Watershed Characterization and Analysis of South Lewis County

Lower Cowlitz River Watershed

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Final

Washington Department of Ecology
Shorelands & Environmental Assistance Program
Washington Department of Fish and Wildlife
Habitat Program

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Introduction

Background

In spring 2008 the Washington State Legislature provided funding to Lewis County, the Department of Ecology, and the Department of Fish and Wildlife to assist in a watershed based subarea plan for the watersheds surrounding the towns of Toledo, Winlock, and Vader. The study area is depicted in Figure 1. The primary objectives of this watershed-based mitigation program are to:

(1) provide better long-term protection of watershed processes and functions
(2) identify the best areas for protection, restoration, and development
(3) create an economic development strategy for the South County (Toledo, Winlock & Vader)

This South County Subarea Plan will be based on a characterization of watershed hydrologic processes, a landscape habitat assessment, an economic forecast, land use assumptions, and input from a broad-based local stakeholders group. The purpose of this document is to present the results of the characterization of watershed processes and wildlife for the study area. The results are presented in Table 1.

Approach

Characterizing watershed processes within the study area is central to developing a successful watershed-based subarea plan. An adequate characterization will provide local jurisdictions with information on the best areas for mitigation, protection of watershed processes, and development.

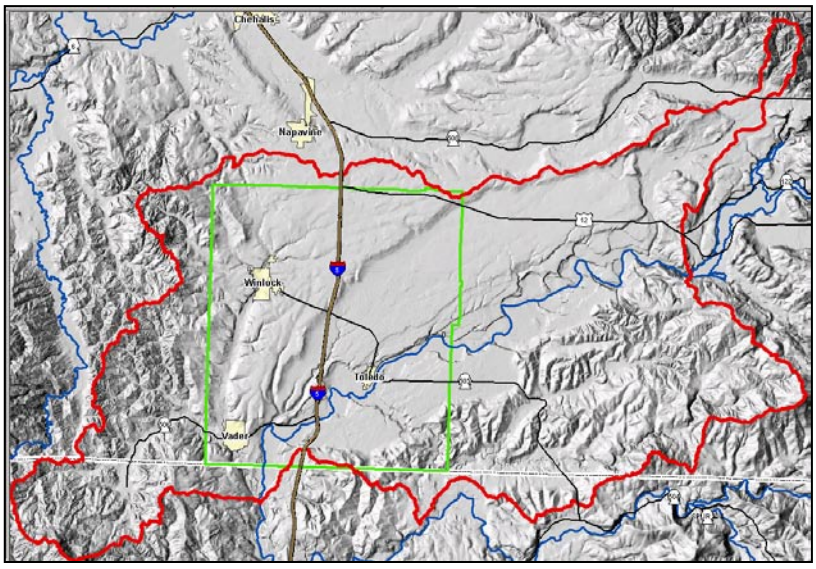

Figure 1. Study Area for South Lewis County (green box) with watershed boundary for study area (red outline).

For example, watershed characterization and analysis helps to identify areas that are important for maintaining watershed processes (Figure 2) as well as how much these areas have been impaired (Appendix Figures C-3 and C-4,).

The central assumption to this characterization approach is that the health of aquatic resources is dependent upon intact, up gradient watershed processes. Research has demonstrated that we must consider the watershed processes that occur outside of aquatic ecosystems if we are to protect and restore our lakes, rivers, wetlands, and estuaries (National Research Council 2001, Dale et al. 2000, Bedford and Preston 1988, Roni et al. 2002, Poiani et al. 1996, Gersib 2001, Gove et al. 2001).

> ***Watershed Processes:*** In this document, *watershed processes* refers to the dynamic physical and chemical interactions that form and maintain the landscape at the geographic scales of watersheds to basins (from hundreds to thousands of square miles).
>
> These processes include the movement of water, sediment, nutrients, pathogens, toxins, and wood as they enter, move through, and eventually leave the watershed.

Our management and regulation of these aquatic ecosystems have typically concentrated on the biological, physical, and chemical character of the individual lake, wetland, stream reach, or estuary, and not on the larger watershed that controls these characteristics.

Scientific studies show that watershed processes interact with landscape features, climate, and each other to produce the structure and functions of aquatic ecosystems that society is interested in protecting (Beechie and Bolton 1999). For example, flooding by streams can create off-channel habitat that is important for fish. Much of the research concludes that protection, management, and regulatory activities could be more successful if they incorporate an understanding of watershed processes.

Potential Uses

The final map showing priorities for protection and restoration could be used by the county to develop an initial suite of potential mitigation sites based on the sub-unit priority for protection and restoration. These mitigation sites can include aquatic resources such as wetlands and riparian areas as well as upland areas that are important to maintaining processes for these aquatic resources.

Lewis County planners and managers can also use this information in updating their Shoreline Master Program and Lewis County Comprehensive Growth Management Plan. For example, WAC 173-26-201(3)(d)(i)(A) of the Shoreline Master Program Guidelines requires local governments to prepare a characterization of ecosystem-wide processes and ecological functions, and to identify measures to protect and restore them. See Appendix B, Framework for Planning, for examples of applying characterization to local planning processes.

The characterization can also be used to develop comprehensive mitigation programs for Critical Area Ordinance updates (e.g., offsite mitigation, in lieu fees, transfer of development rights). This includes using the results from this characterization to establish service areas for mitigation banks. This approach should help sustain aquatic ecosystems by replacing and restoring functions within a common set of watersheds.

Results of Characterization

Identify Areas of Protection, Restoration, and Development

Land use planning should be developed within a framework that first focuses on maintaining or restoring watershed processes (Hidding and Teunissen 2002, Dale et al. 2000, Gove et al. 2001). To assist land use planning efforts in South Lewis County an initial watershed planning framework for protection, restoration, and development is presented below. This framework presents the areas that are most important within the study area for water flow processes.

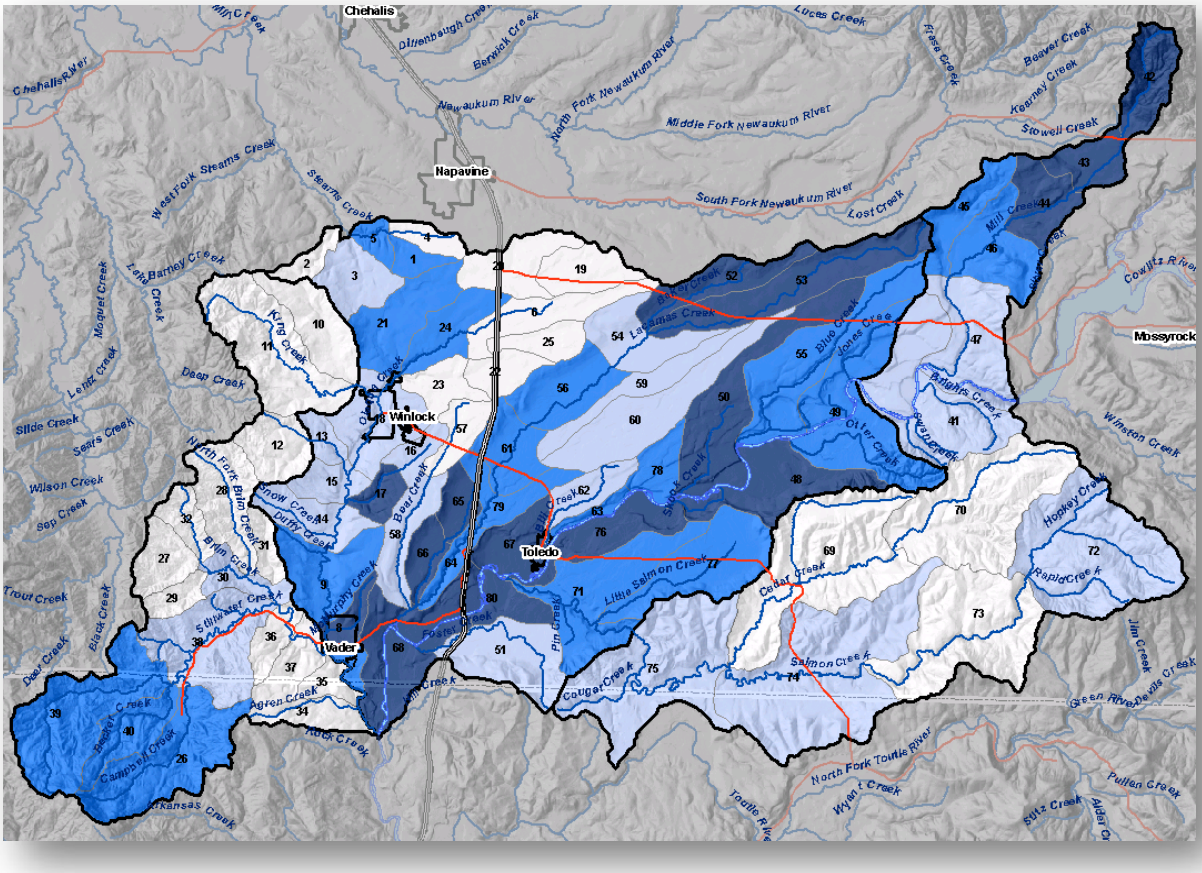

Figure 2: Rating of Areas Important for Water Flow Process. Areas in "dark blue" have the highest importance; areas in "blue" have moderate-high importance; areas in "light blue" have moderate importance; and areas in "white", lower importance.

Overall the areas in the terrace above and adjacent to the Cowlitz (blue area) are of moderate to high importance with areas primarily in the floodplain of the Cowlitz have high importance. Areas of moderate importance are located predominately in the watersheds for the Olequa River south of and including Winlock. The mountainous areas are generally of moderate to lower importance for water flow process. However, the southwest corner (Becker and Campbell Creek watersheds) and northeast corner (Mill Creek watershed) of the analysis area are of moderate to high importance.

We discuss the potential areas for protection, restoration and development for the three Cities of Winlock, Vader, and Toledo in the synthesis section below. A summary of the results of the characterization are presented in Table 1.

***Protection*:** Any activity that ensures that **the watershed process remains relatively unimpaired**. This can encompass traditional efforts of protecting land from human activities (e.g., open space, conservation easements), but it can also mean designing development in a way that allows the watershed process to continue with minimal impairment. For instance, an area important for recharge could be set aside from any development, or new development could be sited and designed to ensure recharge of the additional surface runoff generated by the development.

Restoration: Any activity that ensures that **the watershed process is re-established or re-habilitated**. This can involve restoring the natural condition of an important area but it can also include activities that restore the capacity of the important area to support the process. For instance, an area important for recharge that is covered with impervious surfaces could be modified to accommodate recharge or it could be restored to natural conditions.

The specific design of any of these activities requires further site-level analysis.

Synthesis

In order to identify the most suitable areas for development, protection and restoration in South Lewis County, the results of three different analyses were synthesized. This included characterization of water flow processes, wildlife habitat (Local Habitat Assessment) and assessment of buildable lands. A detailed review of the buildable lands assessment (Berryman and Henigar) is contained in a separate report.

Results of Fish and Wildlife Analysis

The Department of Fish and Wildlife characterized habitat at the broad and mid scales (Figure 9 and Appendix D). For the broad scale, the Local Habitat Assessment found the majority of south Lewis County to have habitat of high suitability for wildlife. Generally, the areas with the lowest suitability were within the cities of Winlock, Toledo and Vader, and the road infrastructure and agricultural areas associated with these cities. The mid-scale analysis examined key species in the areas and their habitat needs. This included Oregon vesper sparrow, western meadowlark, northern flying squirrel, porcupine, merlin, bobcat and short eared owl. Additionally, forest edge and interior bird habitat and amphibian and reptile habitat was assessed.

Overall, south Lewis County was found to have a high suitability for wildlife habitat, including key wildlife species. The Lacamas Creek corridor was found to have the greatest significance, both in terms of number of species present and productivity. This corridor is considered to be a very high importance to fish and wildlife and is shown in a “yellow” outline on the synthesis maps.

Buildable Lands Suitability Analysis

Parcels within the study area were evaluated for their development suitability based on a series of weighted factors, including distance from transportation corridors, zoning, and soils/slope. Results were presented in priorities from high to low suitability for development. The areas with the first and second highest suitability for development were used in this synthesis and are shown as “red” outlined areas on the synthesis maps.

