Small Forest Landowners Database Validation & Data Analysis Study

Report for King County, WA

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Submitted by:

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I. Introduction and Background:

The Department of Natural Resources (DNR) Small Forest Landowner Office (SFLO) assembled a database of small forest landowners in a pilot project number FY01-154. A three month pilot project collected available parcel data from all Washington State counties with forestlands and assembled the information into a database. The purpose of the comprehensive spatially explicit database is to allow the SFLO to fulfill its' legislative mandate to:

- Report on non-industrial private forestland demographics,
- Analyze the cumulative effects of Alternate Plans,
- Describe the small forest landowner constituency, and
- Allow some spatial analysis of the forestland holdings by watershed, sub-watershed, or other community.

II. Objectives:

There is no consistency with how counties collect and store parcel data. The majority of counties have non-spatial databases (no GIS).So it is necessary to analyze and evaluate the database that was developed for its' ability to generate appropriate and accurate reports. This project is focusing on specific areas in Eastern Washington, namely portions of Stevens and Spokane Counties (analysis done by Williamson Consulting, Colville, WA) and Western Washington, namely Clark, and King Counties (analysis done by the Rural Technology Initiative, UW, Seattle, WA).

- Determine the percentage of non-industrial landowners that were identified using county tabular parcel data and county GIS data,
- Analyze the differences between generating reports using tabular data verses GIS data,
- Determine other resources available to identify forestland owners other than information from the county tax assessor. Technologies such as Landsat, orthophotos, and land use land cover datasets will be explored. It is anticipated that some combination of all of these technologies may be used in the final analysis.
- Determine if tabular data can be used to effectively generate accurate reports.
- Explore issues such as contiguousness, significant riparian ownership by watershed, and acreages.

All work will be coordinated with a similar effort being conducted in Eastern Washington by Williamson Consulting. RTI will coordinate the two concurrent efforts and select the methodology that will produce effective results. Clark, and King Counties were selected as the two Westside counties for database validation based on their diverse geographic location and high quality GIS data. In addition to available GIS data, the two counties also contain 5 of the largest 10 cities in Washington[1]. Detailed analysis around these urban centers should provide a good baseline for monitoring conversion trends in the coming years.

III. Methods:

Data for King County was obtained via FTP from the King County GIS Center. The County Assessors office provided 3 different ArcINFO Coverages (Designated Forest, Classified Forest, and Open Space Timber), and 1 property description table with detailed information about each timbered parcel. Additional layers such as the urban growth line, city boundaries and the complete King County Parcel layer were obtained from the Washington State Geospatial Data Archive (WAGDA). In order to be spatially consistent with the raster LANDSAT data (raster data should not be re-projected if at all possible for spatial accuracy), all of the King County data layers were projected into the coordinate system of the LANDSAT datasets.

Projection: Stateplane
Fipszone: 4602
Datum: NAD 83
Units: Meters
Spheroid: GRS1980

To identify individual landowners in the King County Assessor's data the Assessor's PIN was used. Some owners exist in the data more than once as an individual taxpayer may have more than one PIN number (like business and personal). There is no easy way within the GIS data to determine exactly how many individual owners the data represent as addresses and names can be spelled slightly differently even for the same owner.

The first step in determining forested parcels in King County was to digitize the forestland from the Department of Natural Resources 1996 orthophotos of the county. Forestland for the entire county was digitized into an ArcINFO Coverage to take advantage of topology insuring that no polygon in the spatial forest layer overlapped another. In general the forested areas were easy to identify and digitize a boundary. Narrow timbered strips around streams, lakes or wetlands, highly populated areas and timbered areas less than approximately 5 acres in size were not included, see Appendix A – Maps Figure 7.

[1] 2001 Population Trends for Washington State; Washington State Office of Financial Management, September 2001. Available on the web at http://www.ofm.wa.gov/2002pop/2002pop.htm

In addition to the orthophoto validation scheme, LANDSAT data was used to classify the forestland. The LANDSAT data was obtained from the Washington State Geographic Information Council (WAGIC). The LANDSAT data came in two different formats, single band tiff images for the Eastern 2/3 of the state and multi-band Imaging img format images for the Western 1/3 of the state. All of the LANDSAT data was acquired in Stateplane, Washington State South Zone, NAD83, meters.

To classify the images two methods were explored. The first method was to use a routine built by Jeffrey Lee Moffett for his thesis work at the University of Washington[2]. This method of image classification uses custom C language code and ASCII image files to run Bayesian, Markov Chain Monte Carlo simulations on the images. While this method of image classification is excellent at classifying different types of forest ages, structures and species, it has a difficult time in the urban areas. This method of classification will continue to be explored for future NIPF projects as it is far superior in forest identification than the maximum likelihood method that was used for this project.

The second method of image classification was to use ESRI's ArcGrid image classification routines to make 5 classifications; Developed, Clear-cut, Young Forest, Mature Forest, and Water. This method of image classification was chosen for a few reasons, repeatability, fast run times, ease of use and availability. For exact usage of the commands see Appendix B – Tables & Charts Figure 18. The commands are:

- MAKESTACK – makes a stack of images for multi-band classification
- CLASSSAMPLE – creates training datasets for the supervised classification
- SAMPLESIG – creates an ASCII signature file for use in classification
- MLCLASSIFY – classifies the stack of images using maximum likelihood
- FOCALMAJORITY – removes single pixel anomalies in the classification
- BOUNDARYCLEAN – blocks up the classified pixels
- CON – conditional statement to extract forest from the 5 classes
- GRIDPOLY – converts the forest/non-forest grid to a polygon layer
- ELIMINATE – eliminates polygons less than 5 acres in size

This sequence of commands created a polygon layer similar to the ortho digitized forestland except that the data source was the LANDSAT images, see Appendix A – Maps Figure 8.

The second step in the analysis was to eliminate non-candidate parcels from the analysis. King County has an extremely large number of parcels (over ½ million) primarily due to the urban centers of Seattle and Bellevue. To make an analysis feasible (processing over 100,000 parcels may take over 24 hours for a single operation), parcels located within the designated King County urban growth lines were removed from the dataset. Eliminating these "urban" parcels and other parcels less than 1 acre in size from the analysis reduced

[2] Simulation of bidirectional reflectance, modulation transfer, and spatial interaction for the probabilistic classification of Northwest forest structures using Landsat data; Jeffrey Lee Moffett; Thesis (Ph. D.) – University of Washington, 1988.

the number of parcels from 548,329 to 75,106. To later identify the urban areas a flag item was added to the King County parcel data called “URBAN”. For this analysis, we will only focus on parcels outside of the urban growth areas and greater than 1 acre in size. See Appendix A – Maps Figure 9.

To identify industrial landowners who were not of interest, the DNR Small Forest Landowner Office purchased the Atterbury Western Washington Industrial Forestland Owner spatial dataset, see Appendix A – Maps Figure 10. This dataset came as an ArcInfo coverage which covered all of Western Washington. The spatial location of the industrial parcels in the Atterbury layer did not match up with the King County parcel GIS data and therefore had to be remanufactured by hand by visually identifying known industrial forestland owners by Owner Name in the King County GIS data. The Atterbury dataset was used to identify which owner names should be considered industrial in the King County parcel data and a flag item called “INDUSTRIAL” was added to the King County data. In addition to the Atterbury identified industrial owners, careful inspection of owner names added more owners to the industrial class. See Appendix A – Maps Figure 11.

Once the urban and industrial parcels were removed from the data, forested parcels could be identified. To identify forested parcels using the digitized and classified forestlands an overlay process was used. The quickest way to determine the total amount of potential forested land in the remaining parcels would have been to union the parcels with the forestlands, Figure 1.

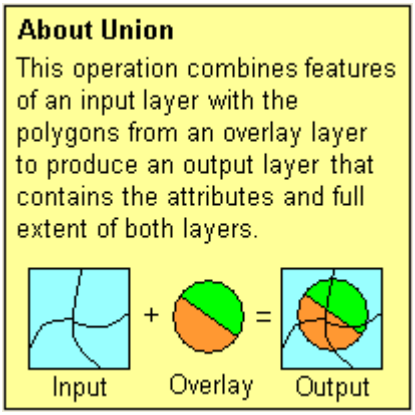

Figure 1 - In this example, the Input layer would be the parcel data and the Overlay layer would be the digitized forestland.

The problem with the union command or any of the overlay commands is that they don’t properly represent the parcel data model. From an assessment and regulatory perspective, a parcel is either forested or it is not. In order to follow that paradigm with our analysis, overlay processes which dissect or split parcels were not used. Instead a model that allowed entire parcels to be either forested or non-forested was chosen. Two different methods of determining a parcels forested status were compared.

The first method was to require that a parcel be completely within a forested area in order to be considered forested, Figure 2. This method is the most conservative since it does not consider a 100 acre parcel as forested even if only 1 acre is not forested. Flag items called ORTHO_WITHIN and LANDSAT_WITHIN were created in the King County parcel data to store the selection for analysis.

Figure 2 - The red features represent the forested areas. The highlighted cyan features represent parcels and are selected because they are completely within the forested area.

The second method was to require that a parcel only had to intersect or touch a forested area in order for the parcel to be considered forested, Figure 3. This method is the most liberal since it considers a parcel as forested even if only 1 acre of a 100 acre parcel is forested. Flag items called ORTHO_INTERSECT and LANDSAT_INTERSECT were created in the King County parcel data to store the selection for analysis.

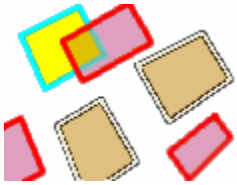

Figure 3 - The red features represent the forested areas. The highlighted cyan features represent parcels and are selected because they intersect the red features.

IV. Analysis and Discussion:

A. Where is the forestland?

In order to be consistent with the Eastside validation effort done by Williamson Consulting, all acres in this analysis will refer to GIS acres unless explicitly stated otherwise. It is important to understand that even within the King County GIS, assessor's acreage values differ somewhat from the GIS acreage values, 281,773 and 275,423 respectively[3]. The total forested area digitized from the orthophotos is 945,311 acres. The total forested area digitized from the Landsat data is 1,066,587acres. This digitized and image classified forest area represents all of King County and has a resolution of approximately 5 acres.

[3] This number represents all acres identified by King County GIS as open space forestland, designated forestland, classified forestland or timberland including industrial and non-industrial owners.

