Using GIS to Strategically Allocate Family Forest Assistance Programs

Luke W. Rogers [a,*], Ara K. Erickson [a]

[a] *Rural Technology Initiative, College of Forest Resources, 355 Bloedel Hall, UW Box 352100, University of Washington, Seattle, WA 98195-2100, USA.*

Abstract

Washington's family forests are often found in the spawning regions of many of Washington State's salmon streams and present an excellent opportunity for cost-share and assistance programs aimed at salmon habitat access and restoration. Washington's departments of Fish and Wildlife and Natural Resources have teamed with many local fish enhancement groups to identify existing fish blockages and habitat enhancement opportunities. It is difficult, however, to know which landowners qualify for assistance programs. A GIS-based approach to locating family forest parcels using county assessor tax roles, GIS-based parcel data, Landsat satellite imagery, and aerial photography has been developed to assist in the prioritization and identification of habitat enhancement opportunities on nonindustrial forest lands in Washington State. This approach identifies certain and probable family forests and allows local fish enhancement groups to prioritize work and contact individual landowners.

Introduction

Washington's forests owned by small forest land owners (SFLOs) represent approximately half of the total private forestland in the state (Bolsinger, McKay et al. 1997). Many of these parcels are often found in the spawning regions of many of Washington's salmon streams (Rogers 2006) and present an excellent opportunity for cost-share and assistance programs aimed at salmon habitat access and restoration. It is unknown, however, which landowners qualify for assistance programs aimed at small forest land owners.

Restoration of Washington's threatened and endangered salmon runs can be assisted by focusing restoration efforts in areas where the most habitats can be created for the least cost. The Washington State Department of Fish & Wildlife and the Department of Natural Resources, along with many local fish enhancement groups, have come together to locate and survey many of Washington's salmon streams. These surveys produced Geographic Information System (GIS) layers which show the location, condition, and fish passage status of dams, culverts, and fishways throughout the state. This information, combined with knowledge of who owns the land, can help local groups and funding agencies identify target restoration areas.

A Geographic Information System-based (GIS-based) approach to locating parcels owned by small forest land owners using county assessor tax roles, GIS parcel data, and Landsat satellite imagery was developed to assist in the prioritization and identification of habitat enhancement

[*] Corresponding author. Tel.:+1-206-543-7418. *E-mail address:* lwrogers@u.washington.edu (L. Rogers).

opportunities on non-industrial forest lands in Washington State. This approach identifies certain and probable small forest land owners and allows local fish enhancement groups to prioritize work and contact individual landowners.

Currently, there are a variety of stream restoration assistance programs targeted specifically at non-industrial private forestlands (NIPFs) and SFLOs; however, it is difficult to identify land owners in this group without door-to-door surveys. This project provides the funding groups with targeted information and mailing lists for land owners eligible for these funding programs using a combination of GIS and tabular data analysis.

The State of Washington's harvest-based definition, created in the Salmon Recovery Act, of SFLOs are those who harvest less than two million board feet of timber on an annual basis [RCW 76.13.120(2)(c)]. Unfortunately, the currently available information on harvest levels is not detailed enough to locate or identify small forest land owners. Alternatively, a previous acreage-based definition considered non-industrial forests and woodlands (also known as NIPFs) as "those 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 a wood processing or handling facilities" [RCW 76.13.010(4)]. Since the use of GIS allows acreage calculations of parcels, this acreage-based definition was used in the identification of possible small forest land owners eligible for stream restoration financial assistance programs.

For the purposes of this project, identification of these small forest land owners was based on two assumptions: 1) land ownerships less than 5,000 acres and taxed as forest or timberland have a high likelihood of meeting the harvest-based definition, and 2) forested lands of certain sizes have the potential of meeting the same definition. County assessor tax roles and GIS parcels, collected from Washington State counties, were used to identify those parcels which have land use codes taxed as forestland, timberland, or open space to identify SFLOs. Additionally, classified Landsat satellite imagery of forest and non-forest cover was intersected with all parcels, regardless of land use, to identify acres of forest land on each parcel; this resulted in the identification of *Possible SFLOs*. With the data produced during this project, it is possible to further identify Possible SFLOs by selecting parcels with non-conflicting land use codes, such as open space or other non-residential or commercial uses, if desired.

