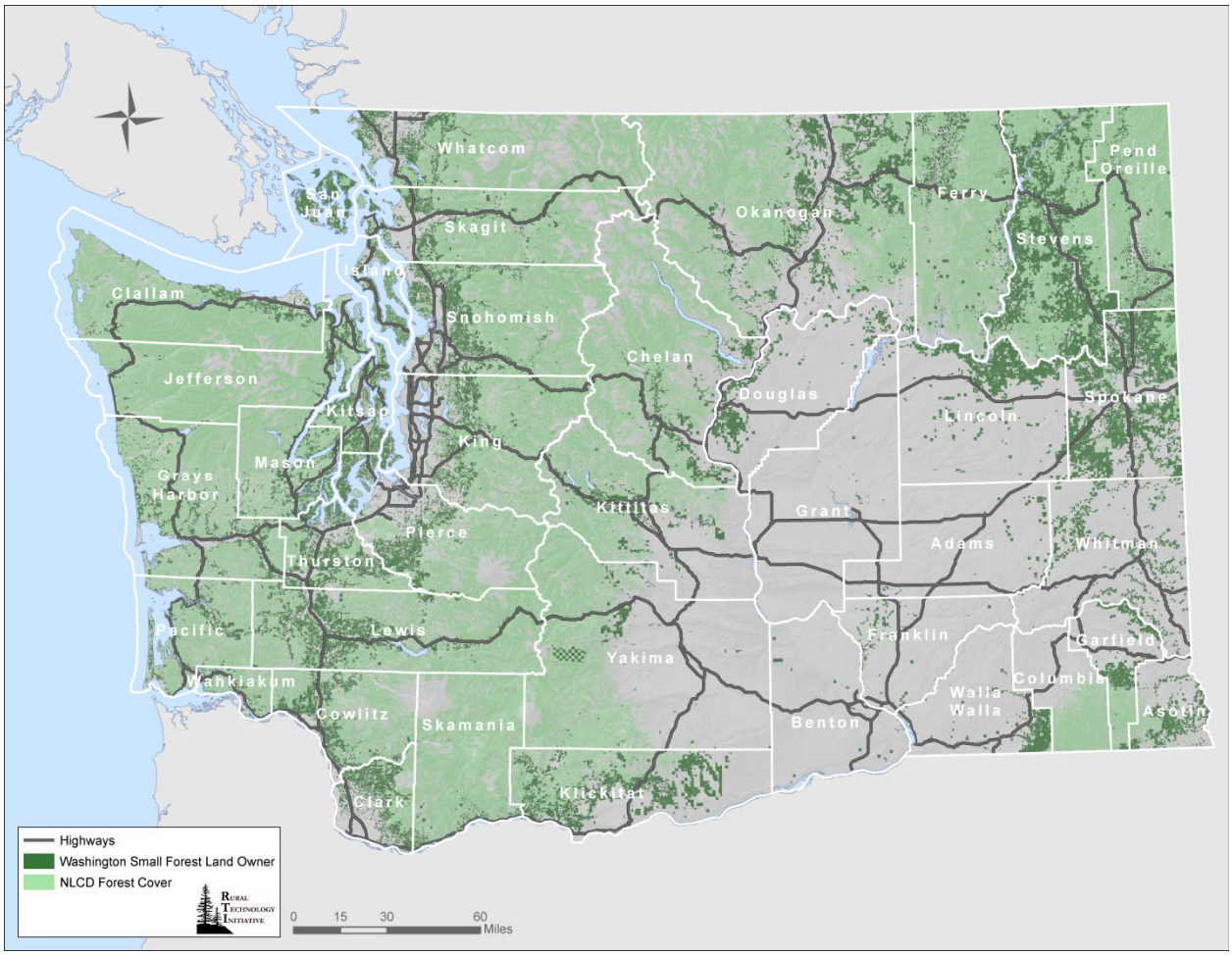

Figure 13: Washington Small Forest Land Owners and Forest Cover.