Results of Synthesis

The synthesis maps displaying the results of combining characterization for water flow processes and wildlife habitat are presented in Figures 3 through 6. Data layers for all three analyses outlined above were combined and presented in four maps for different development scenarios:

- Alternative One. Areas of low importance for water flow processes plus #1 priority for buildable lands plus Lacamas Creek Fish and Wildlfe Corridor overlay;
- Alternative Two. Areas of low importance for water flow processes plus #1 and #2 priority for buildable lands plus Lacamas Creek Fish and Wildlife Corridor overlay;
- Alternative Three. Areas of low and moderate importance for water flow process plus #1 and #2 priorities for buildable lands plus Lacamas Creek Fish and Wildlife overlay.
- Areas of Development Conflict.

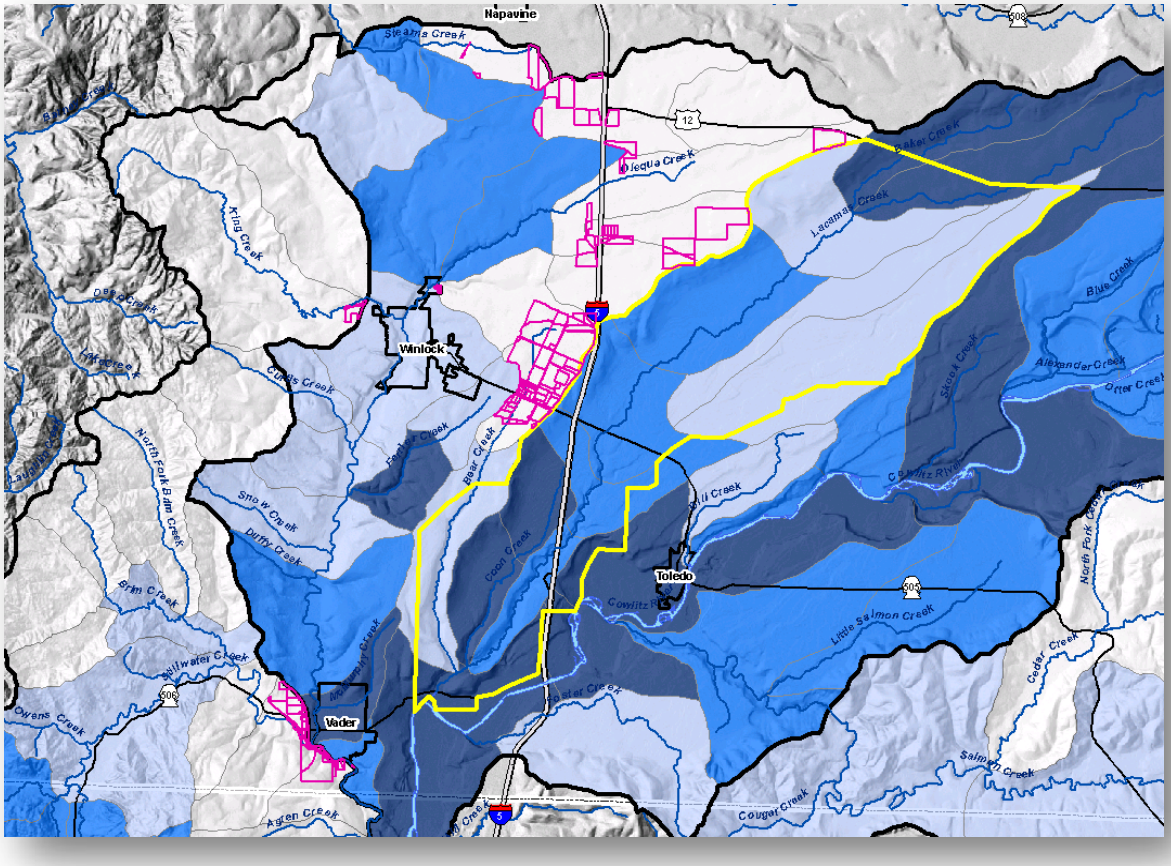

Figure 3 – Development Alternative 1. This alternative represents the lowest risk to south Lewis County ecosystems. Red outlined areas indicate parcels most suitable for development. Buildable lands with the #1 priority development were combined with areas having the lowest importance for water flow processes. Dark blue represents highest importance for water flow processes and light blue the least. Yellow outline area is the Lacamas Creek fish and wildlife overlay which has a low suitability for development.

The first three development scenarios represent the most suitable areas within the study area for development. However, alternative one represents a lower risk to maintaining water flow processes and fish and wildlife habitat relative to alternative three. These alternatives can be used by the county to design the final subarea plan development plan and regulations.

Development alternatives 1 and 2 (Figure 3 and 4) identify the upper terrace (see Figure C-1 and A-3) as the most suitable are for future development. This area has relatively lower permeability and storage, but large areas of wetlands in the headwater portion of Olequa Creek.

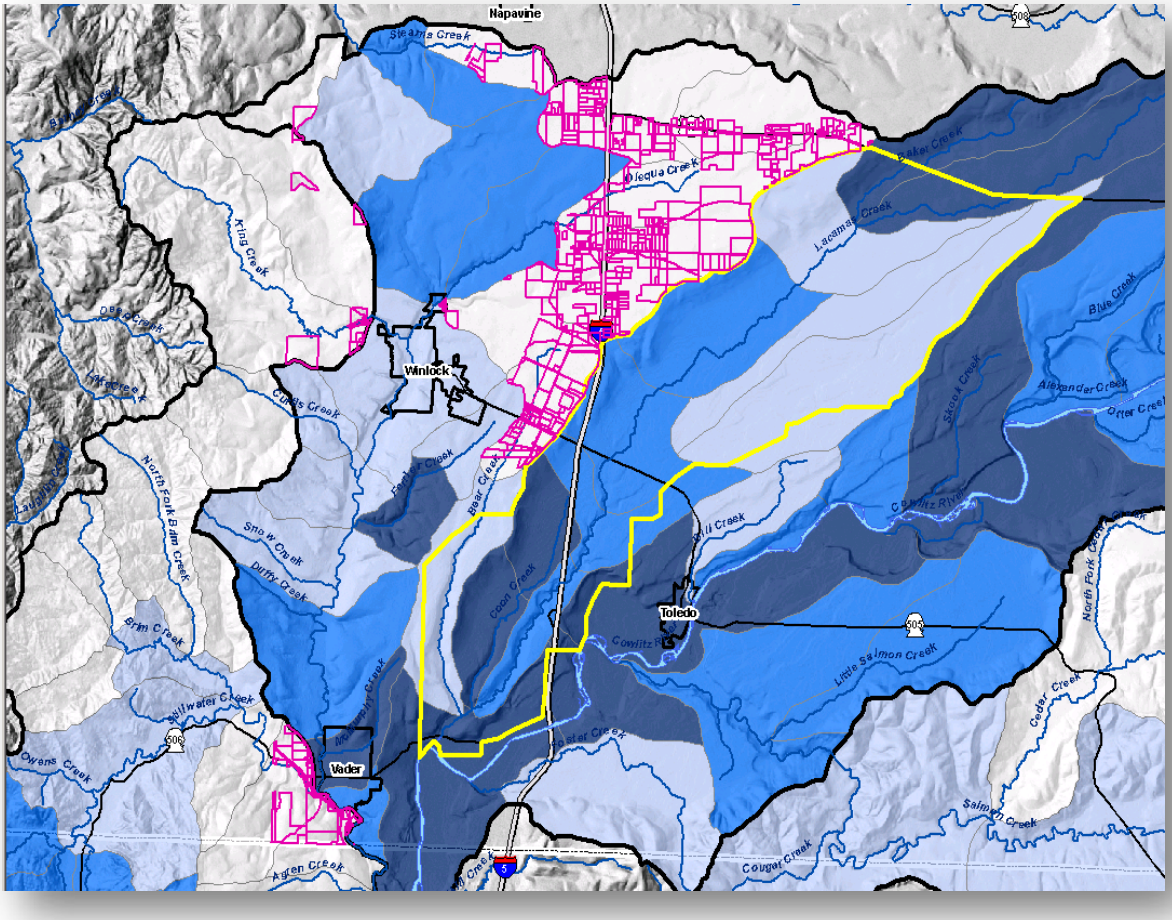

Figure 4. Development Alternative 2. This alternative represents a low risk to the south Lewis County ecosystems. Red outlined areas indicate parcels suitable for development. Buildable lands with the #1 and #2 priorities for development were combined with areas having the lowest importance for water flow processes. Dark blue represents highest importance for water flow processes and light blue the least. Yellow outline area is the Lacamas Creek fish and wildlife overlay; this area has a low suitability for development.

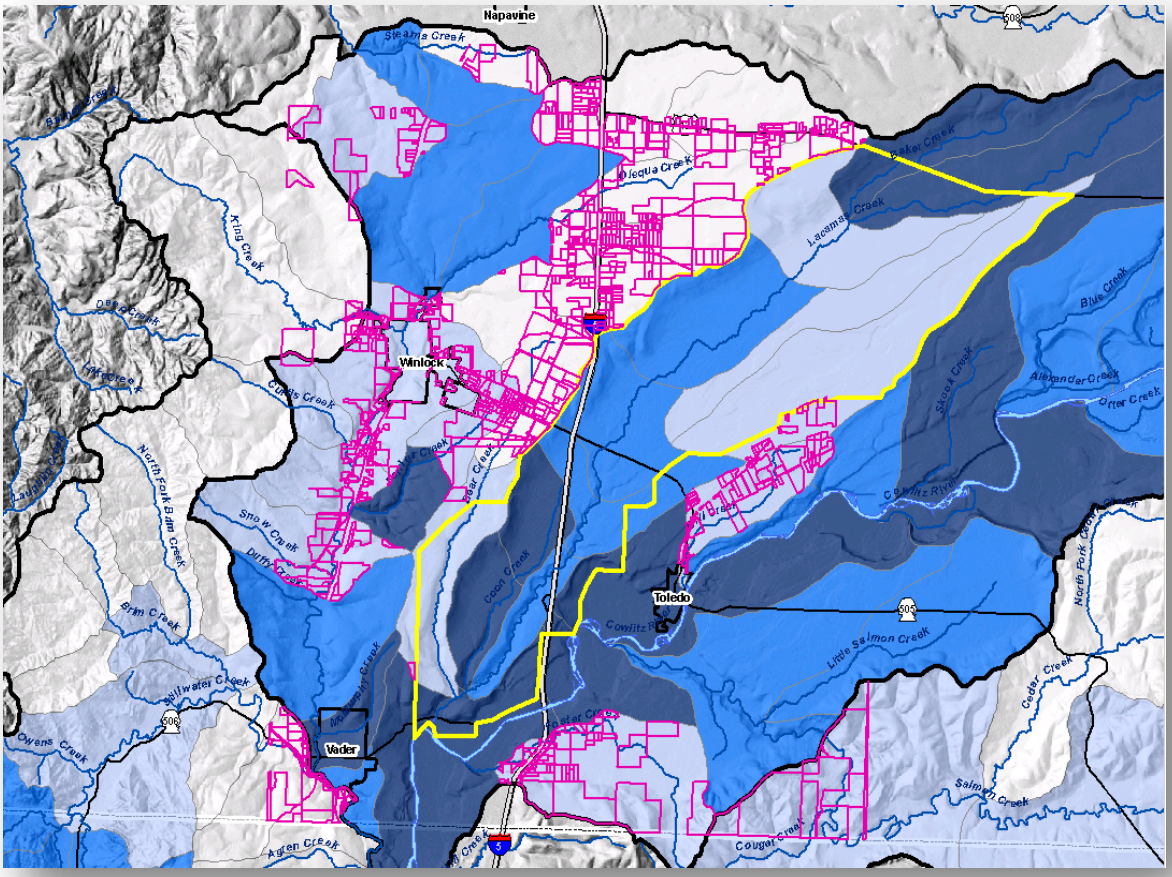

Figure 5. Development Alternative 3. This alternative represents a higher risk to the south Lewis County ecosystems. Red outlined areas indicate parcels suitable for development. Buildable lands with the #1 and #2 priorities for development were combined with areas having the lowest and moderate importance for water flow processes. Dark blue represents highest importance for water flow processes and light blue the least. Yellow outline area is the Lacamas Creek fish and wildlife overlay; this area has a low suitability for development.

Figure 5 shows future development expanded into the intermediate terrace (Bill Creek) above Toledo, along the Olequa River south of Winlock and on Cougar and Foster Creeks.