Since two methods were used to determine where forestland exists in King County, it is appropriate to use the forest area common to both of these methods as our determination of King County forestland. In order to find the area common to both the digitized orthophoto forest and the classified Landsat forest the two layers were unioned, a flag item was added indicating that a polygon existed in both forest layers and then dissolved on the flag item. This common forested area came out at 937,685 acres. As would be expected, this number is lower than either the digitized or Landsat forestland since each method of identification has some level of bias based on operator digitizing. See Appendix A – Maps Figure 12.

After identifying candidate forestland for potential non-industrial forestland the selection methods described in the methods section were performed on the common forestland. Two items were added to the parcel layer to store the selection information, COMMON_WITHIN and COMMON_INTERSECT. By selecting all parcels that intersect the common forestland (even a small sliver of parcel will mean the entire parcel is selected), 84,595 potential NIPF acres exist, Appendix A – Maps Figure 13. By selecting only parcels that fall completely within the common forestland only 22,288 acres are potential NIPF lands, Appendix A – Maps Figure 14.

When analyzing parcels that fall completely within the common forestland 49% (382 of 929 parcels) of the non-urban Small Forest Landowner Database NIPF acres are selected. When analyzing the parcels that intersect the common forestland 91% (790 of 929 parcels) of the non-urban Small Forest Landowner Database NIPF acres are selected. When you add in the 11 urban parcels (129 acres), 41% of the NIPF acreage and 43% of the NIPF parcels in King County are in between the rural areas and industrial forestlands or in an urban area.

Farther from the urban/rural interface are the industrial and public lands. Major industrial and public landowners in King County are the US Forest Service, Weyerhaeuser, the City of Seattle, the Department of Natural Resources, Plum Creek and King County, see Table 1.

Table 1 - Major industrial and public landowners in King County, WA.

OWNER	ACRES
UNITED STATES	329,730
WEYERHAEUSER COMPANY	151,680
CITY OF SEATTLE	116,990
WASHINGTON STATE	96,567
PLUM CREEK TIMBER COMPANY	65,257
KING COUNTY	26,535
GIUSTINA RESOURCES	15,135
CITY OF TACOMA	14,070
WATSON PATRICIA 10PAF	13,926
LONGVIEW FIBRE	9,830
FRUIT GROWERS SUPPLY CO	6,466
BURLINGTON NORTHRN SANTA FE	4,405
PALMER COKING COAL COMPANY	4,375
PUGET SOUND ENERGY	2,751
CITY OF KENT	2,016
PORT OF SEATTLE	1,957
CITY OF BELLEVUE	1,745
CITY OF RENTON	1,326

Industrial forestland owners in King County appear to be farther away from the rural/forestland interface than the non-industrial owners. Non-industrial owners in the tabular database within the common forestland total 8,423 acres. If NIPF owners are selected by intersecting common forestland then 84% more landowners are selected, compared to industrial owners where only 17% more landowners are selected. Nearly half of the NIPF owners are in the rural/forestland interface as compared with industrial owners where only 14% are in the rural/forestland interface.

B. Potential NIPF lands:

Potential NIPF land can be identified by looking at those parcels that fall within and intersect the common forestland. The common forestland is the area identified by both the digitized orthophoto forestland and the classified Landsat forestland. Within the common forestland there are 22,288 acres of land that could potentially be considered NIPF land. Of that 22,288 acres, the major land use codes as identified in the King County parcel GIS are: Vacant(Single-family), Single Family(res Use/Zone), Mobile Home and Vacant(Industrial), see Table 2.

Table 2 - Major acres by land use code for parcels within the common forestland and not industrial, not urban and not in the SFLO database.

LANDUSE DESCRIPTION	ACRES
Vacant(Single-family)	9,636
Single Family(Res Use/Zone)	3,221
Mobile Home	193
Vacant(Industrial)	115
Mining/Quarry/Ore Processing	55
Mobile Home Park	44
Right of Way/Utility	35
Service Building	27
Vacant(Commercial)	17

Of the major land use codes, 2 have the potential to be NIPF land: Vacant (Single-family) and Single Family (Res Use/Zone). With an average ownership size of 8.6 and 6.0 acres, it is unlikely that these parcels are non-industrial private forestland, Table 3. A quick look at the owner names of these parcels reveals that many of them are housing developments: Grand Ridge L P, Lake Moss LLC, Conifer Ridge L P, and Quadrant Corp.

Table 3 - Potential NIPF forestland acres: number of parcels and the number of owners those parcels represent for the "within common forestland" selection.

LANDUSE DESCRIPTION	# PARCELS	AVG ACRES	ACRES	# OWNERS
Vacant(Single-family)	1120	8.60	9,636	849
Single Family(Res Use/Zone)	534	6.03	3,221	512

Intersecting the common forestland there are 84,595 acres of land that could potentially be considered NIPF land. Of that 84,595 acres, the major land use codes as identified by the King County parcel GIS are: Vacant (Single-family), Single Family (Res Use/Zone), and Mobile Home, see Table 4

Table 4 - Major acres by land use code for parcels that intersect the classified Landsat forestland and not industrial, not urban and not in the SFLO database.

LANDUSE DESCRIPTION	ACRES
Vacant(Single-family)	33,645
Single Family(Res Use/Zone)	28,640
Mobile Home	1,510
Park	608
Golf Course	530
Mobile Home Park	512
Mining/Quarry/Ore Processing	423
Resort/Lodge/Retreat	307
Vacant(Industrial)	214
Vacant(Commercial)	210
School(Public)	118
Utility	100
Sport Facility	100

Following the same trend as the parcels within the common forestland, parcels that intersect the forestland have similar land use codes. One major difference between the two selection methods is that the number of non-vacant single family home acres rises dramatically, almost 9 fold. It is reasonable to expect that on the edges of the forest, rather than in the middle of the forest, more and more residential properties will exist and that appears to be the case here. Again, as with the within selection, the parcels with the most potential to be NIPF lands are those with the land use codes of single family vacant or just single family.

Table 5 - Potential NIPF forestland acres: number of parcels and the number of owners those parcels represent for the "intersects common forestland" selection.

LANDUSE DESCRIPTION	# PARCELS	AVG ACRES	ACRES	# OWNERS
Vacant(Single-family)	3,732	9.02	33,645	2,884
Single Family(Res Use/Zone)	4,571	6.27	28,640	4,449

Given the land use codes of parcels that are adjacent to industrial forestlands it appears unlikely that the 2001 SFLO Database project missed many landowners. Examining a table (Table 6) of the zoning laws where the vacant parcels are located reveals that most of the potential NIPF parcels fall into 3 categories: Agricultural, Forest, or Rural area residential. Given the relatively large average acreage per parcel in these zones it seems that these acres may represent the best possibility of being NIPF.

Table 6 - Vacant(Single-family) landuse parcels in forested areas and the average parcel size by King County zoning regulation.

ZONING DESCRIPTION	ACRES	AVG ACRES
Agriculture, one dwelling units per 10 acres	1169.87	9.07
Agriculture, one dwelling units per 35 acres	1821.93	14.35
Forest	2715.29	10.86
Industrial	10.66	5.33
Mining	727.96	26.96
Neighborhood Business	0.21	0.04
Residential, dwelling units per acre	0.00	0.00
Residential, eight dwelling units per acre	0.16	0.01
Residential, four dwelling units per acre	50.05	2.18
Residential, one dwelling units per acre	170.32	3.62
Residential, six dwelling units per acre	15.14	3.78
Rural area, one dwelling units per 10 acres	8470.49	8.02
Rural area, one dwelling units per 2.5 acres	1724.40	2.92
Rural area, one dwelling units per 5 acres	15146.67	6.50
Urban reserve, one dwelling units per 5 acres	122.73	4.09
Un-zoned	1498.90	0.47

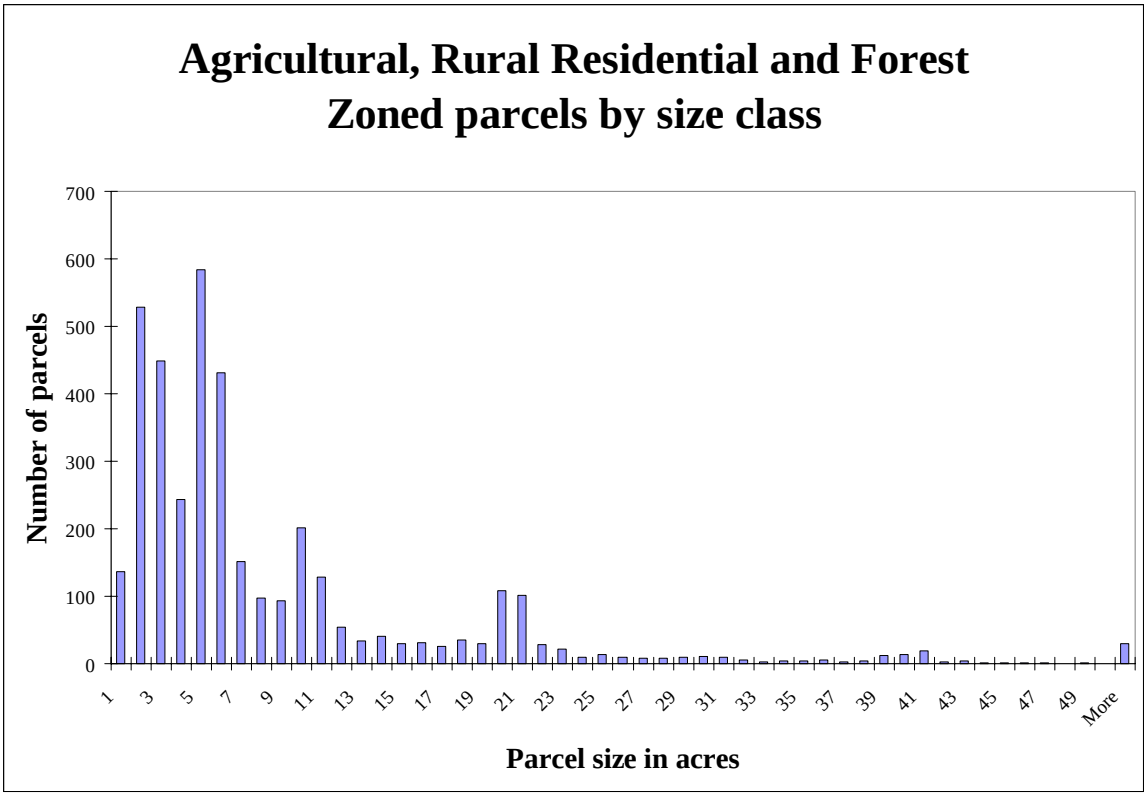

Figure 4 - Histogram of Vacant(Single-family) property acreages in agricultural, rural residential and forest King County zones.