The Washington State Forestland Database demonstrates the spatial relationship between private small forest land owners and natural features, such as forest cover, throughout the state.

The Percent of County Area Owned by Small Forest Land Owners

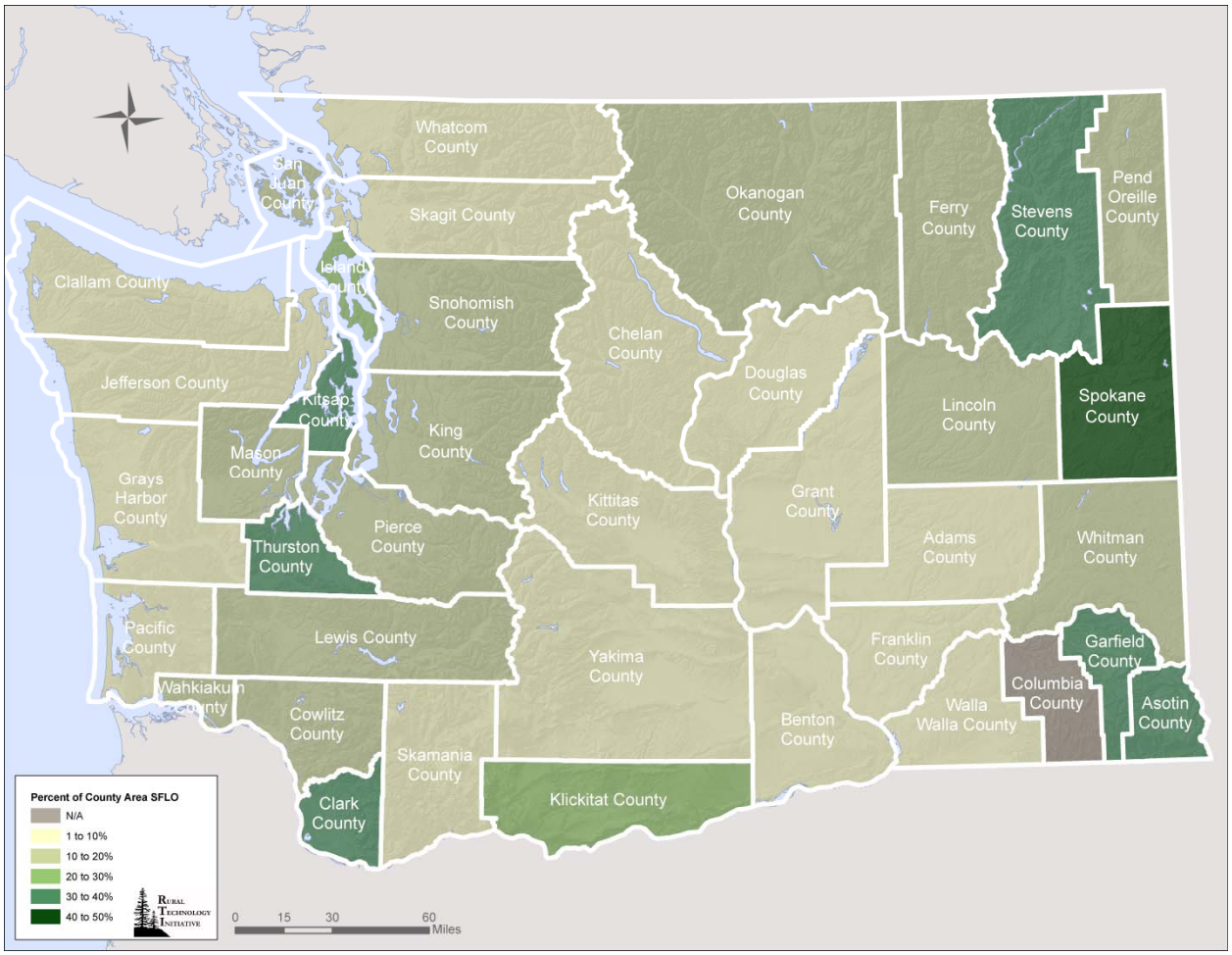

Figure 14: The Percent of County Area Owned by Small Forest Land Owners.