Figure 6 shows the areas where development would have the greatest degree of conflict with the protection and restoration of water flow processes. It is recommended that the county select the type and intensity of development that is compatible with the protection and restoration of these processes.

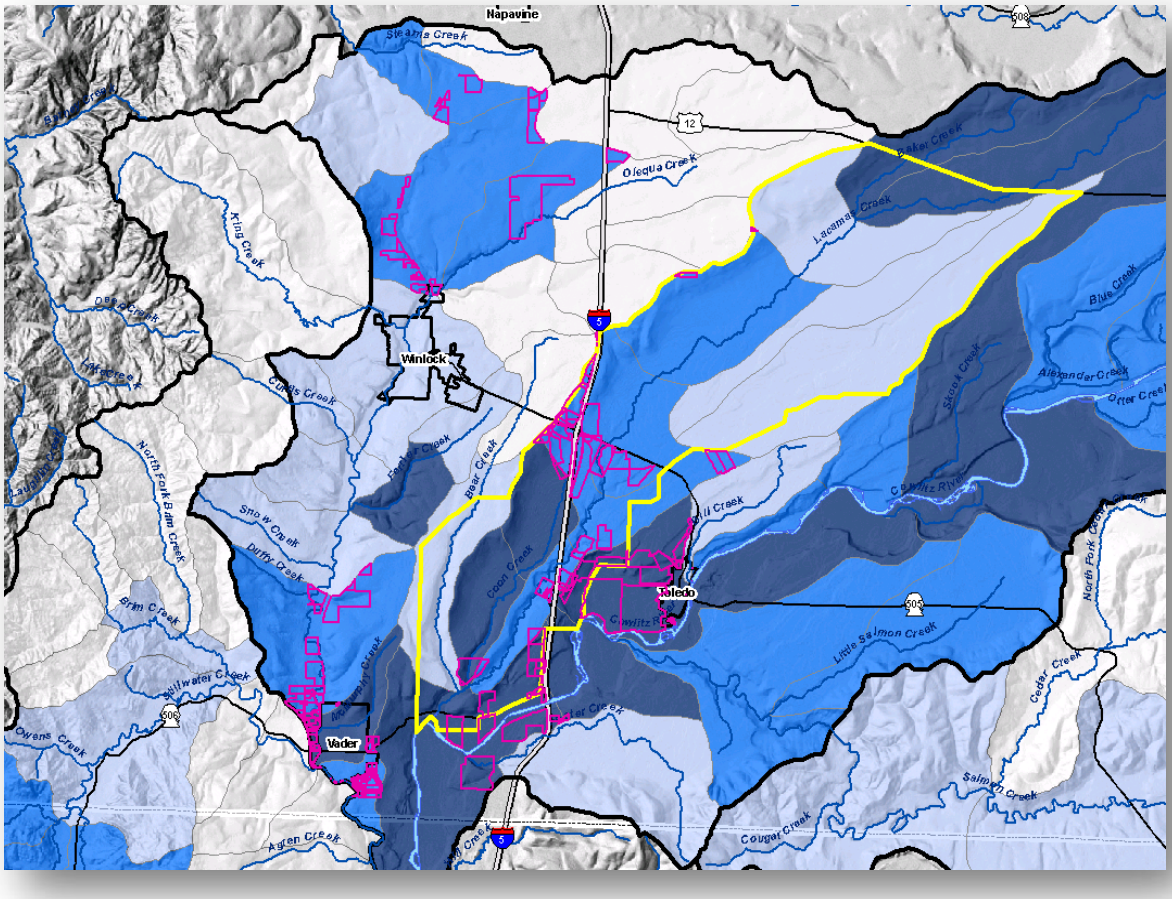

Figure 6. Development Conflicts – Areas to Avoid. Areas that have a high to high/moderate importance for water flow processes and also parcels identified as buildable are depicted on this map. Red outlined areas indicate parcels suitable for development. Yellow outline area is the Lacamas Creek fish and wildlife overlay; this area has a low suitability for development.

Restoration and protection priorities

The synthesis of the important areas with the impairment maps provides information on the best locations for protection and restoration in south Lewis County. Figure 7 provides the results of this synthesis and Appendix C and Figure C-6 presents the details on the analysis of important and impaired areas.

The Cowlitz floodplain and the areas immediately above it include large areas ranked high priority for protection and restoration. This includes the Cowlitz River, Otter, Lacamas, lower Salmon, Mill, and Blue Creeks. In general, the mountainous watersheds and the upper terrace (northwest portion of watershed) generally ranked lower in restoration and protection priority. However, the Becker and Campbell Creek watersheds (southwestern corner of analysis area) and upper Mill Creek (northeast portion) ranked high for both protection and restoration.

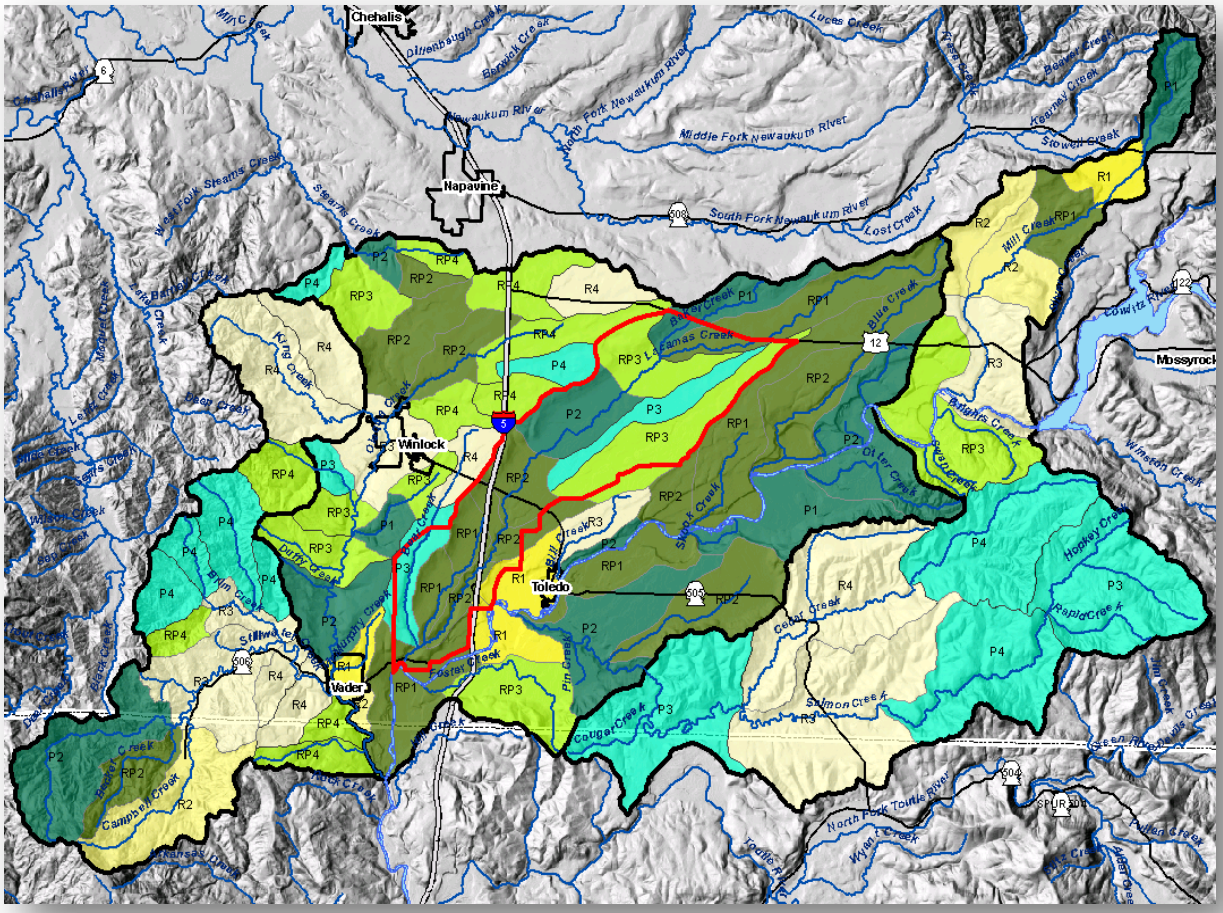

Figure 7. Ranking of Areas for Protection and Restoration for Water Flow Processes. Areas in "dark green" are suitable for protection; areas in "yellow" are suitable for restoration. Lighter greens represent different combinations of restoration and protection. P1 to P4 indicate first through fourth protection priorities. RP1 to RP4 indicate first through fourth restoration/protection priorities; and R1 through R4 represents first through fourth restoration priorities. The "red" outline identifies the Lacamas Creek Fish and Wildlife Conservation overlay.

Winlock

The areas most suitable for future development are located to the east of Winlock in sub-units 16, 23, and 56 (See Figure 8 for sub-basin numbers). These sub-units are of lower importance due to reduced areas of higher permeability and surface storage. Areas suitable for restoration may be located north of Winlock in the sub-units comprising the Olequa River. These areas are rated higher for importance due to the presence of large areas of surface storage (floodplains and wetlands) and have been impaired by clearing of riparian cover and draining of wetlands. Within the City of Winlock existing development has significantly impaired most water flow processes. Therefore, continued development (infill) with measures to encourage protection and restoration of existing streams and wetlands is recommended.

Vader

The areas most suitable for development in Vader are located to the west and southwest of town in sub-units 36 and 37. These sub-units are of lower importance due to reduced areas of higher permeability and surface storage. Areas for protection and restoration are located along McMurphy Creek located to the northeast of town (sub-unit 8) and to the south (sub-unit 7), and east (sub-unit 68). Within the City of Vader existing development has significantly impaired most water flow processes. Therefore, continued development (infill) with measures to encourage protection and restoration of existing streams and wetlands is recommended.

Toledo

On a relative basis sub-unit 62 (Bill Creek watershed) is the most suitable area for future development for the City of Toledo. This sub-unit has a moderate rating for importance due to the presence of wetlands (contribute to surface storage), but has reduced permeability. Again, water flow processes are significantly impaired within the existing city so infill is appropriate. Key areas for restoration, within the historic and existing floodplain of the Cowlitz River, are located immediately west and south of the city.

WRIA 25 and 26 Basin Plan Recommendations

The Basin Plan includes the lower Cowlitz, upper Cowlitz, Cispus, Tilton, Toutle, and Coweeman watersheds. One or more populations of tule fall Chinook, bright fall Chinook, spring Chinook, chum, winter steelhead, summer steelhead, and coho are present and many need to be restored to high levels of viability to meet regional recovery objectives. The Basin Plan for WRIA's 25 and 26 set forth the following priority actions:

- Restoring access above dams in the upper portion of the basin,
- Protecting intact forests in headwaters,
- **Managing forest land to protect and restore watershed processes**, consistent with existing and future land use regulations and authorities,
- **Managing growth and development to protect watershed processes** and habitat conditions,
- Restoring passage at culverts and other artificial barriers,
- Restoring lowland floodplain function, riparian conditions, and stream habitat diversity,
- Addressing immediate risks with short term habitat fixes,
- Aligning hatchery priorities with conservation objectives, and
- Reducing out-of-sub-basin impacts.

Recommendations

In order to adequately implement the results of this characterization, development standards and regulations must be drafted that allow for mitigation and restoration offsite. This is necessary, since many of the highest priority opportunities for protection and restoration are located outside of areas that will experience the highest degree of development. If "credits" for mitigation can be transferred to sub-basins that will provide for a greater degree of process restoration, this will be a greater benefit to the ecosystem relative to onsite mitigation. It is suggested that the County consider the following:

1. Revising the Critical Areas Ordinance to include a policy allowing for the adoption of a watershed based subarea plan and its regulations. Model language for this, from the Whatcom County CAO, Title 16, section 16.16.260 E of the County code, is partially as follows:

   "A watershed-based management plan and/or an alternative mitigation plan for a major development, planned unit development or developer agreement shall be allowed to substitute for the standards and requirements of this chapter when approved by the designated decision maker as per County Code. "

2. The CAO would also contain the following provisions:
   a. Allow for the transfer of development credits from areas that have high importance, habitat significance (i.e. Lacamas Creek Wildlife overlay) or development conflicts, to areas shown as having suitability for development (Figures 3 through 5).
   b. Allow for the clustering of residential development on areas of higher importance outside of urban rural boundaries. This could involve the clustering of residences on 0.5 acre or less parcels with a conservation easement placed on the balance of the existing subdivided parcels that would have one residence each (e.g. Five 10 acre lots would have a conservation easement on 45 acres with 5 residences clustered on 5 acres)..
   c. Application of green infrastructure measures in the terrace areas to maintain infiltration processes.
3. To maximum extent feasible, implementation of the recommendations of the WRIA 25 and 26 Basin Plan including:
   a. Protection of headwater forests and wetlands, especially for Olequa Creek
   b. Restoring watershed processes in managed forest lands.
4. Maintaining and restoring habitat in the Lacamas Creek Fish and Wildlife overlay area (Figure 3-5) consistent with the recommendations of the WDFW characterization report.