It is impossible to know exactly which of these landowners may be a non-industrial private forestland owner. Visually inspecting a histogram (Figure 4) of the parcel sizes in the rural, forest and agricultural zones shows many small parcels (<10 acres) and a few large (>50 acre) parcels. Establishing a lower bound for acreage may increase our confidence that these owners are more likely to be NIPF than some other owners with less acreage, Table 7.

Table 7 - Potential NIPF acres in King County intersecting rural, agricultural or forest zones. If the minimum size of an NIPF parcel were 40 acres then there would be potentially 5,022 additional NIPF acres in King County.

Minimum Size	Potential NIPF Acres
0	32,754
1	32,752
5	27,403
10	20,775
20	13,246
40	5,022
100	1,394

Finally, improvements on the land may be used as a proxy for any structures that may exist on the property. Using all the previous filters for potential NIPF: intersects the common forest, non-industrial, non-urban, not in the SFLO database, and zoned vacant(single-family) another view of the potential NIPF emerges.

Table 8 - Acres of potential NIPF by assessed improvements intersecting the common forestland, non-industrial, non-urban, not in the SFLO database and zoned vacant(single-family).

Value	Acres
No assessed improvements	31,069
Assessed improvements more than $0.00	1,721

V. GIS / Tabular Reports

One responsibility of the DNR Small Forest Landowner Office is to generate reports every 4 years outlining the current status of non-industrial forests in Washington State as outlined in the Salmon Recovery Act (House Bill 2091). The full text of the portion of the bill pertaining to reporting is included here for reference:

(5) By December 1, 2000, the small forest landowner office shall provide a report to the board and the legislature containing:

(a) Estimates of the amounts of non-industrial forests and woodlands in holdings of twenty acres or less, twenty-one to one hundred acres, one hundred to one thousand acres, and one thousand to five thousand acres, in western Washington and eastern Washington, and the number of persons having total non-industrial forest and woodland holdings in those size ranges;

(b) Estimates of the number of parcels of non-industrial forests and woodlands held in contiguous ownerships of twenty acres or less, and the percentages of those parcels containing improvements used:

(i) As primary residences for half or more of most years;

(ii) as vacation homes or other temporary residences for less than half of most years; and

(iii) for other uses;

(c) The watershed administrative units in which significant portions of the riparian areas or total land area are non-industrial forests and woodlands;

(d) Estimates of the number of forest practices applications and notifications filed per year for forest road construction, silvicultural activities to enhance timber growth, timber harvest not associated with conversion to non-forest land uses, with estimates of the number of acres of non-industrial forests and woodlands on which forest practices are conducted under those applications and notifications; and

(e) Recommendations on ways the board and the legislature could provide more effective incentives to encourage continued management of non-industrial forests and woodlands for forestry uses in ways that better protect salmon, other fish and wildlife, water quality, and other environmental values.

(6) By December 1, 2002, and every four years thereafter, the small forest landowner office shall provide to the board and the legislature an update of the report described in subsection (5) of this section, containing more recent information and describing:

(a) Trends in the items estimated under subsection (5)(a) through (d) of this section;

(b) Whether, how, and to what extent the forest practices act and rules contributed to those trends; and

(c) Whether, how, and to what extent:

(i) The board and legislature implemented recommendations made in the previous report; and

(ii) Implementation of or failure to implement those recommendations affected those trends.

Items (5)(d) and (e) and item (6) are beyond the scope of this report and must be answered by the DNR SFLO Office. Items (5)(a) through (c) can be answered to some degree by both the 2001 Small Forest Landowner Database and King County GIS data. For this report, all tabular data uses the assessor's acreage from the SFLO Database, all GIS data uses the GIS acreage. The NIPF parcels used for the analysis in the GIS are the same parcels that are in the SFLO Database. Potential NIPF acres as identified previously in this report are not included for consistency with the 2001 SFLO Database.

Generating the legislatively mandated Small Forest Landowner Office report using tabular data and GIS data create two different reports. One reason for the difference could be that the item stored in the database to relate the tabular data to the GIS data is not necessarily unique for every parcel. Additionally, assessor acres are used in the tabular statistics while GIS acres are used in the GIS statistics. A summary of the (5)(a) statistics can be found in Table 9. The total acres compare well at 23,418 for the tabular and 23,367 for the GIS. Major differences occur at the 20 acre size as assessors likely classify parcels that are ~20 acres as 20 acres exactly, while the GIS does not round the acres. This causes less acres in the <20 acre tabular class as assessors round up the 19+ acre parcels to 20 acres.

Table 9 – Differences between generating Salmon Recovery Act (5)(a) statistics using tabular and GIS methods.

ITEM	TABULAR	GIS
(5)(a) acres of 20 acres or less by parcel	4,851	7,517
(5)(a) acres of 20 - 100 acres by parcel	15,108	12,045
(5)(a) acres of 100 - 1000 acres by parcel	3,460	3,805
(5)(a) acres of 1000 - 5000 acres by parcel	0	0
(5)(a) acres of 20 acres or less by owner	2,242	3,472
(5)(a) acres of 20 - 100 acres by owner	9,880	8,811
(5)(a) acres of 100 - 1000 acres by owner	8,840	9,843
(5)(a) acres of 1000 - 5000 acres by owner	2,457	1,242
(5)(a) persons with 20 acres or less	214	303
(5)(a) persons with 20 - 100 acres	286	240
(5)(a) persons with 100 - 1000 acres	36	39
(5)(a) persons with 1000 - 5000 acres	2	1

Using the Small Forest Landowner Database it is not possible to answer the question of contiguousness in reporting requirement (5)(b). While the SFLO Database is spatially explicit, the resolution of the data is at best ¼ mile and therefore can not accurately represent contiguousness, Figure 5. For King County we do not have residential

information in the database. However, in the GIS data, assessed improvement value can be used as a proxy for residence. We can not determine if these improvements are actually houses and whether or not these improvements are primary residences or vacation homes, Table 10. Using assessed improvement value, 25% of King County small forest landowner parcels contain some type of improvement.

Figure 5 - The difficulty of determining contiguousness using tabular County Assessor data. Each tax parcel in the database is represented by a polygon that is the shape of the 640 acre section of land that the parcel is in.

Table 10 – King County GIS assessed improvement value information for parcels less than 20 acres in size.

ASSESSED VALUE	ACRES	# PARCELS	AVG VALUE
$0	5,995	541	$ 0
Greater than $0	1,522	148	$208,155

Identifying watersheds that have significant NIPF riparian or total ownership is difficult with the tabular data. Since the SFLO Database spatial information is based on legal descriptions, the resolution of the spatial component of the Database is limited to ¼ section at best. Due to the poor resolution, it is difficult to tell what watersheds a parcel may be in, Figure 6. If a section has acreage in multiple watersheds then which

watersheds might the NIPF parcel in that section be in? Therefore, the numbers generated by the database overestimate the acres of NIPF lands in each watershed, see Table 11 and Appendix A – Maps Figure 16.

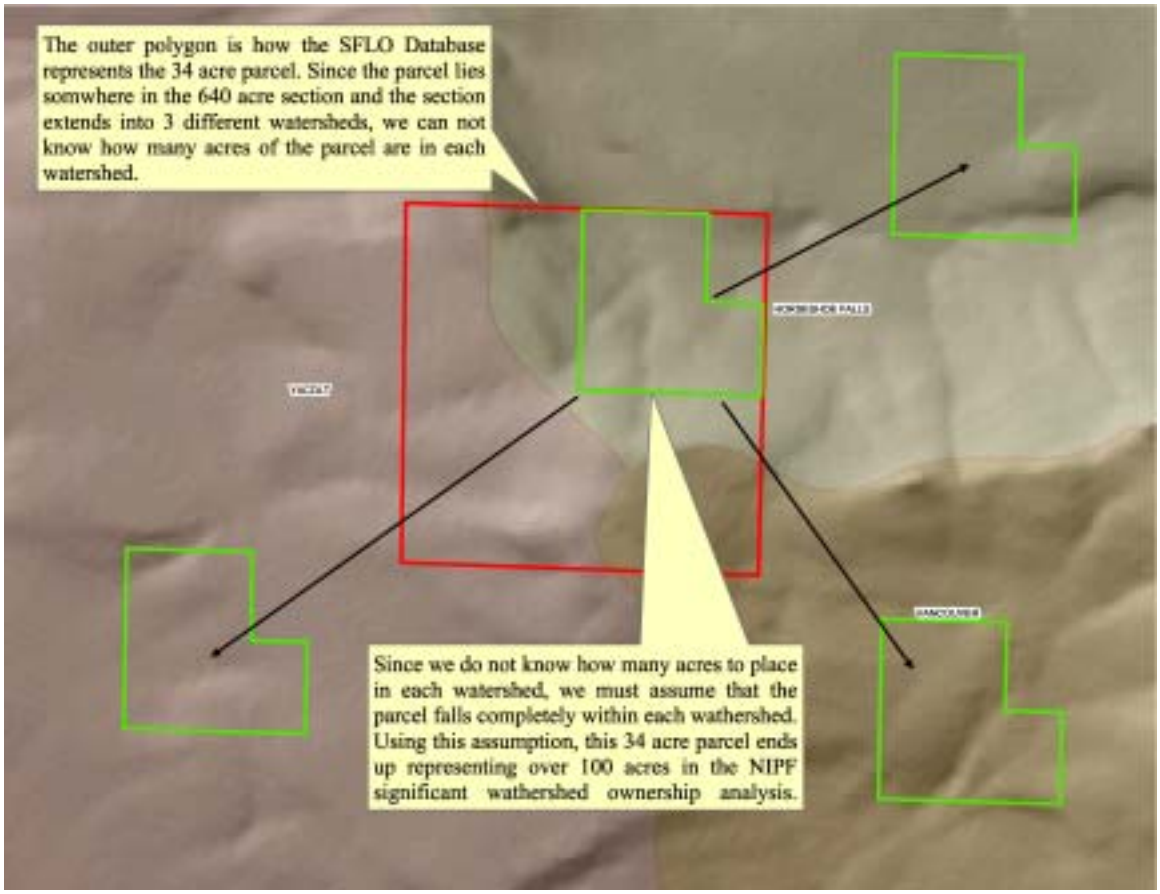

Figure 6 - Representing parcels in the database as sections or quarter-sections causes uncertainty when determining which WAU's a parcel be in. This difficulty overestimates NIPF acreage in WAU's since we must assume that an ambiguous parcel is in all overlapping WAUs.