This paper describes the data used in the analysis and the methods used to determine small forest land owners.

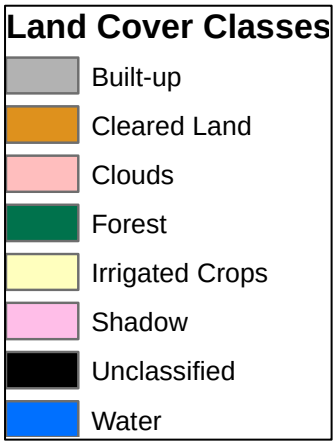
Data

County Data

This project collected and analyzed parcel and in-stream barrier data for Clallam and Jefferson counties, making up Washington's north Olympic peninsula. Previous projects covered Clark, Cowlitz, Lewis, Thurston, and Okanogan counties. County data is usually acquired from two different county departments: 1) a GIS dataset collected as shapefiles or ArcInfo Export Format files, and 2) an associated county assessor attribute table stored in Microsoft Access, Excel or a Dbase file. The spatial GIS data often has very few attributes and is joined to a real property table and ownership table by a parcel identification number or PIN. Rural counties tend to provide data as a flat shapefile with all attributes in the associated shapefile attribute table.

Landsat Data

Landsat satellite images were used to identify forest and non-forest areas in the counties. The images were classified into forest and non-forest cover as part of a land use change analysis done in cooperation with the U.S. Forest Service in the summer and fall of 2005. Eight images were collected, to cover all of western Washington, and a supervised land cover classification was done for all images using a program called *eCognition*. The final mosaiced and classified image was clipped to include just the areas in the counties to use for this project. The scenes that covered the project's study area were acquired in the summer of 2004 (ranging from July to August).



The original Landsat images were classified into a variety of land cover classes in *eCognition*, and aggregated into forest and non-forest categories in *ArcGIS*. Some land cover classes are more difficult to identify correctly than others. Recent forest harvest activity is very hard to distinguish from bare soils and cleared agricultural lands. In order to more accurately define areas of parcel as forest or non-forest, it was necessary to group obvious forest harvest activity, such as clearcuts and patch cuts completely surrounded by forest, into forest cover. This was done by running an analysis that selected areas of cleared land greater than 2 hectares in size that were completely surrounded by classified forest cover, and reclassifying these areas as forest cover. This resulted in a more accurate depiction of forested land, whether it was harvested or not, across the counties' landscape.

An accuracy assessment was conducted using a stratified random sample of points scattered across the study area. At the randomly selected points, aerial photos were compared to the classified land cover—the percent match between the photo and the land cover was 95%. The largest error was distinguishing between cleared land and built-up land; this is mainly due to the similar spectral signature shared by totally bare land and urban cover (concrete, pavement, bare ground, etc.).

Using satellite images for land cover classification is limited by the pixel size and classification accuracy. Landsat images store 30-meter by 30-meter pixels, meaning that any land cover less

than 900 square meters is not discernable. Furthermore, applying land cover classification to individual parcels is not entirely accurate. Nevertheless, for the purposes of this project--to identify land owners potentially eligible for financial assistance in restoring stream habitat and removing fish barriers—this level of land cover accuracy is appropriate. This data, however, must be used with caution when applying it to other projects and analysis.

Non-private lands were removed from the images before classification; therefore, the final land cover layer does not show forest cover for areas that are obviously forested on public lands. The following image (Figure 1) shows the forested areas (in green) in relation to the county boundaries, with the other classified land uses (orange, grey, and blue) appearing in the non-forest areas. The federal ownerships were not analyzed and appear blank on the map.