Table of Results for Water Processes and Wildlife Characterization

Table 1 summarizes the results of the characterization for water flow processes and wildlife. The table lists the sub-basin number which can be located on Figure 8 and the sub-basin name based on the stream system present. Both the importance score and corresponding "high, medium or low" rating is provided. The last column presents the protection and restoration rating based on the synthesis of the results of the importance and impairment maps. Appendix C outlines the method for this synthesis. The definitions for the acronyms used in the column are as follows: P1 through P4 is protection priority 1 through 4; RP1 through RP4 is a combination of restoration/protection priority 1 through 4; and R1 through R4 is restoration priority 1 through 4.

Table 1 –Summary Results for Characterization of Water Flow Process and Wildlife Habitat

Basin Number	Name of Sub-basin	Landscape unit	Importance Score 0-1	Importance Rating H,M,L	Impaired Score 0-1	Impaired Rating H,M,L	Protection Restoration Rating	Wildlife Habitat Rating
1	BUNKER CREEK	Terrace	0.67	MH	0.50	M	RP2	L
2	BUNKER CREEK	Terrace	0.03	L	0.00	L	P4	H
3	BUNKER CREEK	Terrace	0.49	M	0.36	M	RP3	M
4	BUNKER CREEK	Terrace	0.24	L	0.35	M	RP4	M
5	BUNKER CREEK	Terrace	0.64	MH	0.14	L	P2	MH
6	OLEQUA	Terrace	0.16	L	0.43	M	RP4	MH
7	OLEQUA	Terrace	0.60	MH	1.00	H	R2	L
8	OLEQUA	Terrace	0.91	H	0.77	H	R1	L
9	OLEQUA	Terrace	0.63	MH	0.21	L	P2	MH
10	OLEQUA	Mtn	0.07	L	0.51	MH	R4	M
11	OLEQUA	Mtn	0.19	L	0.52	MH	R4	M
12	OLEQUA	Mtn	0.00	L	0.49	M	RP4	MH
13	OLEQUA	Terrace	0.29	M	0.23	L	P3	M
14	OLEQUA	Terrace	0.47	M	0.30	M	RP3	M
15	OLEQUA	Terrace	0.44	M	0.35	M	RP3	M
16	OLEQUA	Terrace	0.29	M	0.43	M	RP3	M
17	OLEQUA	Terrace	0.86	H	0.21	L	P1	M
18	OLEQUA	Terrace	0.41	M	0.76	H	R3	L
19	OLEQUA	Terrace	0.00	L	0.54	MH	R4	M
20	OLEQUA	Terrace	0.19	L	0.40	M	RP4	M
21	OLEQUA	Terrace	0.56	MH	0.36	M	RP2	M
22	OLEQUA	Terrace	0.19	L	0.50	M	RP4	M
23	OLEQUA	Terrace	0.16	L	0.44	M	RP4	M
24	OLEQUA	Terrace	0.59	MH	0.36	M	RP2	M
25	OLEQUA	Terrace	0.09	L	0.17	L	P4	MH
26	STILLWATER	Mtn	0.57	MH	0.76	H	R2	MH
27	STILLWATER	Mtn	0.21	L	0.07	L	P4	H
28	STILLWATER	Mtn	0.05	L	0.15	L	P4	MH

Basin Number	Name of Sub-basin	Landscape unit	Importance Score 0-1	Importance Rating H,M,L	Impaired Score 0-1	Impaired Rating H,M,L	Protection Restoration Rating	Wildlife Habitat Rating
29	STILLWATER	Mtn	0.14	L	0.32	M	RP4	MH
30	STILLWATER	Mtn	0.31	M	0.72	MH	R3	M
31	STILLWATER	Mtn	0.08	L	0.16	L	P4	MH
32	STILLWATER	Mtn	0.16	L	0.25	L	P4	MH
34	STILLWATER	Mtn	0.10	L	0.42	M	RP4	MH
35	STILLWATER	Mtn	0.05	L	0.47	M	RP4	MH
36	STILLWATER	Mtn	0.23	L	0.52	MH	R4	MH
37	STILLWATER	Mtn	0.17	L	0.51	MH	R4	MH
38	STILLWATER	Mtn	0.31	M	0.56	MH	R3	M
39	STILLWATER	Mtn	0.60	MH	0.24	L	P2	MH
40	STILLWATER	Mtn	0.57	MH	0.40	M	RP2	MH
41	MILL CREEK	Mtn	0.48	M	0.47	M	RP3	MH
42	MILL CREEK	Mtn	0.86	H	0.12	L	P1	MH
43	MILL CREEK	Mtn	1.00	H	0.76	H	R1	MH
44	MILL CREEK	Mtn	0.77	H	0.34	M	RP1	MH
45	MILL CREEK	Mtn	0.60	MH	0.54	MH	R2	H
46	MILL CREEK	Mtn	0.62	MH	0.52	MH	R2	MH
47	MILL CREEK	Mtn	0.42	M	1.00	H	R3	MH
48	MILL CREEK	Terrace	0.93	H	0.14	L	P1	H
49	MILL CREEK	Terrace	0.64	MH	0.17	L	P2	H
50	LACAMAS	Terrace	0.80	H	0.33	M	RP1	MH
51	LACAMAS	Terrace	0.47	M	0.46	M	RP3	MH
52	LACAMAS	Terrace	0.99	H	0.20	L	P1	MH
53	LACAMAS	Terrace	0.76	H	0.35	M	RP1	M
54	LACAMAS	Terrace	0.36	M	0.26	M	RP3	MH
55	LACAMAS	Terrace	0.73	MH	0.30	M	RP2	MH
56	LACAMAS	Terrace	0.71	MH	0.24	L	P2	MH
57	LACAMAS	Terrace	0.24	L	0.52	MH	R4	M
58	LACAMAS	Terrace	0.44	M	0.13	L	P3	MH
59	LACAMAS	Terrace	0.36	M	0.10	L	P3	H
60	LACAMAS	Terrace	0.30	M	0.36	M	RP3	MH

Basin Number	Name of Sub-basin	Landscape unit	Importance Score 0-1	Importance Rating H,M,L	Impaired Score 0-1	Impaired Rating H,M,L	Protection Restoration Rating	Wildlife Habitat Rating
61	LACAMAS	Terrace	0.71	MH	0.43	M	RP2	MH
62	LACAMAS	Terrace	0.41	M	0.83	H	R3	M
63	LACAMAS	Terrace	0.63	MH	0.25	L	P2	H
64	LACAMAS	Terrace	0.64	MH	0.38	M	RP2	M
65	LACAMAS	Terrace	0.99	H	0.32	M	RP1	MH
66	LACAMAS	Terrace	0.91	H	0.31	M	RP1	MH
67	LACAMAS	Terrace	0.93	H	0.79	H	R1	M
68	LACAMAS	Terrace	0.91	H	0.45	M	RP1	M
69	CEDAR CREEK	Mtn	0.24	L	0.62	MH	R4	H
70	CEDAR CREEK	Mtn	0.15	L	0.00	L	P4	H
71	SALMON CREEK	Terrace	0.71	MH	0.25	L	P2	MH
72	SALMON CREEK	Mtn	0.28	M	0.16	L	P3	MH
73	SALMON CREEK	Mtn	0.08	L	0.06	L	P4	H
74	SALMON CREEK	Mtn	0.28	M	0.59	MH	R3	H
75	SALMON CREEK	Mtn	0.35	M	0.22	L	P3	H
76	SALMON CREEK	Terrace	0.96	H	0.33	M	RP1	MH
77	SALMON CREEK	Terrace	0.57	MH	0.36	M	RP2	MH
78	LACAMAS	Terrace	0.54	MH	0.35	M	RP2	M
79	LACAMAS	Terrace	0.51	MH	0.46	M	RP2	MH
80	LACAMAS	Terrace	1.00	H	0.63	MH	R1	M

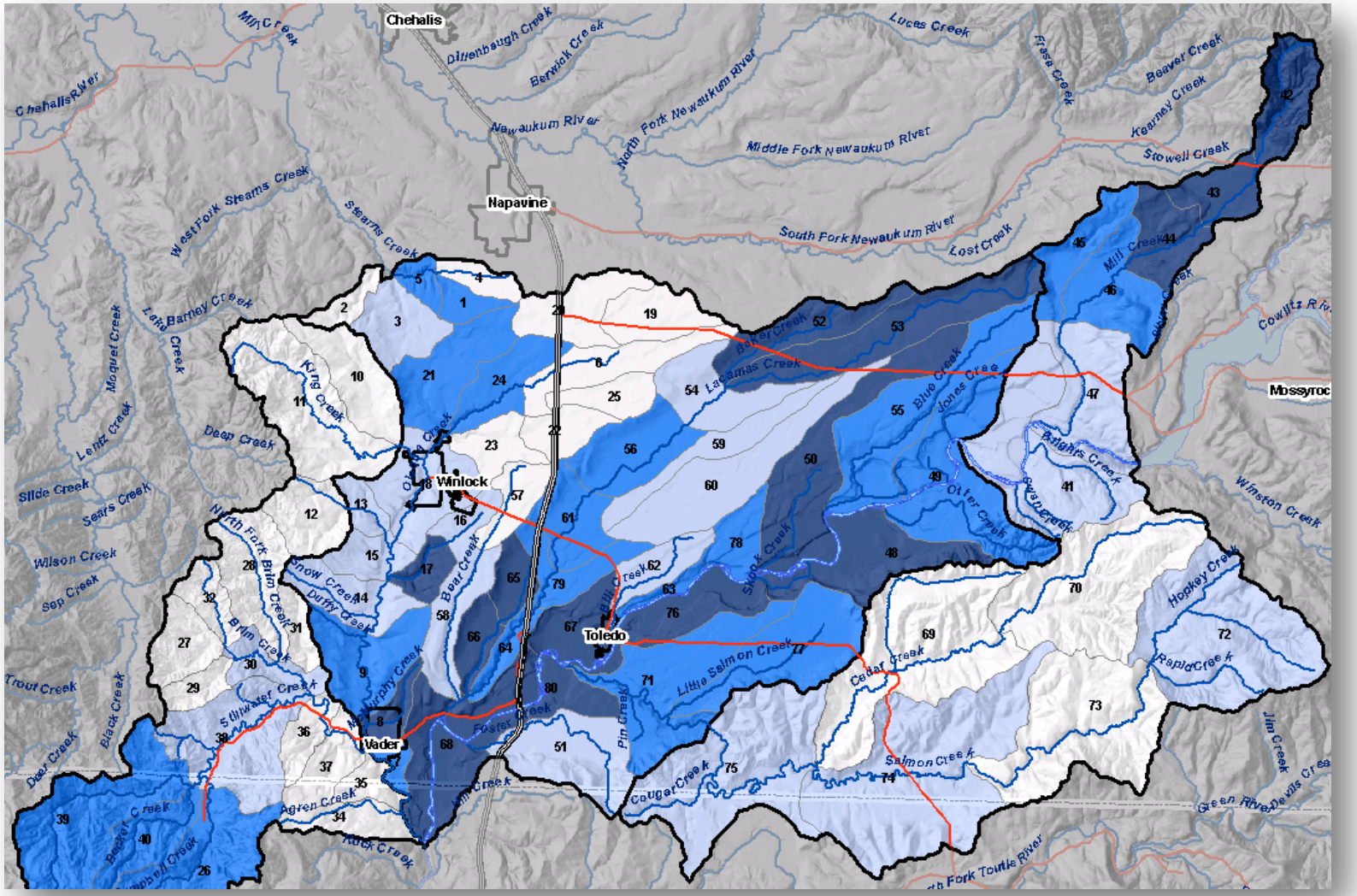

Figure 8. Importance Map with Sub-basin Numbers. To be used in conjunction with Table 1