Generating watershed numbers with the GIS data is straight forward and requires only one overlay operation (union) to complete. The GIS identified acres associated with particular watersheds is highly accurate and it is interesting to note how close the tabular estimates were in most cases, see Appendix A – Maps Figure 17. With the exception of the Cumberland WAU the percent total NIPF ownership by watershed is very close.

Table 11 - NIPF parcel acreage by WAU. Notice the high (and incorrect) total tabular acres caused by the uncertainty of parcel/watershed relationships.

WAU	% NIPF (TABULAR)	% NIPF (GIS)	TOTAL ACRES
BARING	1.81%	1.82%	36,341
BECKLER RIVER	0.15%	0.01%	65,853
CEDAR, LOWER	1.52%	1.09%	19,526
CHERRY	4.33%	3.49%	45,157
CHESTER	0.00%	0.00%	52,064
CUMBERLAND	19.47%	12.17%	19,101
DECEPTION	0.48%	0.47%	51,911
FOSS RIVER	0.16%	0.17%	40,183
GREEN	0.00%	0.00%	23,675
GREEN, NF	4.90%	3.62%	22,602
GREEN-DUWAMISH, LOWER	2.99%	1.86%	123,693
GREENWATER	0.00%	0.00%	49,240
GRIFFIN	2.14%	1.74%	20,024
HAYSTACK	0.00%	0.00%	24,190
HOWARD HANSEN	1.10%	0.47%	46,528
LAKE SAMMAMISH	0.17%	0.03%	23,597
LAKE WASHINGTON, N	0.20%	0.12%	142,906
LAKE WASHINGTON, S	0.72%	0.62%	77,192
LANDSBURG	0.81%	0.00%	22,936
LESTER	0.00%	0.00%	32,833
LOWLAND WHITE	0.30%	0.11%	46,636
MIDDLE, LOWER	9.51%	6.79%	24,249
MIDDLE, UPPER	1.22%	0.63%	85,536
MILLER-MONEY	0.10%	0.10%	39,672
MUD MTN	1.75%	1.41%	33,822
NEWAUKUM	8.48%	4.81%	24,845
PUGET	0.02%	0.02%	109,241
PUYALLUP, LOWER	0.00%	0.00%	87,939
RAGING RIVER	3.47%	2.40%	22,460

SMAY	0.00%	0.00%	14,496
SNOQUALMIE, LOWER	9.63%	7.90%	35,125
SNOQUALMIE, NF	2.81%	2.50%	65,963
SNOQUALMIE, S	1.81%	1.47%	55,194
SUNDAY	0.00%	0.00%	15,598
TATE	10.60%	6.58%	10,694
TIGER	3.10%	2.10%	40,786
TOKUL	2.29%	0.93%	21,398
TOLT	1.91%	1.31%	63,462
VASHON IS	3.34%	3.23%	49,866
WHITE, MIDDLE	0.00%	0.00%	28,678
YOUNGS CREEK	0.00%	0.00%	18,678

Generating riparian ownership with the tabular database is not possible due to the poor spatial resolution of the tabular data. The 1 section resolution of the SFLO database, when overlaid on the riparian areas from the GIS produces vastly overstated NIPF riparian acreage, Table 12. By using the King County GIS data and the Department of Natural Resources stream data, percent riparian ownership by WAU is straightforward. For the stream analysis, 100 and 200 foot buffers were used and a comparison made to examine the difference, Table 13. The difference between using a 100 ft or 200 ft buffer is insignificant. On average the tabular riparian statistics overestimate the amount of NIPF ownership by 43% but vary widely, Table 14.

Table 12 - Percent NIPF riparian ownership by WAU using the SFLO Database. Those WAUs that are not listed have no NIPF riparian ownership. The difference between using 100 ft and 200ft buffers is shown on the right.

WAU	100 FT	200 FT	DIFF
BARING	19.56%	19.59%	-0.03%
BECKLER RIVER	1.42%	1.49%	-0.07%
CEDAR, LOWER	20.36%	20.44%	-0.08%
CHERRY	78.92%	78.77%	0.15%
CUMBERLAND	225.61%	226.30%	-0.69%
DECEPTION	7.77%	7.76%	0.01%
FOSS RIVER	2.09%	1.91%	0.18%
GREEN, NF	13.01%	13.25%	-0.24%
GREEN-DUWAMISH, LOWER	40.97%	41.31%	-0.34%
GRIFFIN	45.60%	44.51%	1.09%
HOWARD HANSEN	2.25%	2.19%	0.06%
LAKE WASHINGTON, N	5.77%	5.71%	0.06%
LAKE WASHINGTON, S	23.89%	23.52%	0.37%
LOWLAND WHITE	0.57%	0.59%	-0.02%
MIDDLE, LOWER	44.49%	44.98%	-0.49%
MIDDLE, UPPER	5.10%	5.06%	0.04%
MILLER-MONEY	0.33%	0.34%	-0.01%
MUD MTN	28.31%	28.11%	0.20%
NEWAUKUM	81.47%	81.94%	-0.47%
PUGET	0.08%	0.17%	-0.09%
RAGING RIVER	34.76%	35.25%	-0.49%
SNOQUALMIE, LOWER	187.41%	189.13%	-1.72%
SNOQUALMIE, NF	9.47%	9.42%	0.05%
SNOQUALMIE, S	22.91%	22.88%	0.03%
TATE	94.74%	94.46%	0.28%
TIGER	44.84%	44.90%	-0.06%
TOKUL	2.07%	2.08%	-0.01%
TOLT	15.84%	15.83%	0.01%
VASHON IS	113.14%	112.57%	0.57%

Table 13 - Percent NIPF riparian ownership by WAU using the King County GIS data. Those WAUs that are not listed have no NIPF riparian ownership. The difference between using 100 ft and 200ft buffers is shown on the right.

WAU	100 FT	200 FT	DIFF
BARING	1.16%	1.20%	-0.04%
CEDAR, LOWER	0.22%	0.23%	-0.01%
CHERRY	3.92%	3.98%	-0.06%
CUMBERLAND	7.81%	7.97%	-0.16%
DECEPTION	0.66%	0.69%	-0.03%
GREEN, NF	1.12%	1.10%	0.02%
GREEN-DUWAMISH, LOWER	1.85%	1.84%	0.01%
GRIFFIN	2.34%	2.28%	0.06%
HOWARD HANSEN	0.25%	0.25%	0.00%
LAKE SAMMAMISH	0.14%	0.12%	0.02%
LAKE WASHINGTON, N	0.09%	0.10%	-0.01%
LAKE WASHINGTON, S	0.83%	0.89%	-0.06%
LOWLAND WHITE	0.01%	0.02%	-0.01%
MIDDLE, LOWER	5.59%	5.80%	-0.21%
MIDDLE, UPPER	1.16%	1.12%	0.04%
MILLER-MONEY	0.01%	0.02%	-0.01%
MUD MTN	0.60%	0.61%	-0.01%
NEWAUKUM	4.25%	4.20%	0.05%
RAGING RIVER	1.24%	1.33%	-0.09%
SNOQUALMIE, LOWER	7.39%	7.62%	-0.23%
SNOQUALMIE, NF	1.66%	1.72%	-0.06%
SNOQUALMIE, S	1.58%	1.59%	-0.01%
TATE	7.19%	6.94%	0.25%
TIGER	2.06%	2.14%	-0.08%
TOKUL	0.86%	0.90%	-0.04%
TOLT	1.28%	1.33%	-0.05%
VASHON IS	7.30%	7.13%	0.17%

Table 14 - Differences between generating NIPF riparian statistics with the King County GIS data and the 2001 Small Forest Landowner Database. On average the database overestimates the amount of NIPF land by 43%.

WAU	GIS	TABULAR	DIFF
BARING	1.16%	19.56%	18.40%
CEDAR, LOWER	0.22%	20.36%	20.14%
CHERRY	3.92%	78.92%	75%
CUMBERLAND	7.81%	225.61%	217.80%
DECEPTION	0.66%	7.77%	7.11%
GREEN, NF	1.12%	13.01%	11.89%
GREEN-DUWAMISH, LOWER	1.85%	40.97%	39.12%
GRIFFIN	2.34%	45.60%	43.26%
HOWARD HANSEN	0.25%	2.25%	2%
LAKE WASHINGTON, N	0.09%	5.77%	5.68%
LAKE WASHINGTON, S	0.83%	23.89%	23.06%
LOWLAND WHITE	0.01%	0.57%	0.56%
MIDDLE, LOWER	5.59%	44.49%	38.90%
MIDDLE, UPPER	1.16%	5.10%	3.94%
MILLER-MONEY	0.01%	0.33%	0.32%
MUD MTN	0.60%	28.31%	27.71%
NEWAUKUM	4.25%	81.47%	77.22%
RAGING RIVER	1.24%	34.76%	33.52%
SNOQUALMIE, LOWER	7.39%	187.41%	180.02%
SNOQUALMIE, NF	1.66%	9.47%	7.81%
SNOQUALMIE, S	1.58%	22.91%	21.33%
TATE	7.19%	94.74%	87.55%
TIGER	2.06%	44.84%	42.78%
TOKUL	0.86%	2.07%	1.21%
TOLT	1.28%	15.84%	14.56%
VASHON IS	7.30%	113.14%	105.84%

VI. Conclusions:

The 2001 Department of Natural Resources, Small Forest Landowner Office Small Forest Landowner Database is believed to be the first comprehensive, spatially explicit record of Washington's Small Forest Landowners and their land. The 2001 projects short timeline and continually changing scope left no time to validate the results of the data collection and compilation effort. This 2002 Database Analysis and Validation Study questions the comprehensiveness of the database and examines the GIS and tabular differences encountered when generating a sample report as outlined in the Salmon Recovery Act (House Bill 2091).