The Washington State Forestland Database can be used to calculate statistics for different areas of the State. The total area owned by Small Forest Land Owners in each County can be divided by the total area of each County.

The Number of Small Forest Land Owner Parcels per County

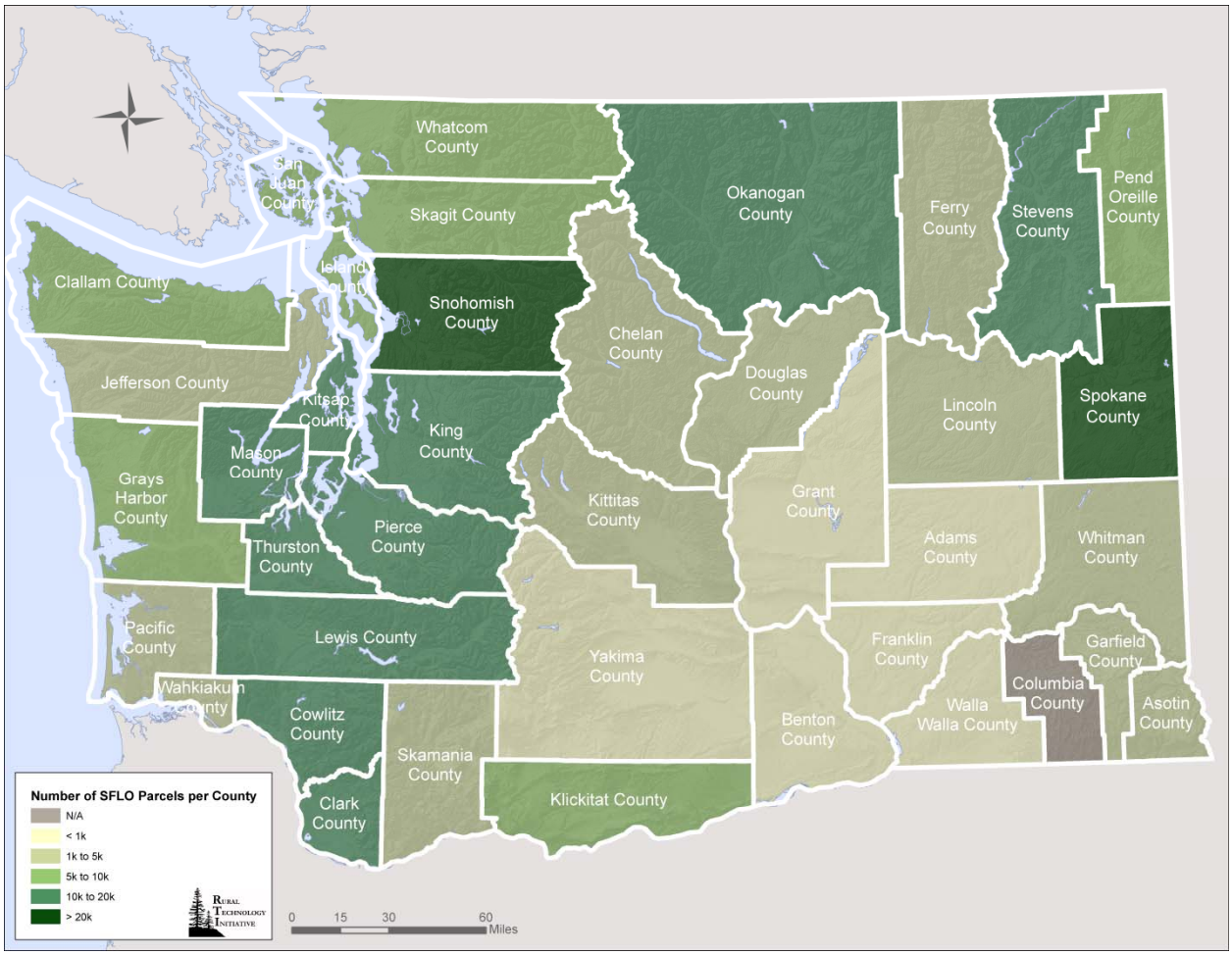

Figure 15: The Number of Small Forest Land Owner Parcels per County.