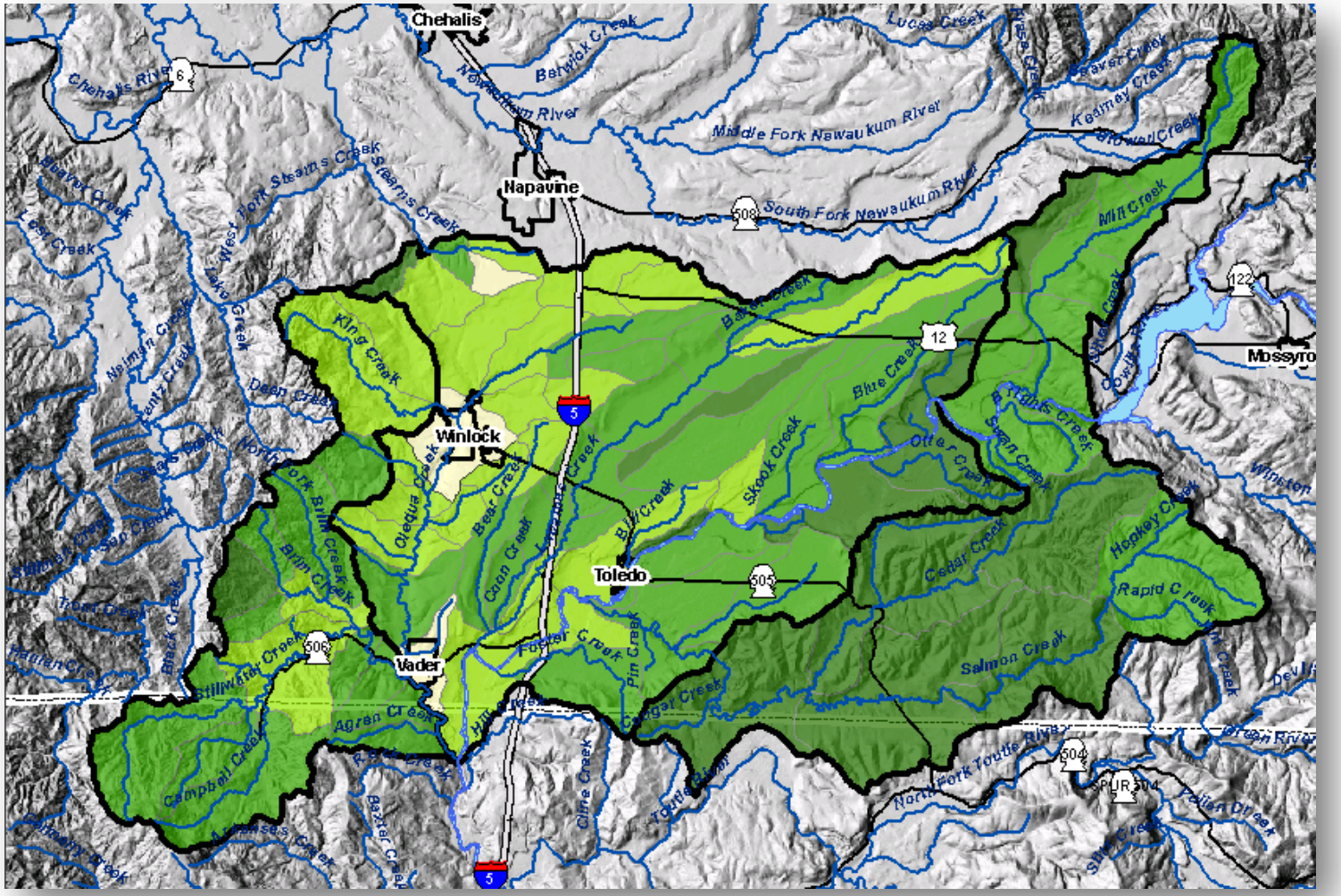

Figure 9. Summary of Results for Wildlife Characterization. Darker green areas represent higher importance for wildlife habitat; lighter color areas have lower importance. See Appendix D for more detailed wildlife characterization maps.

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Appendix A. Methods for Characterization

Methods

The approach used for this project is described in Ecology publication #05-06-027, "Protecting Aquatic Ecosystems by Understanding Watershed Processes: A Guide for Planners." This document provides guidance on how to conduct a coarse-scale characterization for multiple watershed processes. Appendix B and C of this publication also present the planning framework and models used to score the hydrologic process.

The appendices provide tables describing the individual components of each process, as well as human activities that are impairments to the process. Three processes, water, nitrogen, and pathogens, also have numeric models that can identify the areas in a watershed that are more important to maintaining that process, and areas where that process is most impaired. The equations in these models use the environmental characteristics described in the tables as variables that establish the relative level of importance and impairment.

Variables receive maximum values of 1, 2, or 3, representing low, medium, or high importance of a characteristic or impairment of a characteristic. The models reflect that a higher total score represents a sub-unit of greater importance for supporting a process in a watershed, or one with a higher degree of impairment to that process.

In general, scoring is normalized to conditions within in a watershed or basin. However, indicators of importance or impairment are based on peer-reviewed research suggesting regional thresholds for certain process components (e.g., minimum wetland area and relationship to affecting surface water flows). Thus, the models provide a *comparison* of the *relative level of importance and impairment* of process components (see Steps 3 and 4 of Ecology publication #05-06-027). The scores do not represent a specific rate (e.g., rate of removal of sediment or nitrogen) or specific level of impairment of a process, and cannot be compared to scores outside of the analysis area. We do not have enough information at this time to calibrate models to conditions throughout the state and establish relative importance of processes and impairments among different watersheds.

Appendix C of this document presents a series of maps that display the results of the individual models applied to Lewis County. See the appendices in Ecology publication #05-06-027 for descriptions of the scoring methods.

Landscape Units (LU)

This characterization uses a landscape classification approach based on the "hydrologic-landscapes" described by Winter (2001) and the hydrogeologic work of Bedford (1999 & 1988). This landscape approach considers regional climate, surficial geology, topography (landform), groundwater and surface flow patterns and morphology in relationship to aquatic resources. This report uses precipitation type, landform, geology, and surface water/groundwater patterns to develop landscape units (LU).

These landscape units were divided so that watersheds with significantly different patterns of precipitation and geomorphology were not compared to one another during the scoring process. For example, because the watersheds within the mountainous portions of the study area have higher precipitation patterns including rain-on-snow zones, they will score higher than the rain dominated Terrace units if analyzed together. The Terrace units, however, support important aquatic ecosystems and should be characterized separately from the mountainous watersheds so that characterization scores are not artificially suppressed by the scores for the higher precipitation levels in the study area.

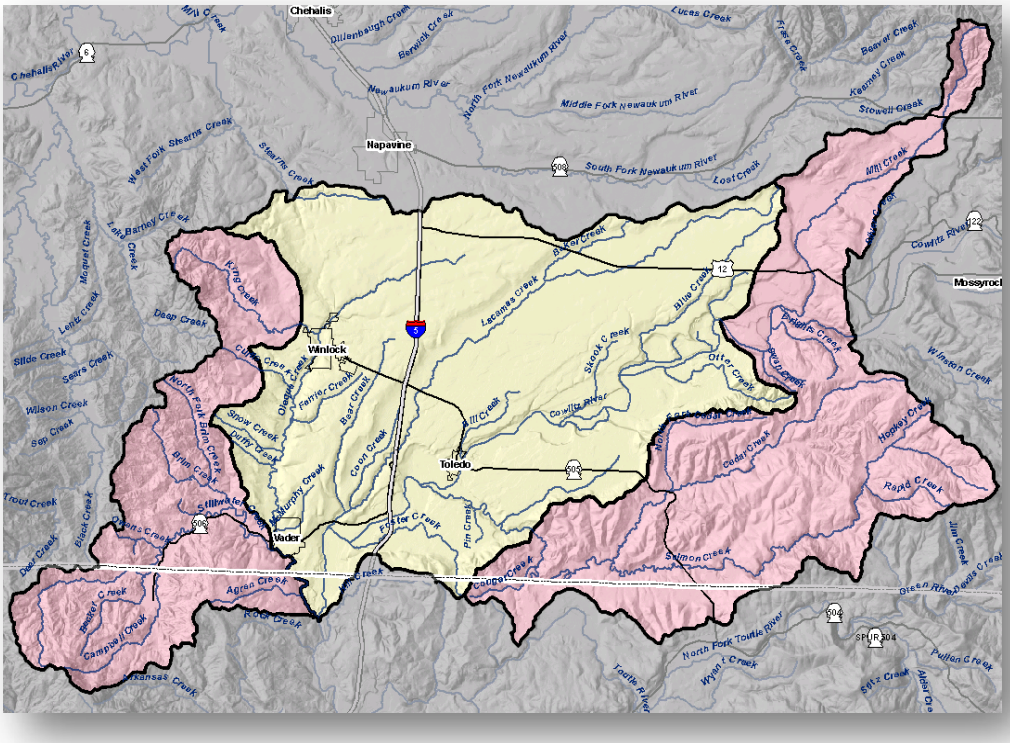

Figure A-1. Landscape Units (LU). The pink unit is the Rain-on-snow and rain-dominated Mountainous unit; yellow unit is the Rain-dominated Terrace unit.

There are two landscape units (see Figure A-1) used in the South Lewis County characterization. The western-most and southeastern areas are characterized by rain-on-snow and rain dominated precipitation, generally shallow groundwater flow patterns, consolidated bedrock, and steep topography. This is called the "Rain-on-snow and rain-dominated" Mountainous unit.

The second unit includes the lowland terraces above the Cowlitz and Olequa River systems. This unit is dominated by rain, and has a westward to southeastern trending groundwater flow pattern towards the Cowlitz River.

The geology, landform, and groundwater flow patterns of these units are discussed in further detail below.

Geology and Landforms

The description of the geology of the study area is based on the work of Weigle and Foxworthy (1962). The study area is located within the Puget Trough which extends from Oregon northward to British Columbia. It is underlain by bedrock consisting of lava flows and pyroclastic and marine sedimentary rocks. These older rocks are overlain by relatively deep deposits of alluvium and drift originating from alpine glaciers in the adjacent Cascades Mountains. These younger deposits are located on terraces adjacent to the Cowlitz River and Olequa River. The benches and terraces in the study area were formed during the Pleistocene by glacially fed streams and rivers discharging across a basin filled with silt, sand and gravel.

Figure A-2 shows the major landforms for the study area. They consist of foothills or mountainous areas, upland plains, intermediate terraces, and floodplains. The upland terraces or plains are the oldest and have experienced the greatest degree of erosion. They have rolling hills and deep gullies (i.e. Winlock, Vader) and are represented by the Jackson and Grand Prairies.

The intermediate plains have been subject to less erosion and are relatively flat as a result. This includes the Lacamas Creek terrace, which is the largest intermediate terrace in Lewis County. It is approximately 150 feet lower than the Jackson Prairie and 200 to 450 higher than the floodplain of the Cowlitz.

The Cowlitz floodplain and associated low elevation terraces are broad, extending to 2 miles width in places.