Using orthophotos and Landsat classification 937,685 acres of forestland were identified in King County. In and around the forestland that is common to both the Landsat and digitized forestland there are a potential 84,595 acres of NIPF land which was not included in the original SFLO Database. Of those acres the most likely NIPF lands are those with King County land use code 'Vacant (Single-family). The vacant single family timbered parcels larger than 5 acres in size represent 27,403 acres amounting to 1885 parcels and 1512 unique owners. The residential zone where these parcels reside and the single family land use information cast suspicion on these potential NIPF lands.

Generating the legislatively mandated reports with the SFLO Database and the King County GIS data yields similar results. Generating statistics on parcel acreages and numbers by size classes was very close for all size ranges except the 20 acre and less category where the assessor's acres came out far less than the GIS acres. Information on residence status in the SFLO database is not available versus the King County GIS where information about improvements and assessed value is available. Using the assessed improvement value in the GIS data, 25% of NIPF parcels less than 20 acres have some type of improvement.

Identifying watersheds with significant NIPF riparian or total ownership is possible using either the SFLO database or the King County GIS data. However, the tabular data tends to overestimate the amount of NIPF land in a watershed by 43%, and is not sufficiently accurate to determine watersheds with significant NIPF ownership.

It appears that the SFLO database is a good representation of the NIPF ownership in King County, WA. Likely additional NIPF owners in King County were identified through visual (orthophoto) and automated (Landsat) methods. Tabular and GIS information was compared to assess the quality of the tabular database and reports were generated that provide the foundation for the statistics in the legislatively mandated Small Forest Landowner Office report. In King County, the Small Forest Landowner Database is a good tool for analyzing non-industrial ownerships but could be improved with the addition of GIS data and residence information.

Appendix A – Maps

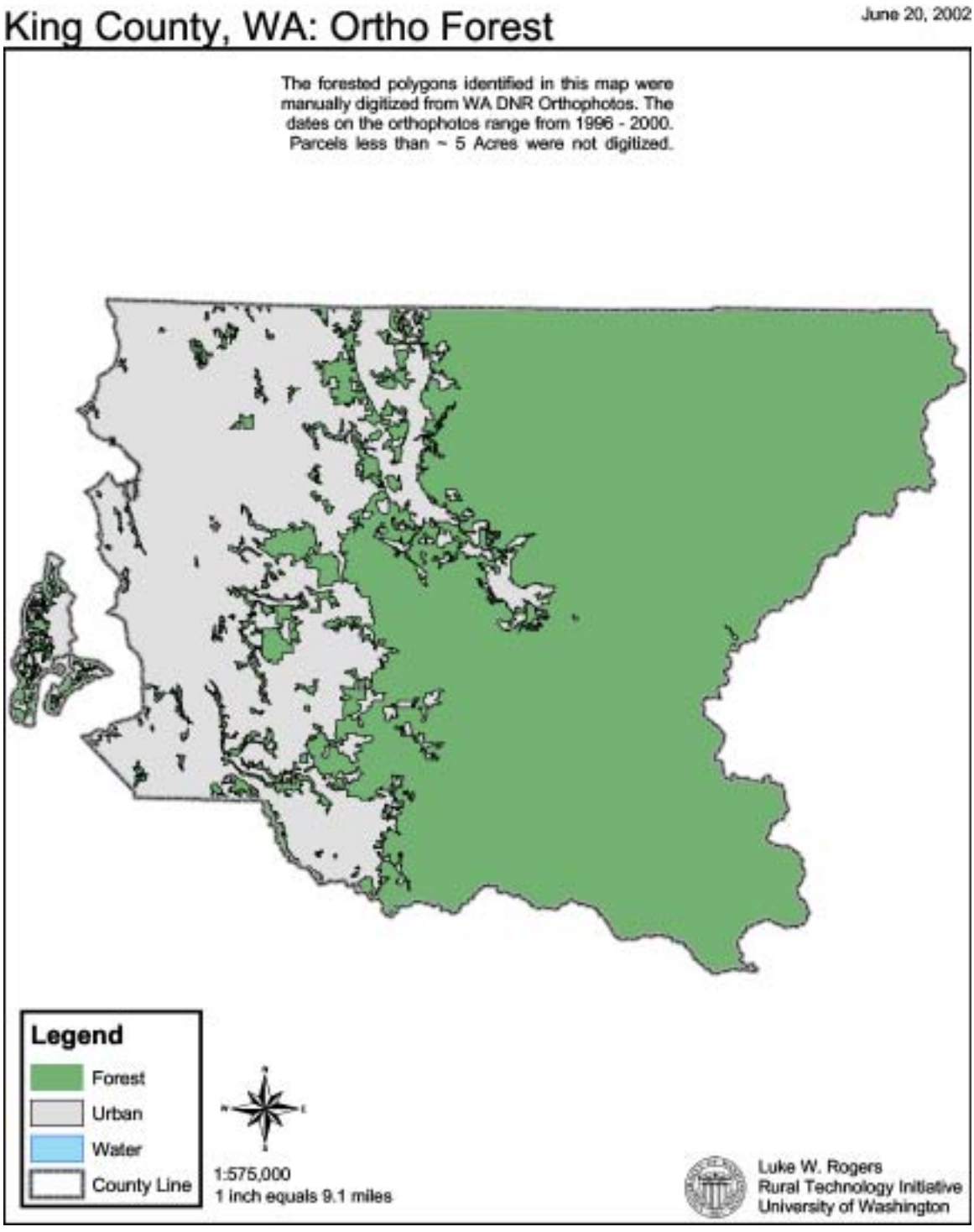

Figure 7 - Digitized forested areas in King County

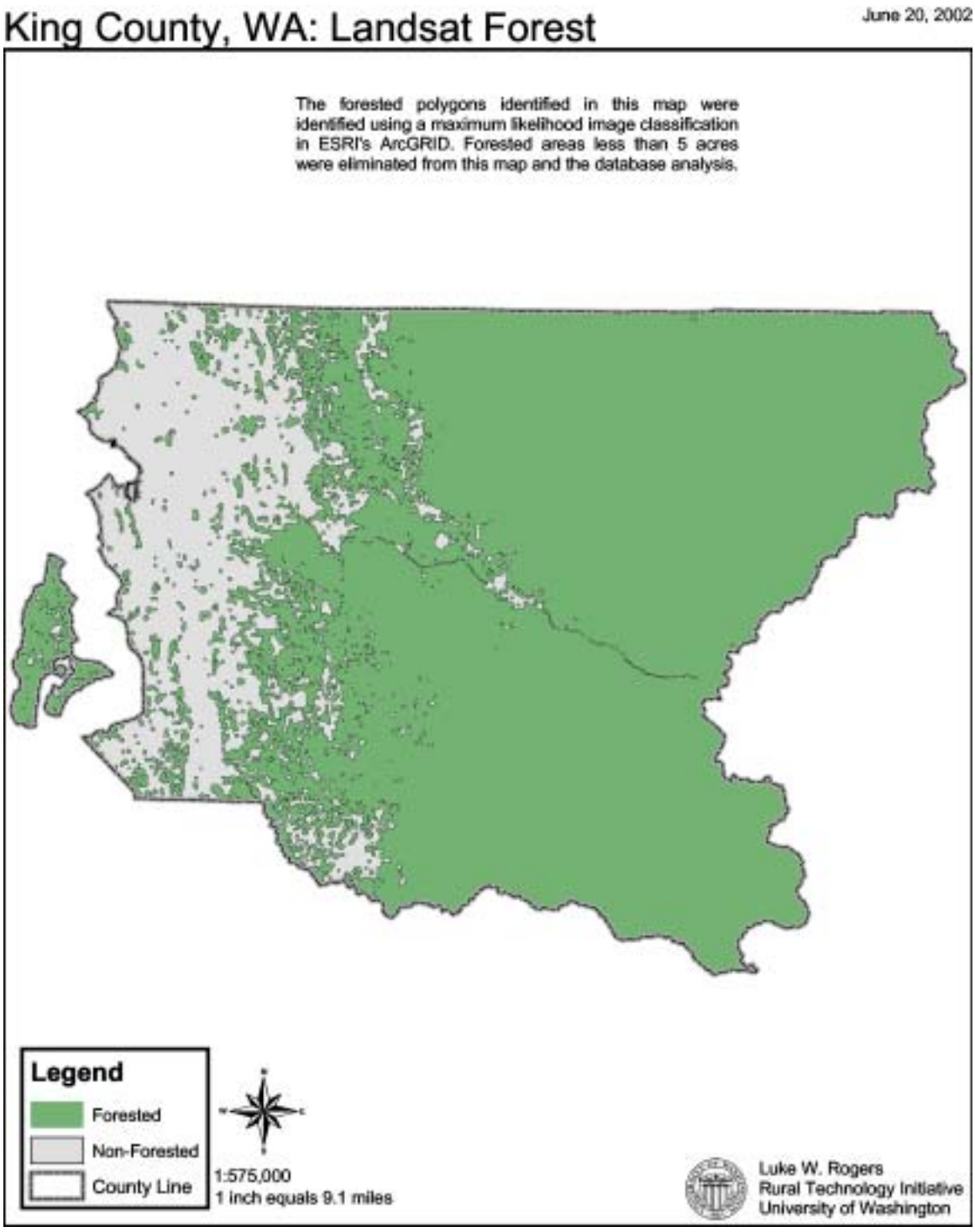

Figure 8 - Maximum likelihood Landsat classified forestland in King County.