The Washington State Forestland Database can be used to calculate statistics for different areas of the State. The number of Small Forest Land Owner Parcels in each County can be counted.

Small Forest Land Owner Density, Counties

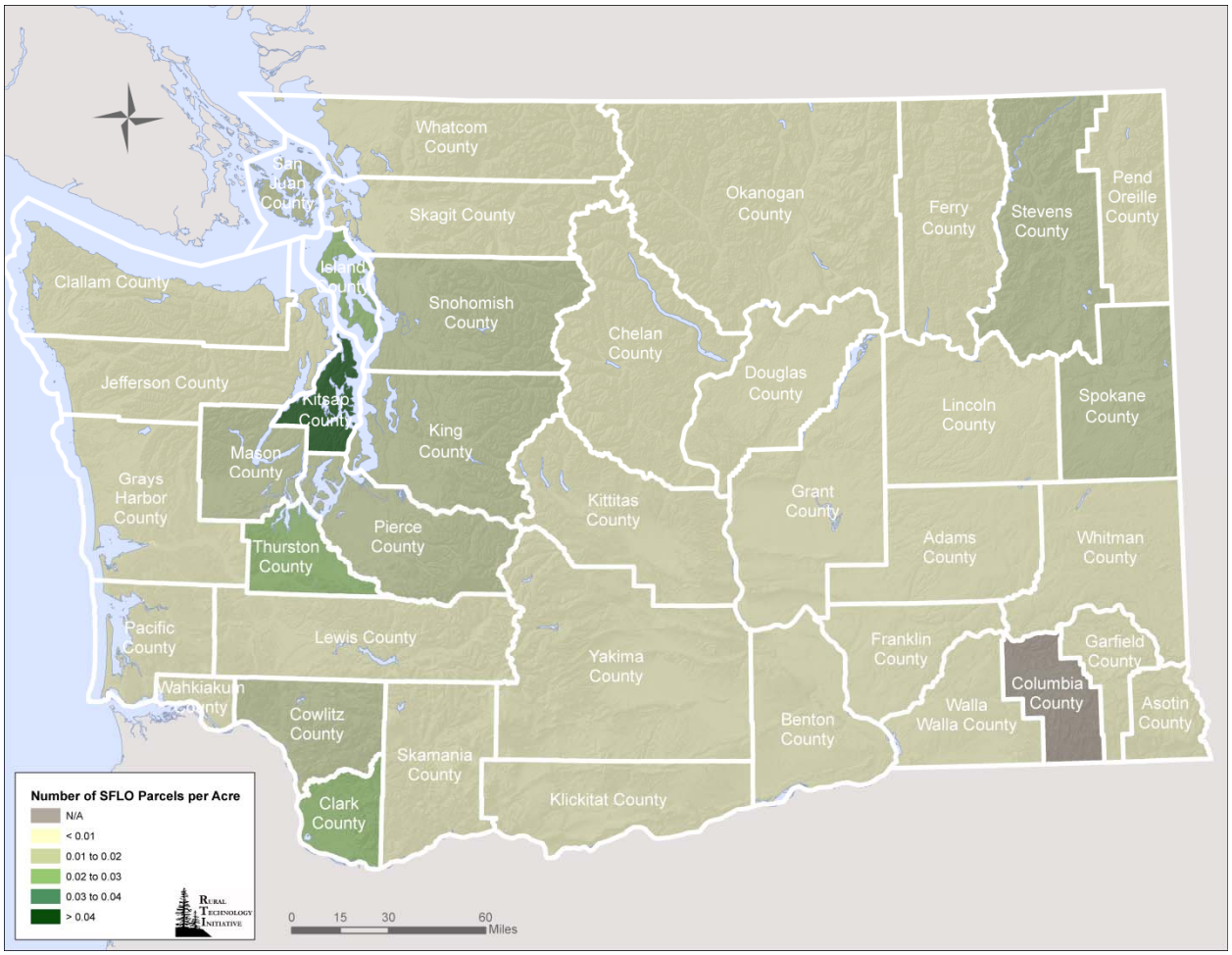

Figure 16: Small Forest Land Owner Density, Counties.