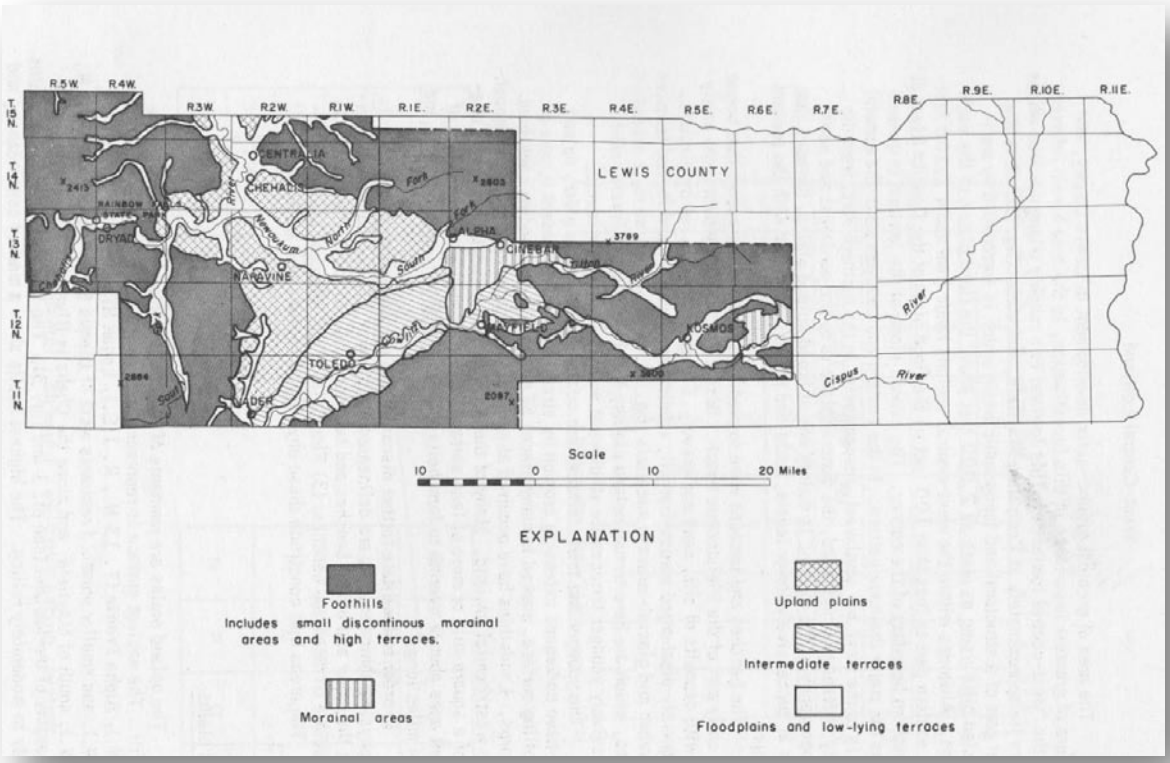

Figure A-2. Landforms for South Lewis County. Major landforms consist of upland plains, intermediate terraces and foothills or mountainous areas. Source: Water Supply Bulletin No. 17.

Groundwater Flow Patterns

Figure A-3 presents the generalized geology for the study area on a cross-section running south from Napaville to just east of Toledo. A general pattern of intermediate groundwater flow can be determined using this map. The pink "Tu" unit is bedrock and acts as a controlling surface in directing groundwater flow generally towards the Cowlitz River. The overlying deposits (Qlh, Qlc, Qnt, Qlp, Qt) have varying degrees of permeability and water yield, with the oldest most weathered deposits (Qlh – Logan Hill Formation) having lower permeability and water yield and younger deposits such as the Qlc having higher permeability and yields.

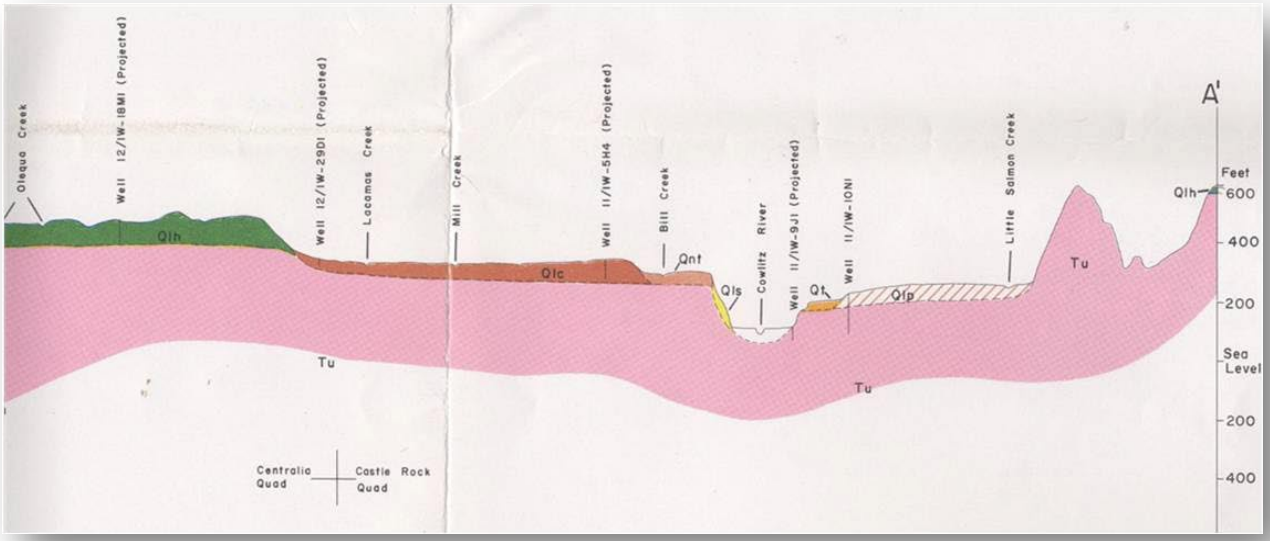

Figure A-3. Generalized depiction of geology for south Lewis County. Cross-section running south from Napaville to just east of Toledo. Pink "Tu" units represents bedrock which generally controls flow of groundwater towards the Cowlitz River. Qlh represents the Logan Hill formations which is the most weathered of the terrace formations. Qlc represents the Logan Hill formation which is less weathered and more permeable; this area would be a discharge zone for the Qlc formation above it. Qnt is the Newaukum formation and has high permeability and yields large quantities of water. Qlp is the Layton Prairie unit and yields high quantities of groundwater. Source: Water Supply Bulletin No. 17.

Appendix B. Framework for Planning

Framework for planning

Successful watershed planning uses larger scale information (i.e. the characterization) to help identify planning solutions at smaller scales. To accomplish this, a watershed based planning framework, as presented below, should be applied. A more detailed discussion of this planning framework is presented in "Guidance for Protecting and Managing Wetlands in Western Washington", Volume 2, Chapters 4 and 5 (Granger et al. 2005).

The methods described in this document for mapping important areas and relative impairments to watershed processes address the first box of the diagram above, "Characterize Watershed Processes." Planners can then use this information to develop preliminary solutions (box 2, "Prescribe Solutions") including alternative scenarios for development/ management. Examples include:

- Selecting the appropriate types and intensity of development for different locations
- Changing zoning to better protect the ecological services provided by the environment
- Identifying the best locations for mitigation
- Identifying the types of mitigation needed in different areas
- Locating the best areas for cost-effective restoration.

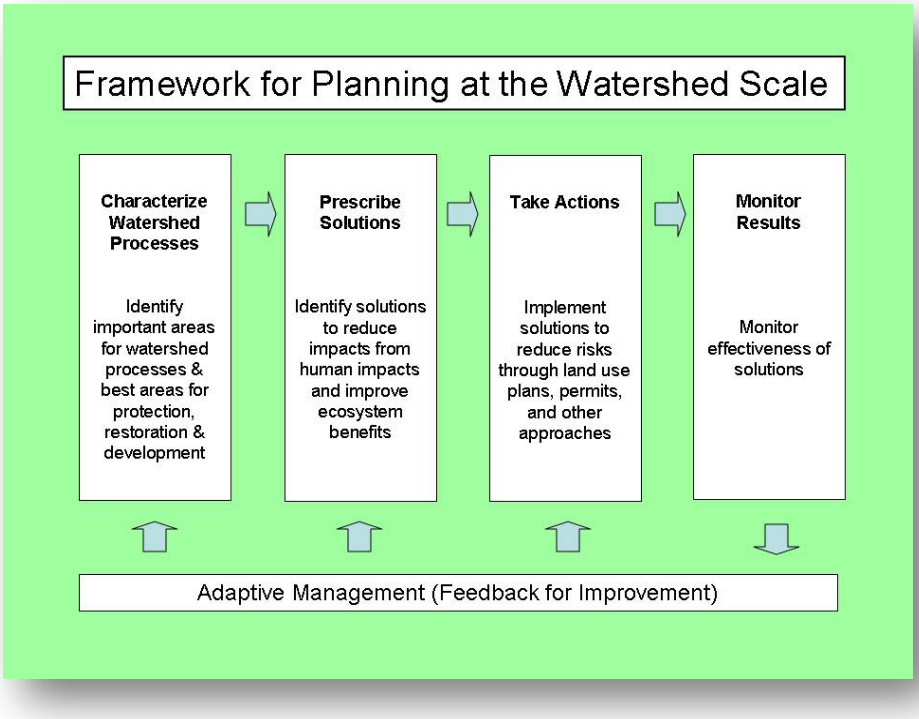

Figure B-1 – Framework for Planning at the Watershed Scale. The four main steps for developing a watershed based plan.

When scenarios for future development and management are analyzed, locally reviewed, and accepted, the solutions can be incorporated in Shoreline Master Program and/or Comprehensive Plan updates and implemented through the regulatory process . The final, and most important step in the framework, is monitoring the results of the adopted plan. This determines if the provisions of the plan are effectively protecting and/or restoring aquatic ecosystems. Feedback from this monitoring effort can be used to modify or "adapt" the plan to correct those aspects that are not meeting the objectives of protection and restoration.

Examples of Use of a Planning Framework by Other Jurisdictions

Whatcom, King, and Jefferson counties are presently using a framework for planning at the watershed scale as part of their Shoreline Master Program (SMP) updates. These jurisdictions are using variations of earlier versions of the characterization models outlined in Ecology Publication 05-06-027. The Whatcom County Council adopted their draft SMP on February 27, 2007. The draft SMP characterization and restoration reports (Appendix C, Volumes I and II) are available at the following site:

http://www.co.whatcom.wa.us/pds/shorelines_critical_areas/workproducts.jsp

Whatcom County's characterization work provided information necessary to: 1) select appropriate environment designations and development standards for shoreline areas and 2) develop watershed-based restoration and protection recommendations for shoreline resources. Figure B-2 displays the important areas identified for the hydrology process in Whatcom County at the watershed scale. Using this information, as well as a characterization of the level of impairment, the county developed tables providing recommendations at a reach scale for protection and restoration measures and environment designations (Figure B-3).

A draft watershed management plan was developed by Whatcom County in 2007 for the Birch Bay watershed. Using a watershed based characterization of both hydrologic processes and wildlife, the plan identified protection, restoration and development management zones (Figure B-4).

Additionally, specific measures for restoration of processes were proposed for each sub-unit within the study area. The County is in the process of preparing regulatory and non-regulatory measures to implement the management plan. The draft management plan is available at the following site:

http://www.co.whatcom.wa.us/pds/shorelines_critical_areas/pdf/CompleteBBCharacter_PublicDraft.pdf

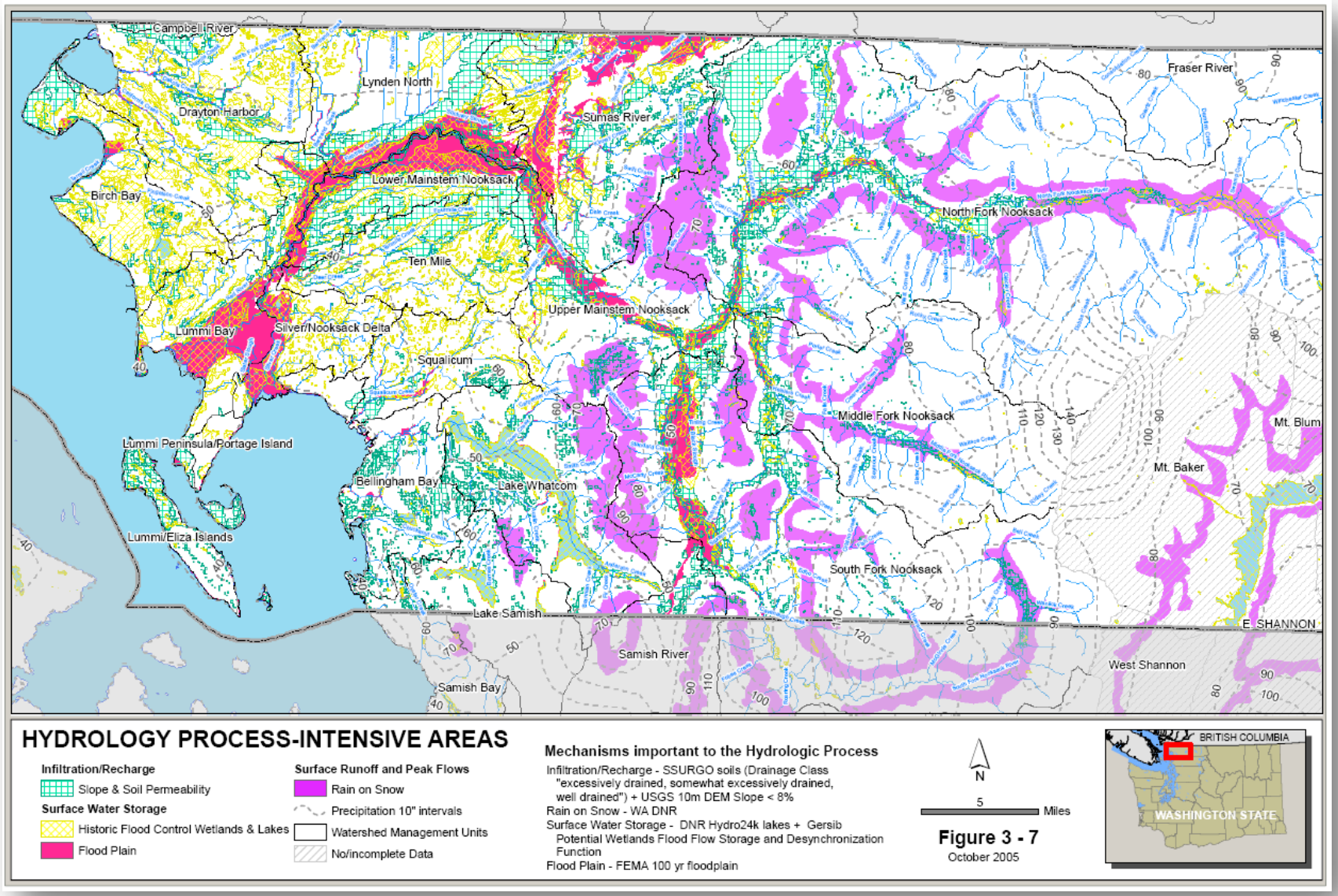

Figure B-2. Example of characterization map for water process. (Whatcom County). This map was developed using methods described in the Department of Ecology publication # 05-06-027 (Protecting Aquatic Ecosystems). This map, along with maps for four other watershed processes, was used to develop SMP protection and restoration measures (Figure B-3).