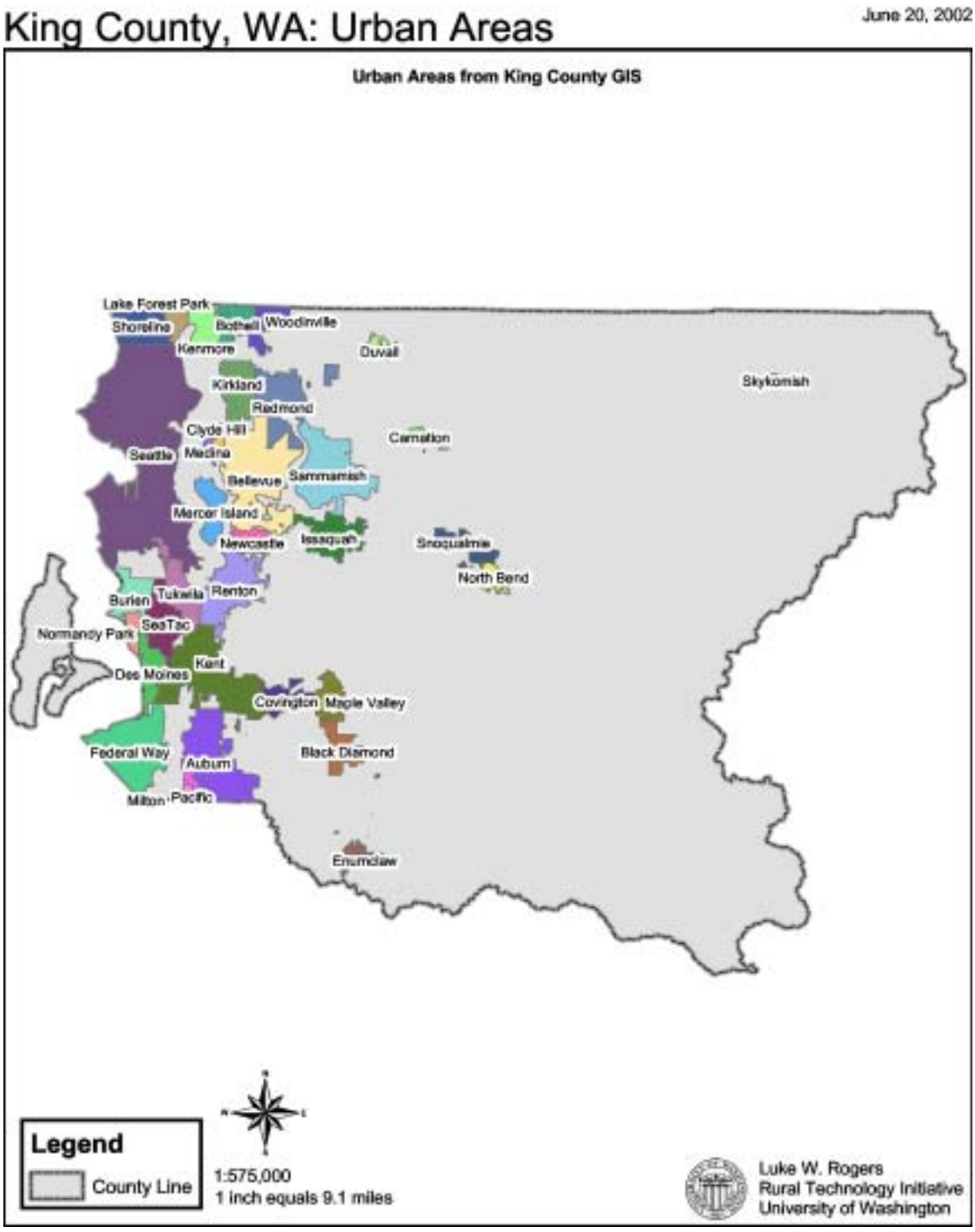

Figure 9 - King County urban areas that were removed from the analysis.

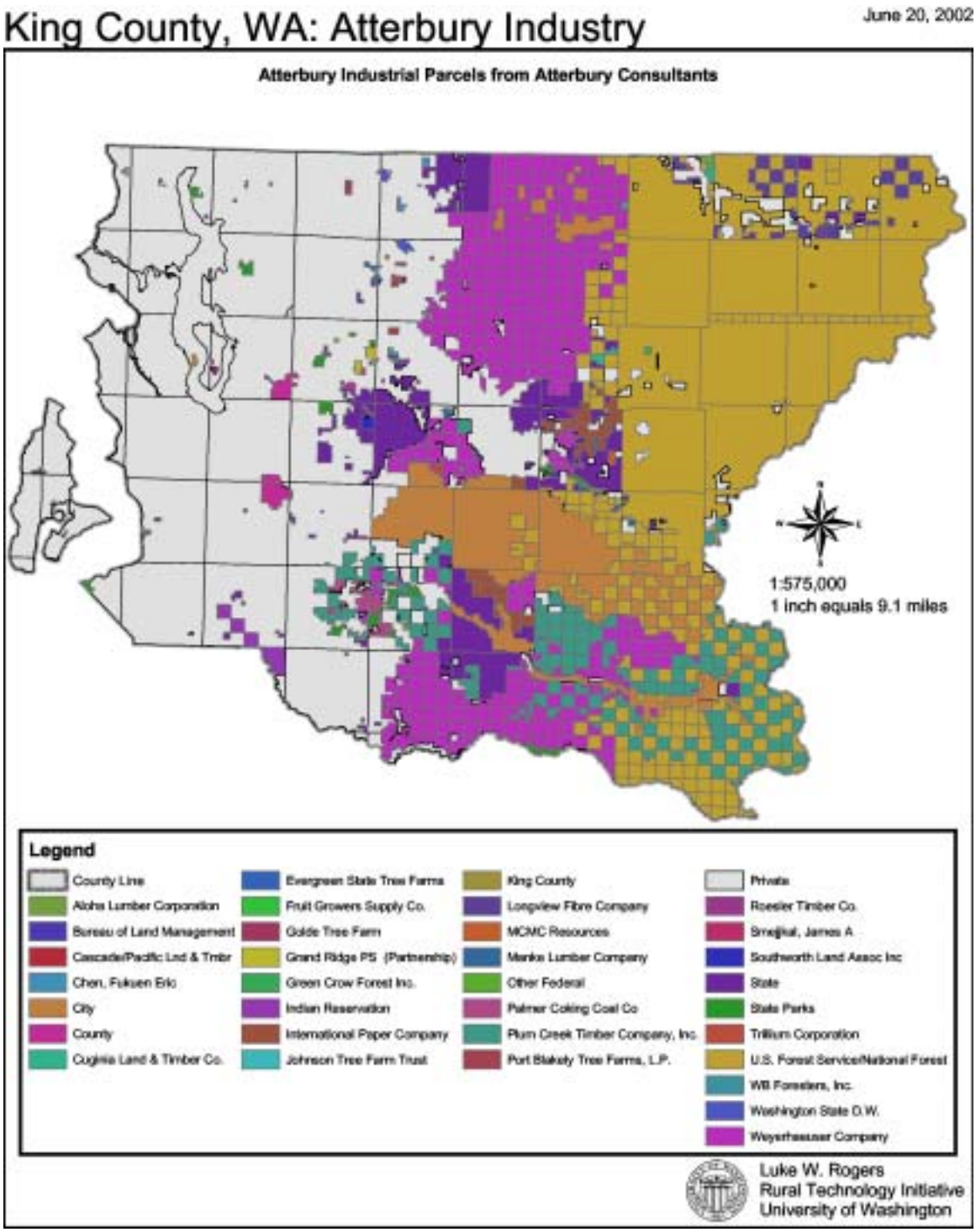

Figure 10 - Atterbury Industrial and Public parcels in King County.

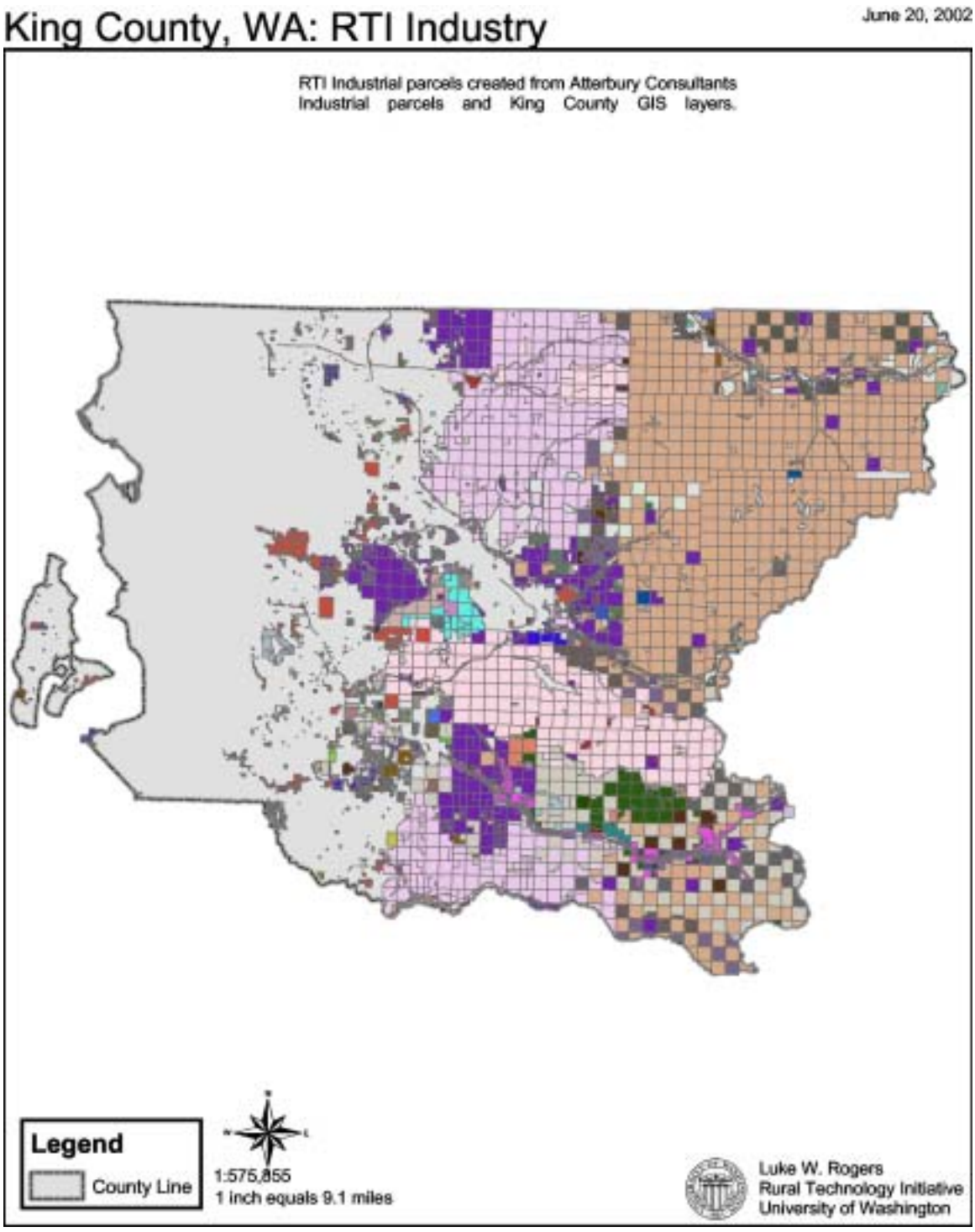

Figure 11 - RTI hand attributed industrial and public ownership.