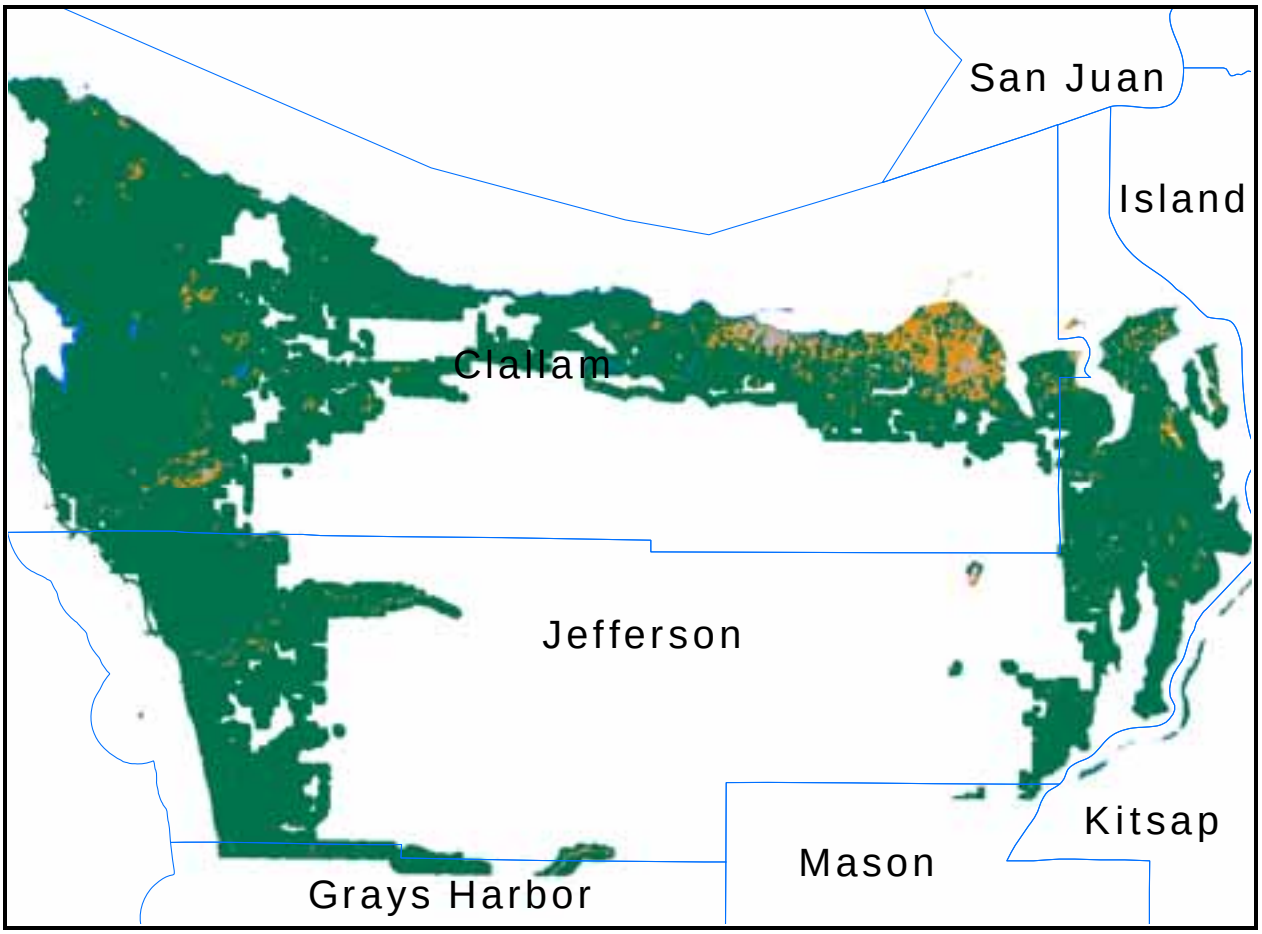


Figure 1. Land cover in Clallam and Jefferson Counties

Analysis

Standardizing Parcel Data

Counties store assessor parcel data in many different formats including ArcSDE, Geodatabases, Coverages and Shapefiles. In addition to storing the data in different formats, every county uses different attributes with diverse values. These differences make inter-county analyses difficult and inconsistent. To assist end users of the data with their analyses, a single cross-county format was created. This cross-county format includes information like the owner name and address, the parcel size, land use, location, owner type, timber acres, percent forest, and more. Before any analysis was done, a series of standard empty fields were added to the original parcel data from each county to allow for a final standard table.

All analysis was done using a combination of ArcGIS geoprocessing tools and Microsoft Access update and select queries. The process for each county differs, since each county stores data in different formats. A process table was built for each county, documenting the analysis steps; this process is also saved in each county's Microsoft Access analysis workspace.

The spatial parcel data for all of the analyzed counties was migrated to a standardized ESRI Personal Geodatabase Feature Class (PARCELS). Lookup tables included in the Geodatabase can be joined to the Parcels Feature Class for reporting or display. The relationships between the tables are shown in Figure 2, and the primary GIS tables and their associated lookup tables are described below:

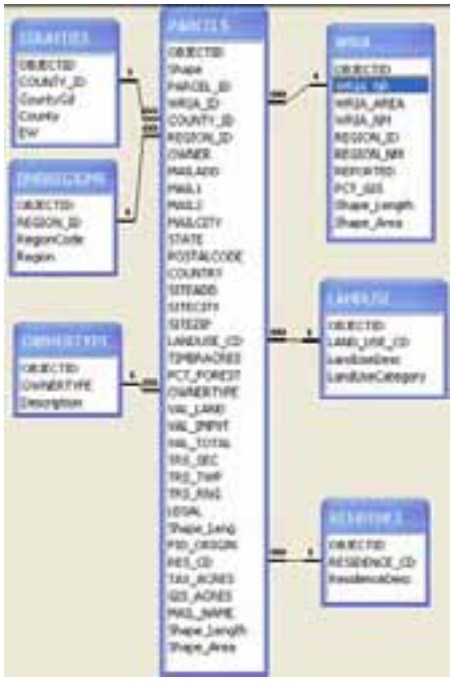


Figure 2. Relational structure of the small forest landowner database

- PARCELS – Compiled county parcels
- OWNERTYPE – Owner type table which describes OWNERTYPE field in the PARCELS table
- LANDUSE – Land use table which describes the LANDUSE_CD field in the PARCELS table
- COUNTIES – County table which describes the COUNTY_ID field in the PARCELS table