ble 7-1. Summary of Process Intensity and Alterations by Drainage Area, Upper Mainstem Nooksack WMU

		Process Intensity*																					
Process		Hydrology								Sediment						Water Quality				LWD		Heat/Light	
Mechanism		Infiltration & Recharge		Surface Water Storage		Snowmelt and Runoff		Ground-water		Mass Wasting		Surface Erosion		Storage		Inputs		Storage		LWDRP		Canopy Cover	
Intensity		Process	Alteration	Process	Alteration	Process	Alteration	Process	Alteration	Process	Alteration	Process	Alteration	Process	Alteration	Process	Alteration	Process	Alteration	Process	Alteration	Process	Alteration
1	Lower Nooksack Floodplain	↑	↓	↑	↓	↓	↓	↑	↔	↓	↓	↓	↔	↑	↓	↓	↔	↑	↓	↔	↑	↓	↑
2	Smith Creek	↓	↓	↓	↓	↑	↓	↓	↓	↓	↔	↓	↓	↓	↓	↓	↓	↓	↓	↑	↓	↑	↑
3	Lower Anderson Creek	↔	↓	↔	↑	↓	↓	↔	↔	↓	↓	↓	↓	↔	↑	↓	↔	↔	↑	↑	↔	↑	↔
4	Upper Anderson Creek	↓	↓	↓	↓	↑	↑	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↑	↓	↑	↔
5	Upper Nooksack Floodplain	↑	↔	↑	↔	↓	↓	↑	↔	↓	↓	↓	↔	↑	↔	↓	↔	↑	↔	↔	↑	↓	↑
6	Other Tributaries	↓	↓	↓	↓	↔	↔	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↑	↓	↑	↔

	Potential for Restoration and Protection
1	This portion of the Nooksack Mainstem has significant, intact riparian wetlands, but armoring and levees likely limit surface, hyporheic, and groundwater interactions between the river and its floodplain. Strategic levee setbacks accompanied by riparian restoration may help restore natural stream morphology and improve habitat.
2	Upper Smith Creek is relatively unimpaired by forest practices. Lower Smith Creek lies on the Nooksack floodplain, and has a hydrologic connection to the larger river system. Restoring /preserving connectivity in the lower drainage may improve functions in both the Nooksack and the creek.
3	Restoring lost wetlands and riparian areas in lower Anderson Creek has the potential to improve water quality, water quantity, and habitat complexity.
4	The upper Anderson Creek is relatively unimpaired by forest practices. Protection of rain-on-snow zones and landslide hazard areas is recommended to prevent increased disturbance regime.
5	Riparian restoration is the key component for re-establishing natural geomorphology. Such restoration will likely succeed only in the context of reduced sediment supply from upstream sources. The area in the vicinity of Smith Creek is highly altered and may provide significant opportunities for restoration projects.
6	These are typically short, steep tributaries upstream of the major tributaries. Opportunities for restoration may be more limited.

Red: High restoration potential: Moderate to high process intensity with high degree of alteration
Blue: Moderate restoration potential: -- Moderate to high process intensity with moderate degree of alteration; OR low process intensity with high degree of alteration
White: Low restoration potential: Low process intensity with low to moderate degree of alteration
Gold: High protection potential: Moderate to high process intensity with low degree of alteration

* Function responses to alteration of these processes tend to be less dependent on the level of process-intensity, which is historically low in Whatcom County. Therefore, the assessment of restoration potential is based primarily on the degree of alteration.

Reach	Existing SEDs	Recommended SEDs		Comment
		Left Bank	Right Bank	
Reach 16	Conservancy	Resource/ Conservancy	Conservancy	Rural near downstream end of Reach 16 near Everson, otherwise Conservancy designation will protect existing process-intensive areas
Reaches 17-19	Conservancy/ Tribal	Conservancy/ Tribal	Conservancy/Tribal	

Recommended SMP environment designations for upper mainstem Nooksack Water Management Unit based on characterization results. Includes the upper and lower Nooksack floodplains listed in table 7-1 above. The characterization suggested important areas for several watershed processes including removal of nitrogen (water quality), surface water and sediment storage and recharge

Figure B-3. Protection and Restoration Measures. The upper table was used by Whatcom County to summarize watershed characterization results for the upper mainstem Nooksack Water Management Unit. Components for each process are evaluated based on intensity/importance of the processes, the degree of impairment, and the potential for protection and restoration. This table was then used to help determine appropriate land-use designation (lower table) for shoreline reaches and specific restoration measures in a separate restoration plan.

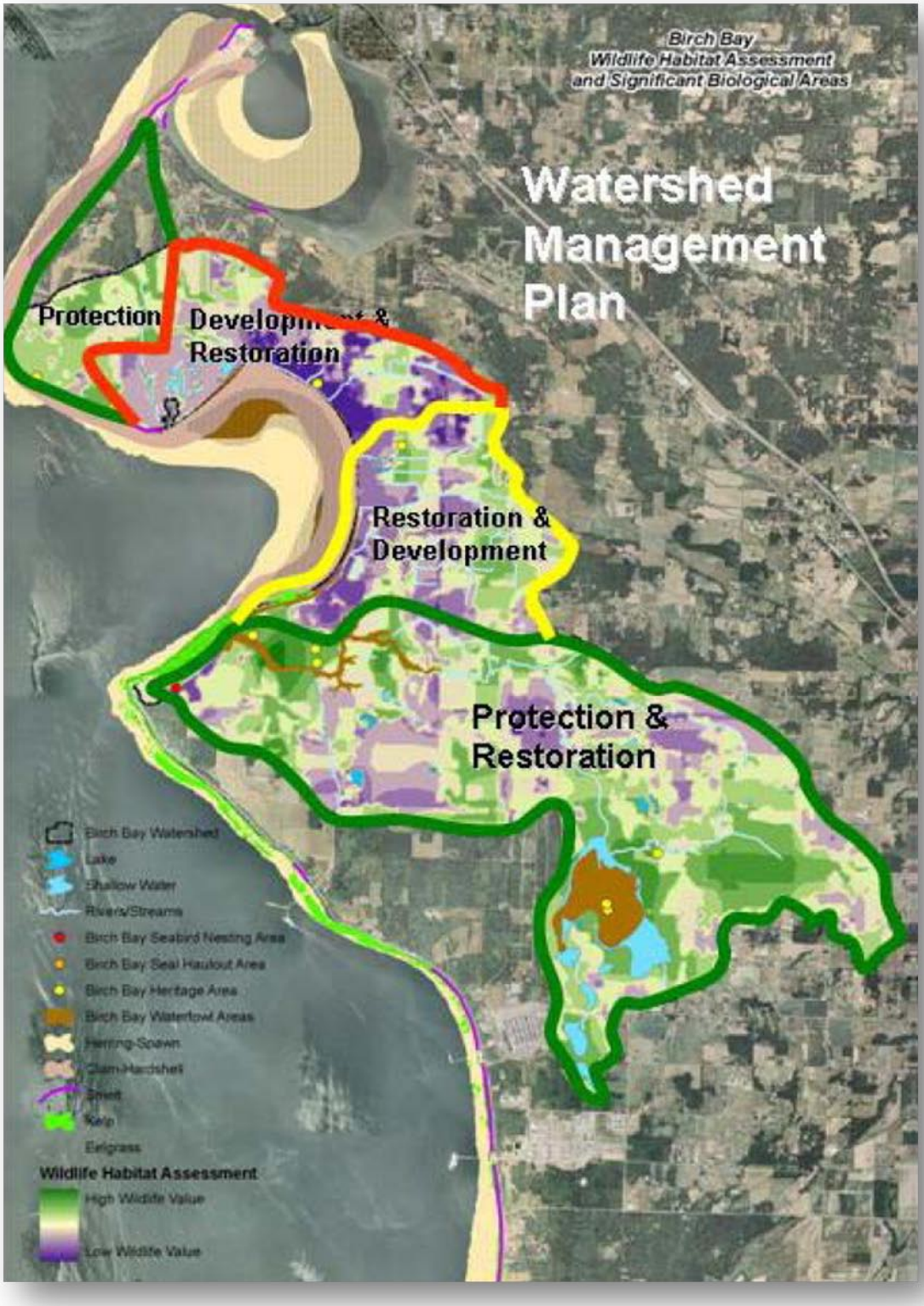

Figure B-4. Draft Management Plan for Birch Bay, Whatcom County.

Appendix C. Detailed Results of Characterization

C-1.0 Areas of Importance to the Hydrologic Process

Figures C-1 and C-2 depict the final score for areas of high, moderately high, moderate, and low importance to the hydrologic process. This section will discuss the basis for the level of importance for subunits for each landscape unit (Figure A-1) in the analysis area.

Terrace Landscape Unit

The Terrace Landscape unit is located in the central portion of the analysis area, extending northeast, and includes the towns of Winlock, Vader, and Toledo (Figure C-1). It steps down in elevation through a series of three terraces towards the alluvial floodplain of the Cowlitz River.