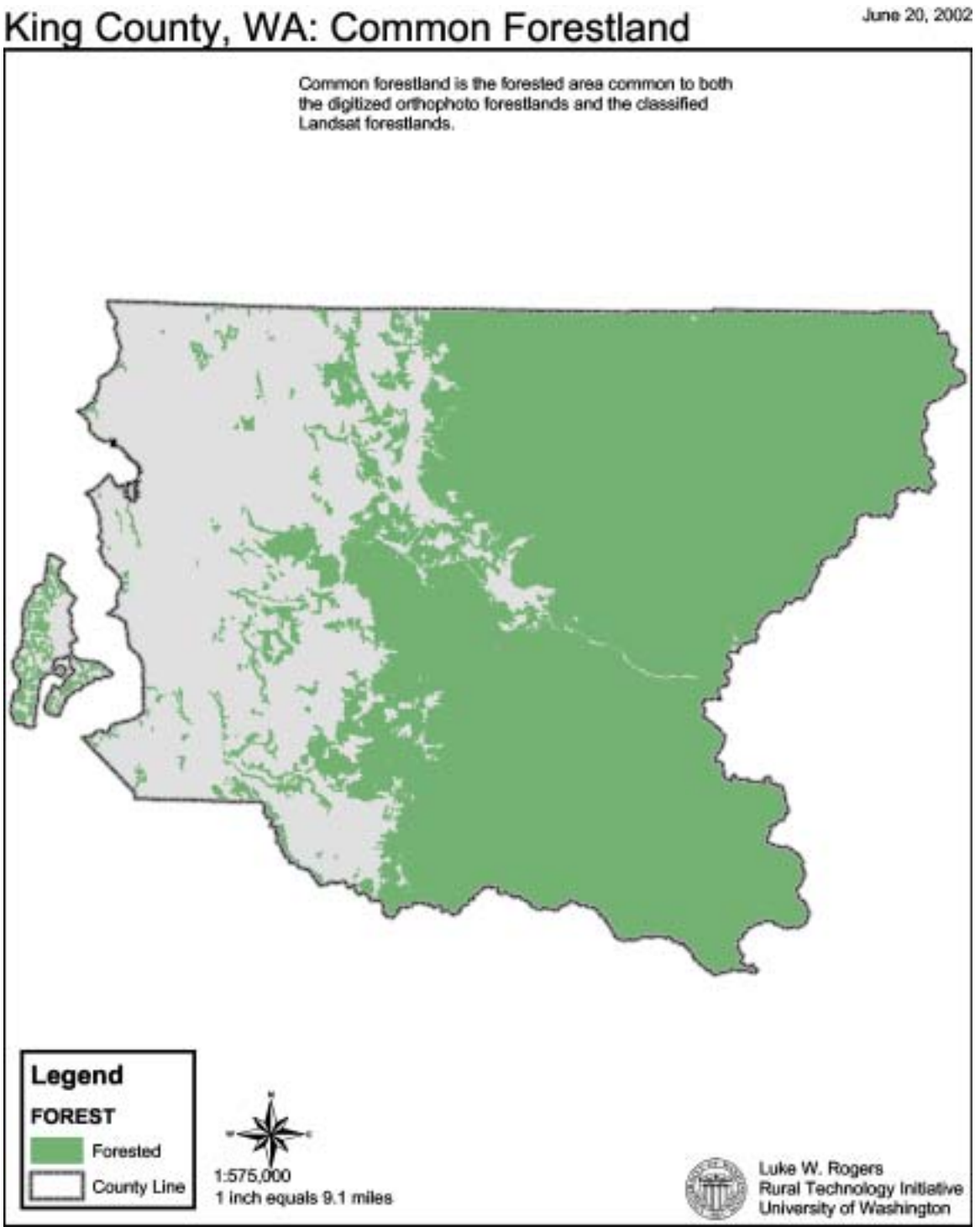

Figure 12 - Forested areas common to both the digitized forestland and the classified Landsat forestland.

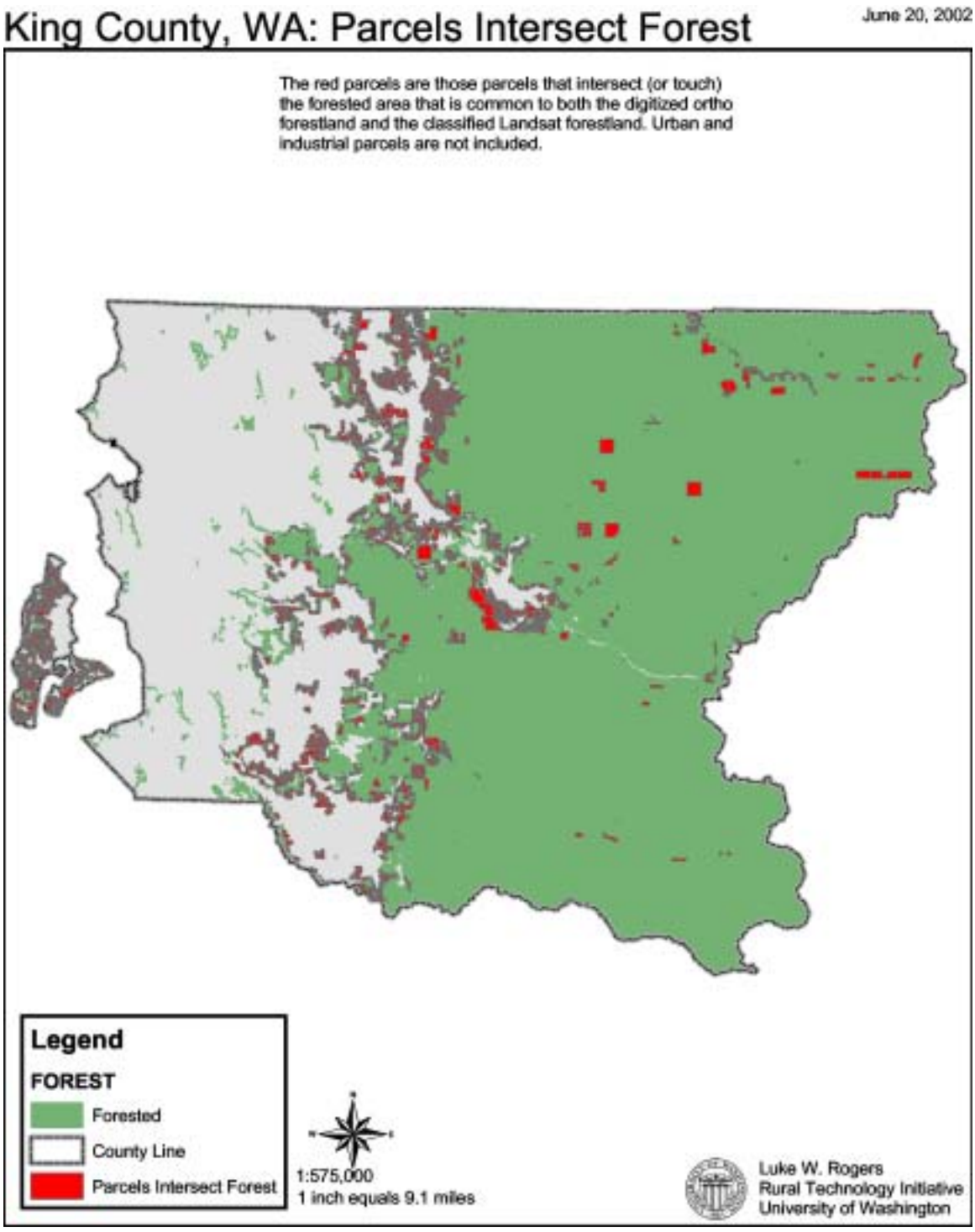

Figure 13 - King County non-urban and non-industrial GIS parcels that intersect the forested area common to both the digitized ortho forestland and the classified Landsat forestland.