The Washington State Forestland Database can be used to calculate statistics for different areas of the State. The number of Small Forest Land Owner Parcels in each County can be divided by the total area of each County.

The Percent of WAU Area Owned by Small Forest Land Owners

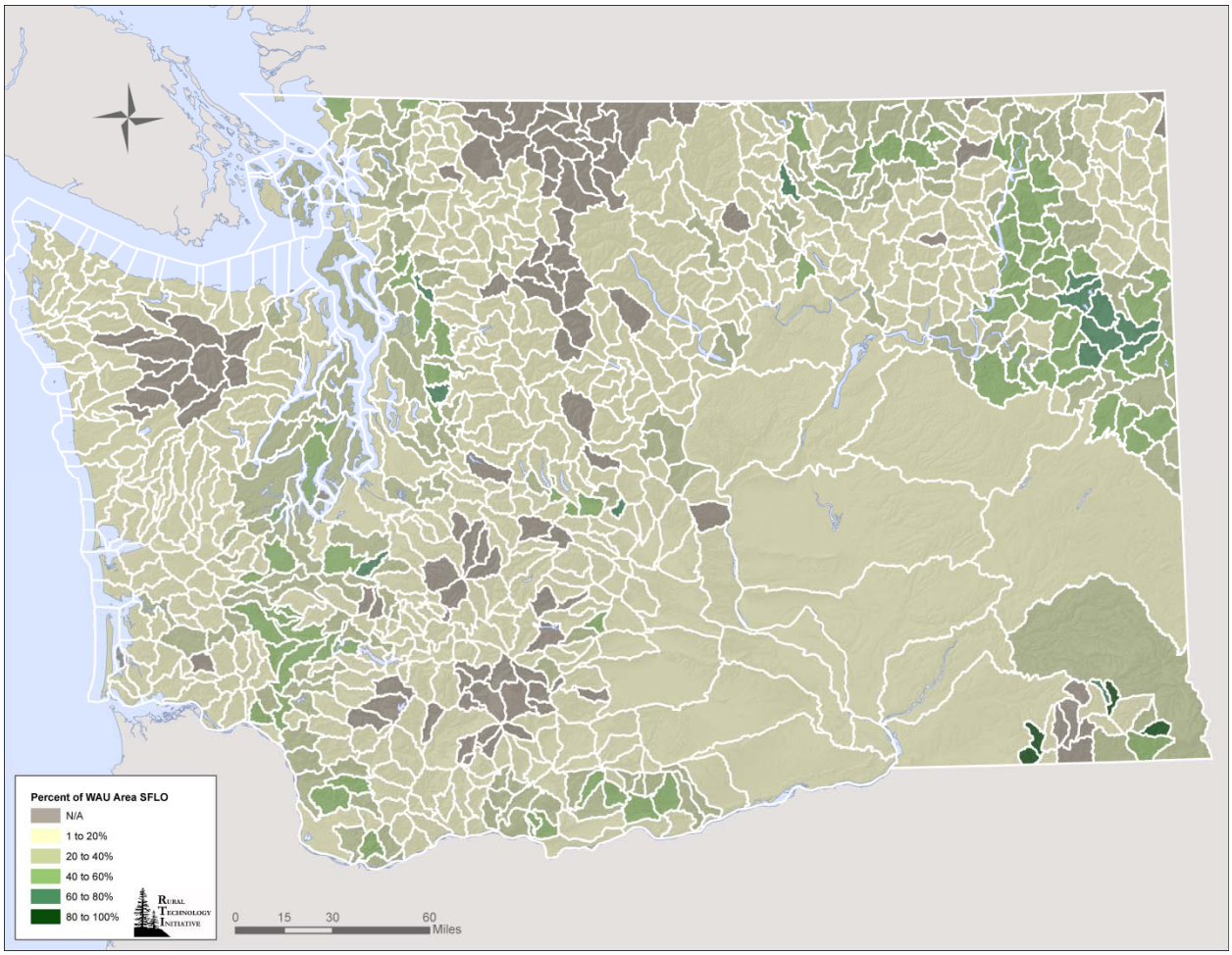

Figure 17: The Percent of WAU Area Owned by Small Forest Land Owners.