- RESIDENCE – Residence status table which describes the HOME_CD field in the PARCELS table
- WRIA – Water Resource Inventory Areas table which describes the WRIA_ID field in the PARCELS table
- DNRREGION – Washington State Department of Natural Resources Regional Office service area table which describes the REGION_ID field in the PARCELS table

In addition to the combined dataset, each county has its own personal geodatabase. This file includes all of the original data, analyzed data, and queries used to update and analyze the standardized data. The queries stored in each respective personal geodabatase can be accessed via Microsoft Access, and can be run to update newly added data, as needed. Additionally, users of the data can use the queries to see exactly what analysis went into each step, as well as follow the process of the analysis.

Identifying Small Forest Land Owners

Small forest land owners were identified using two methods. The first method used only the county assessor's tax roles to identify parcels that have land uses taxed as forestland, timberland, or open space. The second method used Landsat imagery to construct a forest cover layer, which was intersected with the parcel data to determine percentage and amount of forested land per parcel.

Industrial and Public Owner Types

Industrial forestlands were distinguished using local knowledge of the forestry industry and unique land owners with more than 5,000 acres of land in each county. Industrial owners, such as Weyerhaeuser, Boise Cascade, Longview Fibre, and other entities owning more than 5,000 acres, were not considered SFLOs and were categorized as *industrial* owners. Additionally, public lands were distinguished by a series of queries to identify land owned and administered by federal, state, and local governments. The remaining parcels were sorted into four categories: SFLO, Possible SFLO, and Possible FPP (eligible for Fish Passage Program funding opportunities), and Other/Unknown.