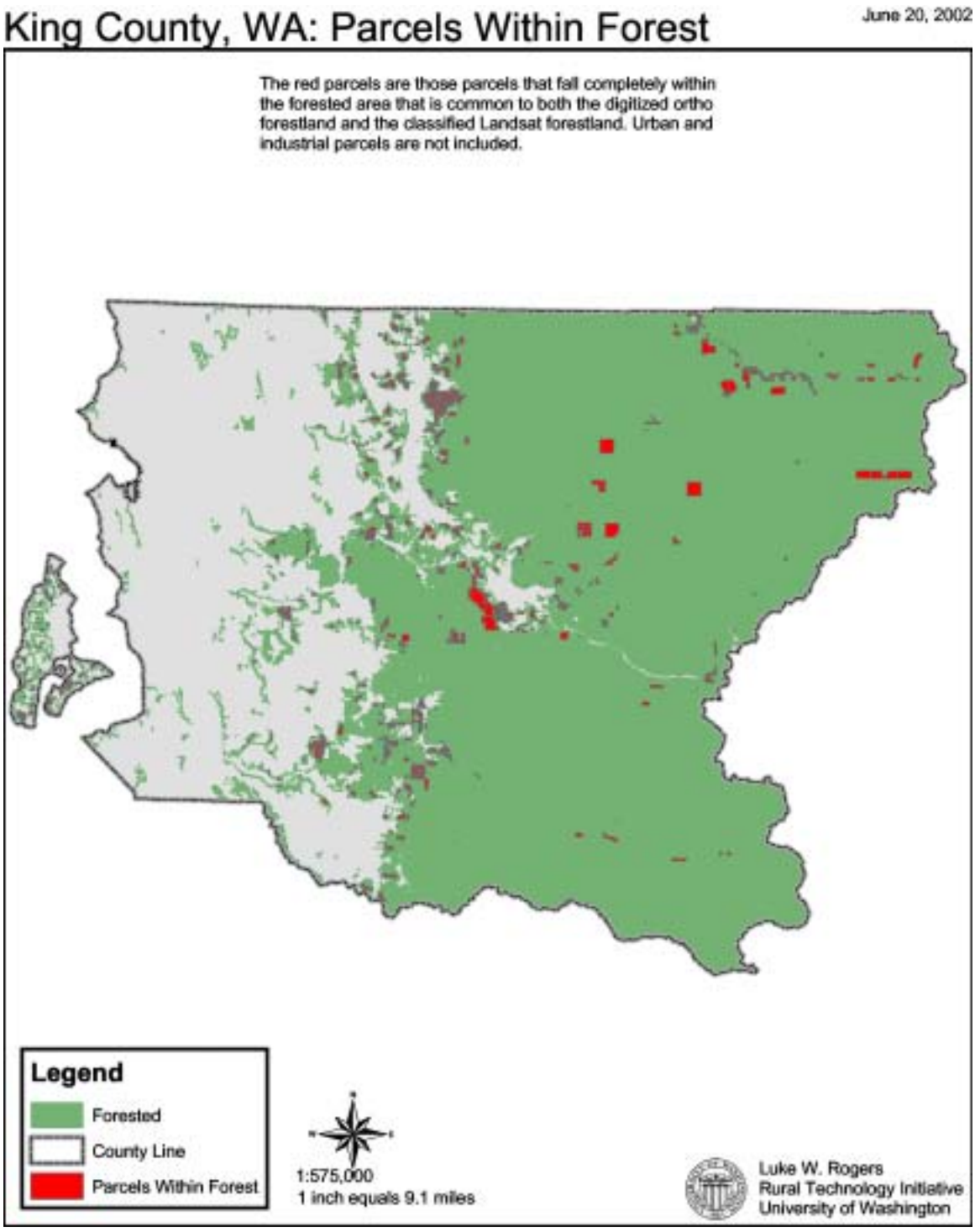

Figure 14 - King County GIS parcels that fall within the forestland common to both the digitized ortho forestland and the classified Landsat forestland.

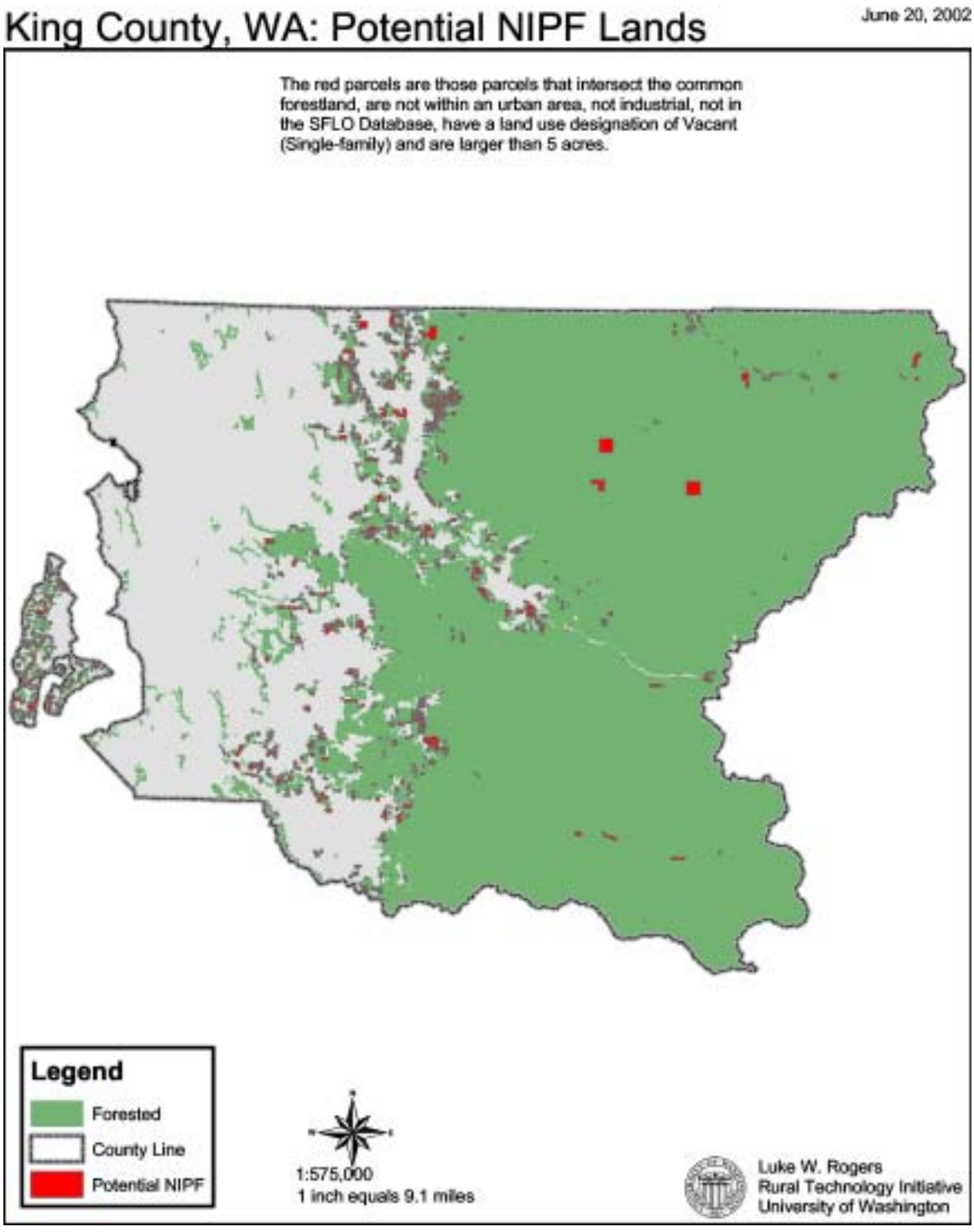

Figure 15 - Potential King County GIS parcels that could be NIPF land.

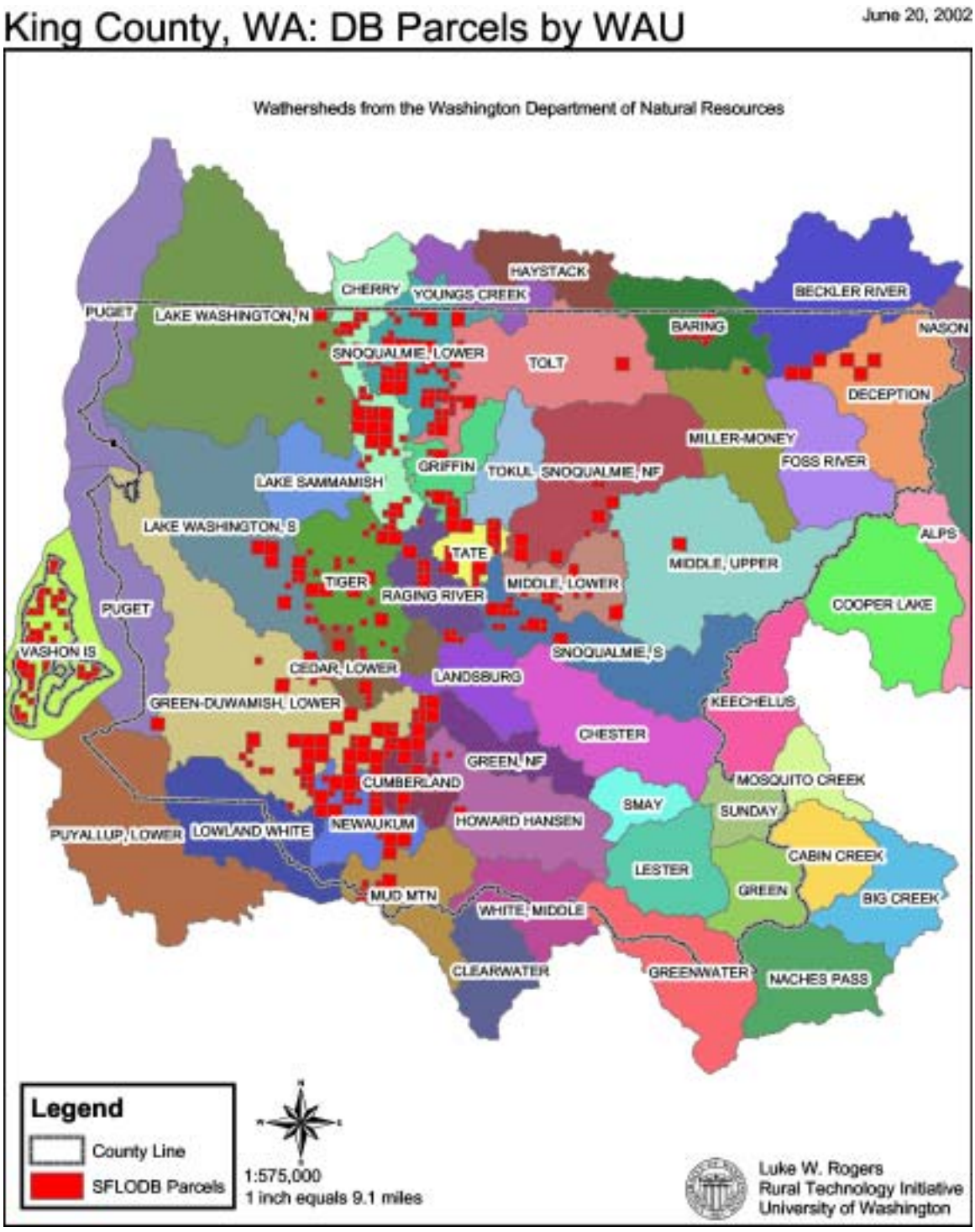

Figure 16 - SFLO Database parcels with 1/4 section resolution and the WAUs the parcels are in.

Figure 17 - GIS parcels and the WAUs the parcels are in.

Appendix B – Tables & Charts

Command	Parameters	Output
MAKESTACK	RAWDATA LIST BAND1 BAND2 BAND3 BAND4 BAND5 BAND7	RAWDATA
CLASSSAMPLE	RAWDATA TR	TR
CLASSSIG	RAWDATA TR COVAR	MLRAW.GSG
MLCLASSIFY	RAWDATA, MLRAW.GSG, #, EQUAL	MLRAW
FOCALMAJORITY	MLRAW, CIRCLE, 5	MLRAW_FOCAL
BOUNDARYCLEAN	MLRAW_FOCAL, DESCEND	BNDCLEAND
CON	BNDCLEAND == 0, 0, BDNCLEAND == 4, 0, 1)	FOREST_GRID
GRIDPOLY	FOREST_GRID	FOREST_POLY
ELIMINATE	FOREST_POLY FORESTED	FORESTED

Figure 18 - ArcGrid commands used to classify the 6 band LANDSAT data