The Washington State Forestland Database can be used to calculate statistics for different areas of the State. The total area owned by Small Forest Land Owners in each Watershed Administrative Unit (WAU) can be divided by the total area of each WAU.

The Number of Small Forest Land Owner Parcels per WAU

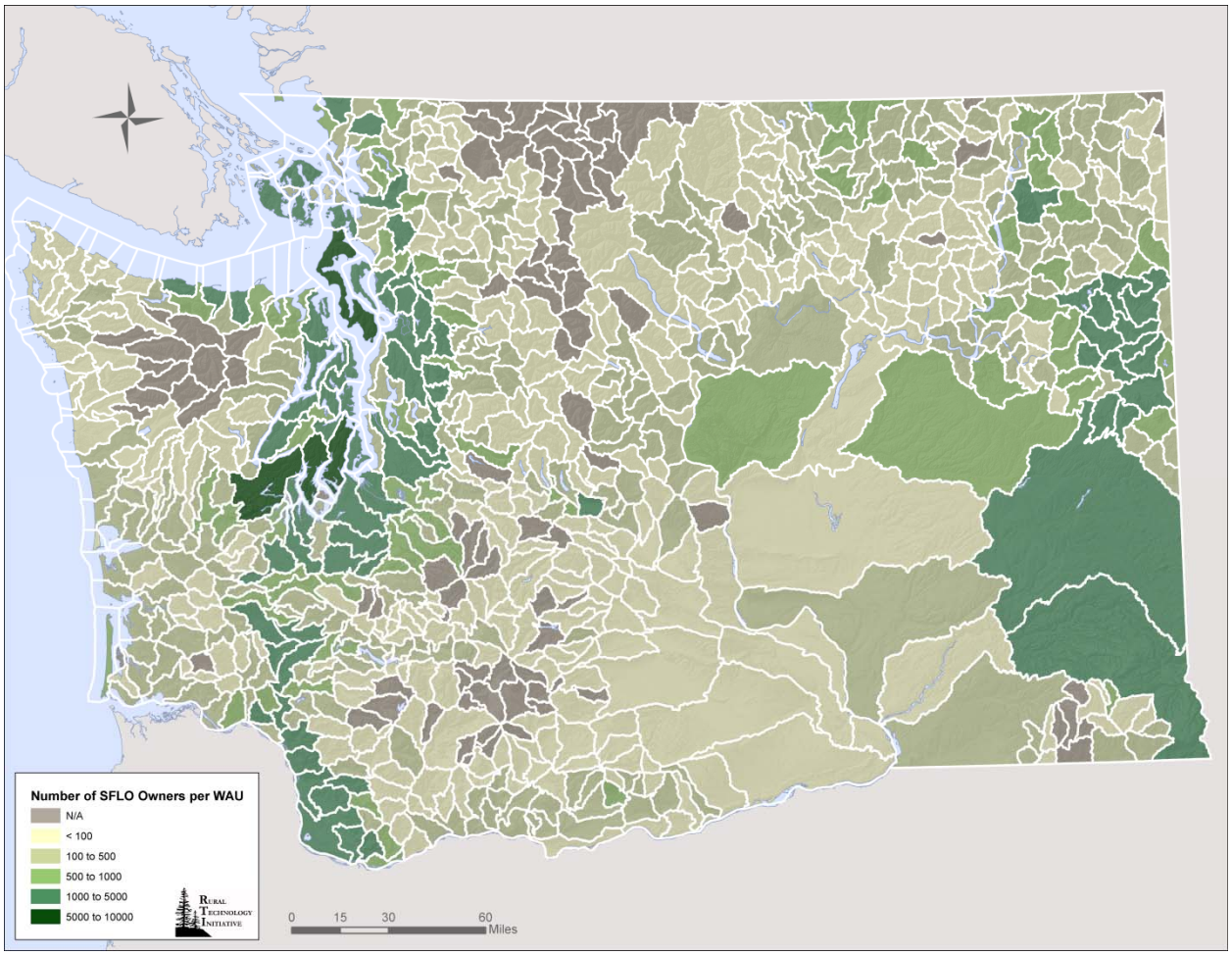

Figure 18: The Number of Small Forest Land Owner Parcels per WAU.

The Washington State Forestland Database can be used to calculate statistics for different areas of the State. The number of Small Forest Land Owner Parcels in each Watershed Administrative Unit (WAU) can be counted.