Land Use Codes: Identifying SFLO

County assessors typically follow a land use tax scheme that is closely related to Washington's state land use coding scheme. Although there are some variations, the land uses that are typically found relating to forestland are as follows: 87 - Classified forest land, 88 - Designated forest land, 92 - Noncommercial forest, 94 - Open space land, and 95 - Timberland. According to county assessors, these tax designations indicate that a parcel is being managed as forestland or is protected under a conservation agreement. Clallam County followed the same land use tax scheme as the state codes, while a crosswalk had to be developed to relate Jefferson County's data with the state codes.

Forested Acres: Identifying Possible SFLO and Possible FFP

The identification of Possible SFLO and FFP parcels required additional analysis, and was based on forest land cover analysis using Landsat satellite images. It is estimated that somewhere around half of Washington's non-industrial private forests are not in forest tax classifications. These parcels typically have land uses that do not conflict with forestry, but little data exists on what land uses are likely. Previous analyses have focused on assessor land use codes of: 89 –

Other resource protection, 91 – Undeveloped land, and 99 – Other undeveloped land. This method resulted in a significantly larger number of parcels being identified as SFLO in the previous studies.

For this analysis, however, all forested parcels of a certain size, regardless of land use classification, were considered as possible small forest land owners to ensure that all potential recipients of forest land assistance programs were identified. Overlaying the forest/non-forest layer on the parcels enabled the calculation of forested acres and percent forest of each parcel. For this analysis, parcels that had at least 5 acres of forested land (timberacres), regardless of the size of the total parcel, and that were not already identified as SFLO by land use codes, were considered *Possible SFLOs*. Parcels with at least 1 acre of forested land were identified as *Possible FFP*.

Remaining Parcels: Identifying Other/Unknown

All remaining parcels, not already identified as industrial, public, SFLO, Possible SFLO, or Possible FFP, were classified as other/unknown. These included parcels less than 1-acre and/or not taxed as forestland, timberland, or open space.

Coding Owner Type

Table 1 lists the codes and short descriptions associated with the owner types assigned to each parcel during the analysis. It is important to remember that the codes are assigned based on both size of the individual parcel as well as the unique owner. For example, a parcel of land owned by a known industrial owner would be considered industrial, even if it is less than 5,000 acres.

Table 1. Owner types identified in the analysis and the associated codes used in the datasets.

Owner Type Status Codes	
CODE	DESCRIPTION
0	Other/Unknown
1	SFLO
3	Industrial
4	Public
5	Possible SFLO - minimum of 5 forest acres
6	Possible FPP - minimum of 1 forest acre

Identifying Potential Fish Blockages

By overlaying potential in-stream barriers, collected by the Washington Department of Fish and Wildlife (WDFW), over all parcels in each county, it is possible to determine which parcels may

be eligible for potential fish habitat restoration or barrier removal funding. A mailing list and dataset was produced that lists the parcels and all respective attribute data. These attributes also include the status, location, and other information of the culvert, dam, or fishway on the property.

Results

Parcels

Combining assessor tax roles with remote sensing techniques yielded two to four times as many candidate 5-acre and larger SFLOs compared to using assessors tax roles alone. Assuming forested parcels over 5-acres are being at least partially managed as forestland they will qualify for assistance programs aimed at habitat restoration. Previous analyses have identified possible SFLO lands as forested parcels that have assessor land use codes of: 89 – Other resource protection, 91 – Undeveloped land, and 99 – Other undeveloped land. By limiting the Possible SFLO by non-conflicting land use codes (i.e. 89, 91 and 99), the number of parcels was reduced to 1,092, compared to just the acreage-based definition of 6,935 parcels for Clallam County. The Possible SFLOs were reduced to 1,258 from 2,848 for Jefferson County. Depending on the objectives of the data use, one method may be more appropriate than the other.