Small Forest Land Owner Density, WAUs

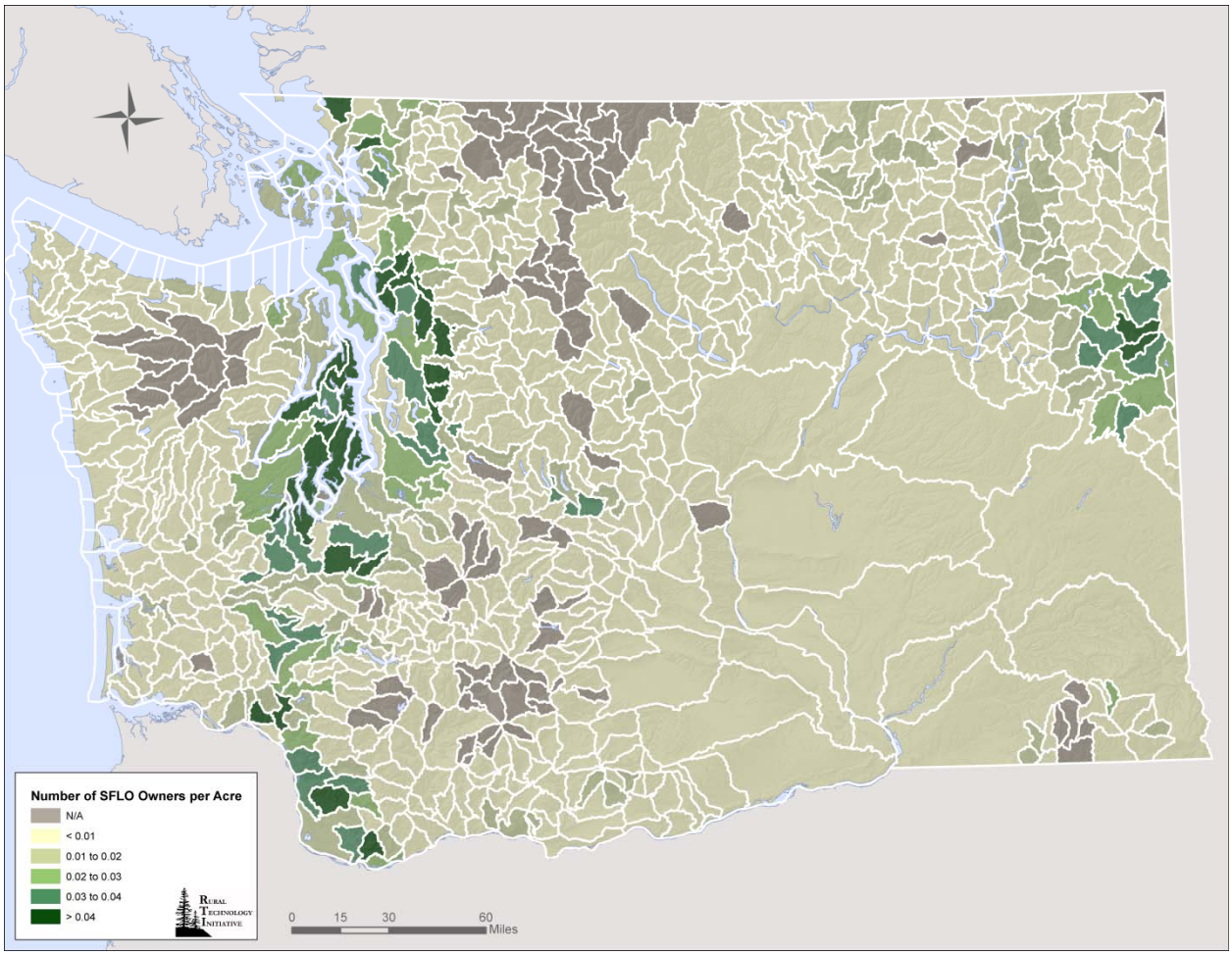

Figure 19: Small Forest Land Owner Density, WAUs.

The Washington State Forestland Database can be used to calculate statistics for different areas of the State. The number of Small Forest Land Owner Parcels in each Watershed Administrative Unit (WAU) can be divided by the total area of each WAU.

Appendix F: Land Use Codes in the Forestland Database

Use Code	Land Use Description
0	Undefined
11	Household, single family units
12	Household, 2-4 units
13	Household, multiunits (5 or more)
14	Residential condominiums
15	Mobile home parks or courts
16	Hotels/motels
17	Institutional lodging
18	All other residential not elsewhere coded
19	Vacation and cabin
21	Food and kindred products
22	Textile mill products
23	Apparel and other finished products made from fabrics, leather, and similar materials
24	Lumber and wood products (except furniture)
25	Furniture and fixtures
26	Paper and allied products
27	Printing and publishing
28	Chemicals
29	Petroleum refining and related industries
30	Rubber and miscellaneous plastic products
31	Leather and leather products
32	Stone, clay and glass products
33	Primary metal industries
34	Fabricated metal products
35	Professional scientific, and controlling instruments; photographic and optical goods…
36	Not presently assigned
37	Not presently assigned
38	Not presently assigned
39	Miscellaneous manufacturing
41	Railroad/transit transportation
42	Motor vehicle transportation
43	Aircraft transportation
44	Marine craft transportation
45	Highway and street right of way
46	Automobile parking
47	Communication
48	Utilities
49	Other transportation, communication, and utilities not classified elsewhere
50	Condominiums - other than residential condominiums
51	Wholesale trade

Use Code	Land Use Description
52	Retail trade - building materials, hardware, and farm equipment
53	Retail trade - general merchandise
54	Retail trade - food
55	Retail trade - automotive, marine craft, aircraft, and accessories
56	Retail trade - apparel and accessories
57	Retail trade - furniture, home furnishings and equipment
58	Retail trade - eating and drinking
59	Other retail trade
61	Finance, insurance, and real estate services
62	Personal services
63	Business services
64	Repair services
65	Professional services
66	Contract construction services
67	Governmental services
68	Educational services
69	Miscellaneous services
71	Cultural activities and nature exhibitions
72	Public assembly
73	Amusements
74	Recreational activities
75	Resorts and group camps
76	Parks
77	Not presently assigned
78	Not presently assigned
79	Other cultural, entertainment and recreational
81	Agriculture (not classified under current use law)
82	Agriculture related activities
83	Agriculture classified under current use chapter 84.34 RCW
84	Fishing activities and related services
85	Mining activities and related services
86	Not presently assigned
87	Not presently assigned (formerly Classified forest land chapter 84.33 RCW)
88	Designated forest land under chapter 84.33 RCW
89	Other resource production
91	Undeveloped land
92	Noncommercial forest
93	Water areas
94	Open space land classified under chapter 84.34 RCW
95	Timberland classified under chapter 84.34 RCW
96	Not presently assigned
97	Not presently assigned

Use Code	Land Use Description
98	Not presently assigned
99	Other undeveloped land