Barriers

Overlaying in-stream structures such as culverts, fishways and dams on the parcel database uses the power of the GIS to extract information useful to land managers. Using the mangers knowledge of the local area and the information generated in this analysis, individual landowners can be contacted about replacement of in-stream fish barriers. Information contained in the report for each barrier is shown in Figure 3.

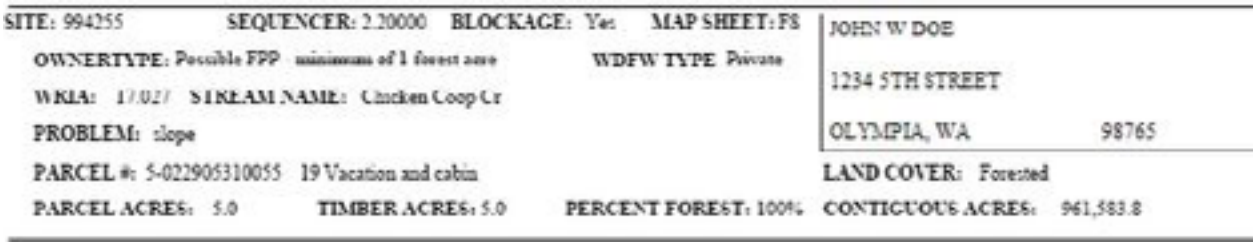


Figure 3. An example report that is generated for each in-stream fish barrier and cross referenced to a map.

Maps & Datasets

Map sets produced for the project show the location and identification information for all of the in-stream structures in the WDFW database overlaid on the known and possible SFLO and FPP parcels. These map sets, see Figure 4 and Figure 5, and the associated reports and spreadsheets can be used to locate individual blockages and the parcels that they are on. With this information, interested groups can contact individual landowners about the fish passage barrier on their property. All of the reports and maps produced for this project were products of either Access or ArcMap. The Map Series extension was used to produce the tiled maps, and the Report function in Access was used to produce the mailing lists.

Figure 4. Example map sheet.

Figure 5. Legend for barrier maps

Conclusion & Recommendations

Utilizing county assessor tax roles is an effective way to identify small forest land owners. However, many of Washington's small forest land owners are not taxed as forestland or timberland. Often, owners are not aware of the tax benefits associated with a forest tax classification or their parcel is too small to realize the benefit. It is estimated from previous studies conducted around the 2001 Small Forest Land Owner Database that there are likely twice as many non-industrial forests in Washington State as can be identified solely from county assessor tax information. Identification of these parcels and their owners can be assisted by using remote sensing techniques (to identify forest land) in combination with county assessor tax information.

Validation of this method of identifying small forest land owners requires on-the-ground surveys of land owners. The outreach efforts of local fisheries enhancement groups can help to verify the validity of this approach. Future efforts to identify small forest land owners using remote sensing and assessor tax roles could benefit from information gained from these local groups.

Acknowledgements

The authors would like to acknowledge the Washington State Department of Natural Resources and the Lower Columbia Fish Recovery Board for making this project possible.

References

Bolsinger, C. L., N. McKay, et al. (1997). Washington's Public and Private Forests. Portland, OR, U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. **PNW-RB-218:** 144.

Rogers, L. W. (2006). "Who Owns Washington's Forestlands? A Spatial Database for Analyzing Land-Use Patterns and Trends." Western Forester **51**(2): 24.

Author Information

Luke Rogers is a geographic information scientist and forest engineer working on quantifying the social, economic and ecological values of family forestlands for the Rural Technology Initiative at the University of Washington in Seattle. He can be reached at 206-543-7418 or lwrogers@u.washington.edu

Ara Erickson is a research consultant with the Rural Technology Initiative at the University of Washington's College of Forest Resources. She can be reached at 206-543-7418 or arake@u.washington.edu