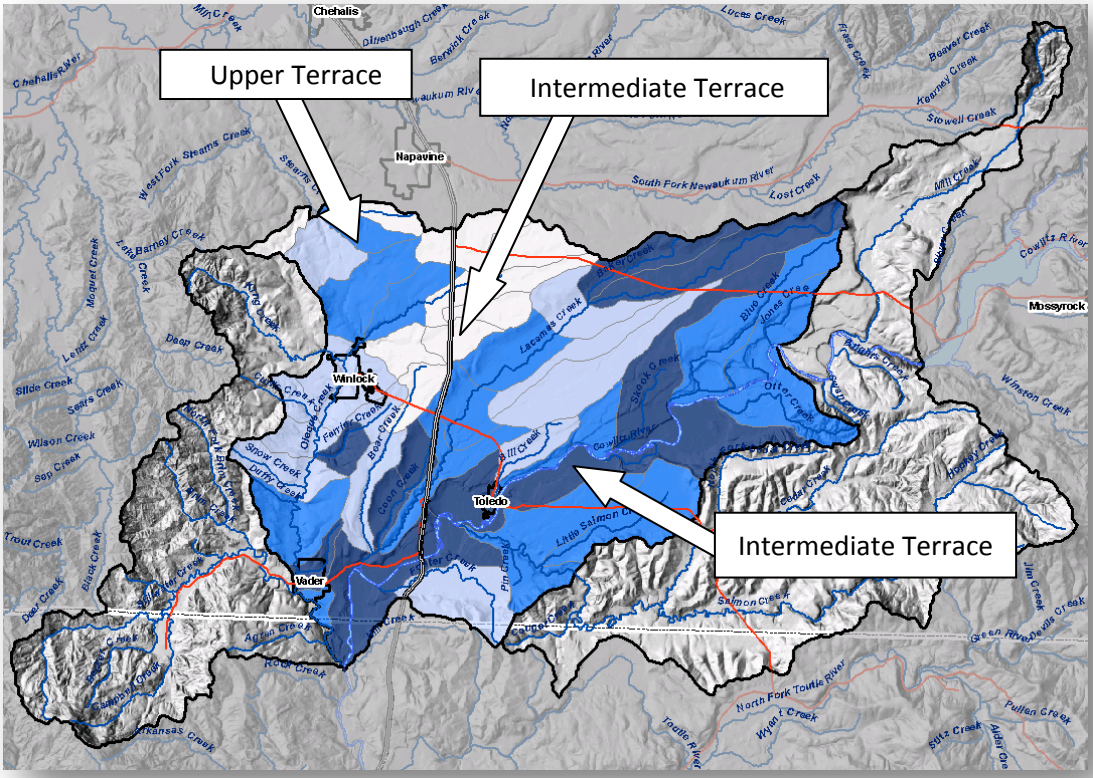

Figure C-1. Rating of Importance for the Hydrologic Process in the Terrace. Areas in "dark blue" have the highest importance; areas in "blue " have moderate-high importance; areas in "light blue" have moderate importance; and areas in "white", lower importance. (HU_M1)

The upper terrace is primarily of moderate importance to the hydrologic process. It is highly weathered and tends to have deposits of lower permeability, lower infiltration rates, and lower precipitation levels (Figure C-7), especially in its northeast portion. The presence of a low gradient, broader floodplain and weathering, in the northeast portion of this terrace at the headwaters of Olequa Creek, has lead to the formation of wetlands (Figure C-11). These characteristics provide considerable surface storage and a moderate level of infiltration. Here, groundwater moves towards the Olequa River and also southeast towards the intermediate terrace (i.e. Lacamas Creek). Subunits 3, 5, 6, 20, 21, 22, and 24 received a rating of moderate importance based on these characteristics.

As you move south of Winlock, downstream on the Olequa River toward Vader, the subunits increase to moderately high and high importance. This southern portion of the upper terrace has higher permeability (Figure C-9), higher rainfall (Figure C-7) and fewer wetlands (Figure C-11). This is an important area for infiltration and recharge. Subunits 7, 9, 17, and 8 received a rating of moderate-high to high based on these characteristics.

The intermediate terrace area is located north of the Cowlitz River and supports Lacamas, Bill, Bear, Blue, and Skook Creeks, and contains the town of Toledo. It is characterized primarily as moderately high and high for importance in Figure C-1. This terrace is an important area for discharge of groundwater originating from the upper terrace to the northwest. As a result of this discharge, large areas of hydric soil (Figure C-10) and wetlands (Figure C-11) dominate the Lacamas Creek watershed. The discharge also supports flows in Lacamas Creek. This area provides considerable area for surface storage (i.e. depressional wetlands) and has greater rainfall than the higher elevation terrace to the northwest. Deposits of higher permeability are present in the headwaters of Lacamas and Blue Creek. Recharged groundwater in this terrace moves towards and discharges in the lower elevation Cowlitz alluvial floodplain. Based on these characteristics, subunits 56 and 59 were ranked high in importance and the balance of subunits ranked moderate-high except for subunits 58 and 62 (i.e. moderate ranking for Bear and Bill Creeks).

The Cowlitz floodplain is comprised primarily of alluvial and outwash deposits (Figure C-8) and shows primarily as darker blue areas in Figure C-1. Because this floodplain is located below the intermediate terraces it is a significant area for groundwater discharge. The higher permeability deposits in the floodplain (Figure C-9) facilitate groundwater discharge and recharge. These characteristics result in the largest contiguous area ranked as high in importance (Subunits 48, 50, 63, 76, 80, 68) with the rest of the sub-units ranking moderate-high in importance.

Another intermediate terrace is located southeast of the Cowlitz River and it has considerable areas of higher permeability deposits (Figure C-9) and wetlands (Figure C-11). This terrace area provides both surface storage and recharge and supports groundwater discharge in the adjacent Cowlitz River floodplain. Additionally, there are large areas of groundwater discharge at the base of the mountainous unit where it intersects this intermediate terrace. This discharge has created a long continuous band of hydric soils (Figure C-10) and wetlands (Figure C-11). Based on these characteristics, these subunits were ranked of moderate to moderate-high importance (51, 71, and 48).

Mountainous Landscape Unit

The rain dominated mountainous unit is comprised primarily of bedrock (Figure C-8) and has markedly higher precipitation levels than that of the Terrace Unit. Areas of higher permeability

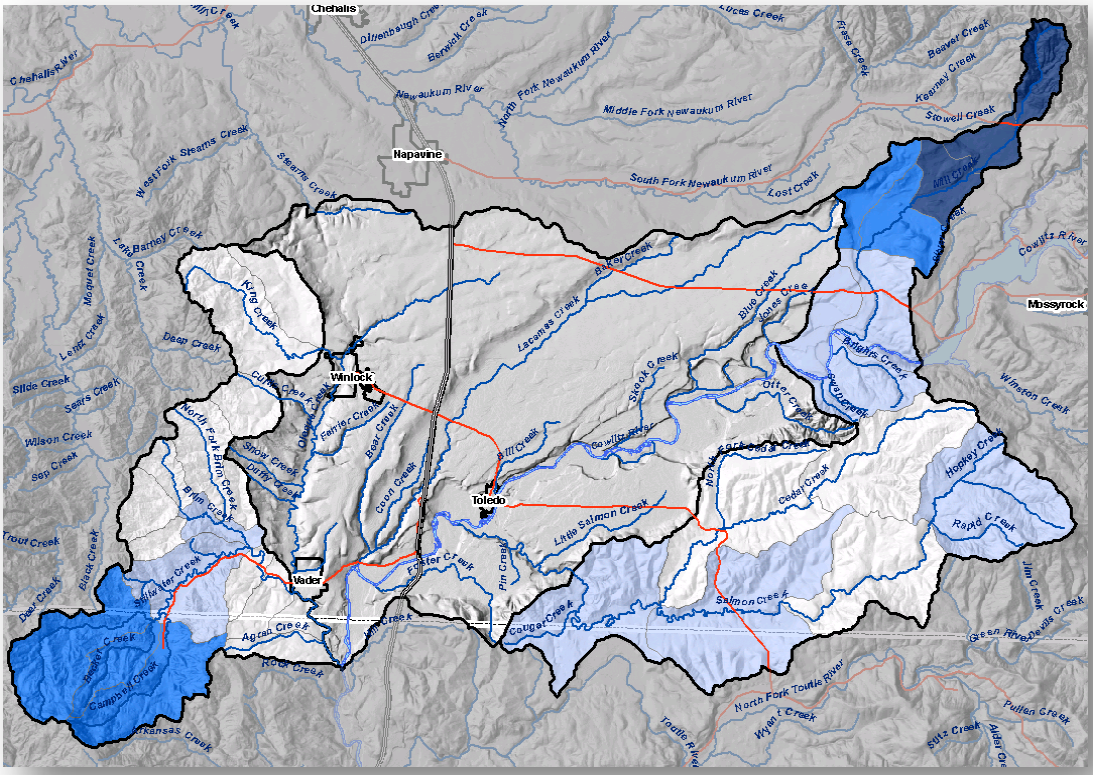

Figure C-2. Rating of Importance for the Hydrologic Process in the Mountainous Unit. Areas in "dark blue" have the highest importance; areas in "blue" have moderate-high importance; areas in "light blue" have moderate importance; and areas in "white", lower importance. (HU_M1)

are limited in the southern portion of the unit but increase in the north eastern and southwestern and western portions of the unit (Figure C-9). Wetlands are not as prevalent and are mainly concentrated in creek floodplains (Figure C-11). The areas with higher precipitation and higher permeability were rated from moderate to high importance (subunits 26, 39, 40, 41, 42, 43, 45, 46 and 47). The balance of the subunits ranked lower in importance.

C-2.0 Areas of Impairment to the Hydrologic Process

Figures C-3 and C-4 depict the final score for areas of high, moderately high, moderate, and low impairment to the hydrologic process. The impairment score includes consideration of areas of forest clearing and impervious surfaces and rating of wetland and stream impacts. The relative degree of impairment for each landscape unit is discussed below.

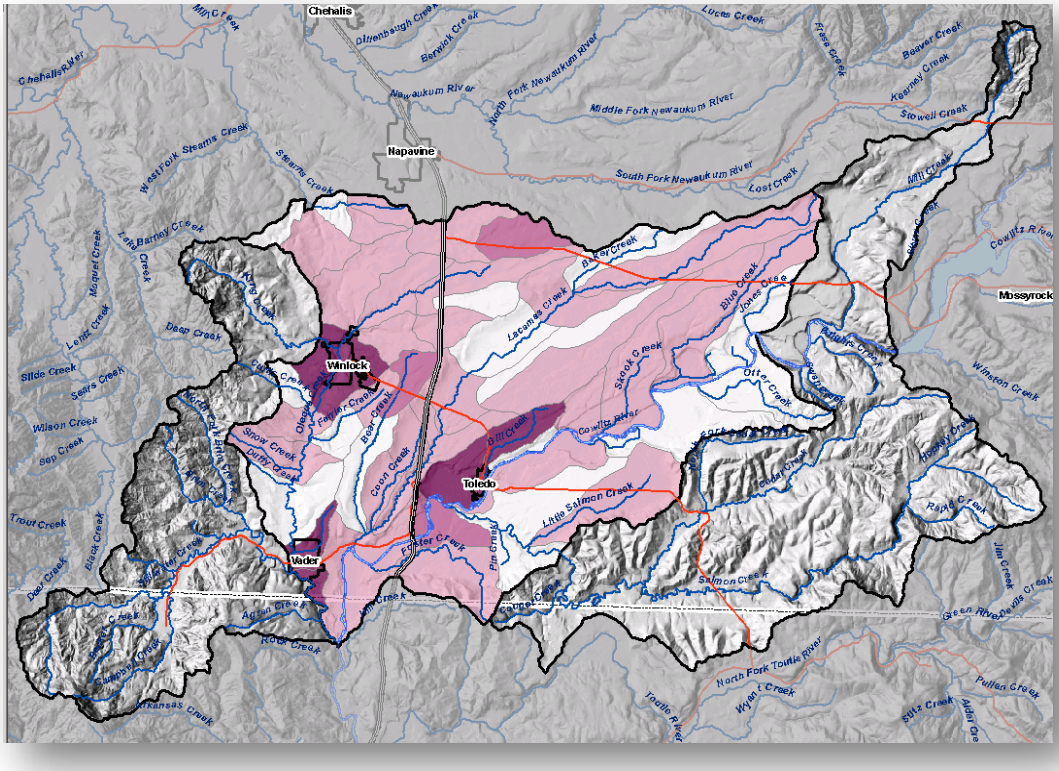

Figure C-3. Rating of Impairment for the Hydrologic Process in the Terrace Unit. Final Score. Lightest = lowest levels of impairment and darkest = highest impairment. (HI_M2)

Terrace Landscape Unit

For the Terrace unit, high levels of impairment are present within the towns of Winlock, Vader, and Toledo. This is due to impervious surfaces, roads and clearing of forest. Outside of these urban areas, impairment is predominately moderate due to forest clearing for agriculture and rural residential. Areas of low impairment are present in the upper Lacamas Creek watershed (subunits 52, 54, 56, 59), Otter Creek (subunit 48, 49), Pin Creek (subunit 71), Bear Creek (subunit 58, 66), and McMurphy Creek (subunit 9). Impairment is moderate to moderate -high in the Cowlitz floodplain due primarily to clearing of riparian forest for agriculture.

Mountainous Landscape Unit

For the Mountainous unit, the most significant causes of impairment are from forest loss and road density. Both of these factors are reflected in the overall impairment to groundwater, since they affect recharge and shallow sub-surface water movement. The highest levels of impairment are present in subunit 47, at the confluence of Mill Creek with the Cowlitz River as it exits Mayfield Lake just below the dam (Figure C-4). Subunits 69 and 74, in the mid reaches of the Salmon and Cedar Creek basins, have moderately high impairment due to forest activity. Results are similar in the lower Stillwater subunits (30, 36, 38) and Campbell Creek (26). The majority of the Cedar and Salmon and the Cougar Creek watersheds have relatively low impairment to the water flow processes.

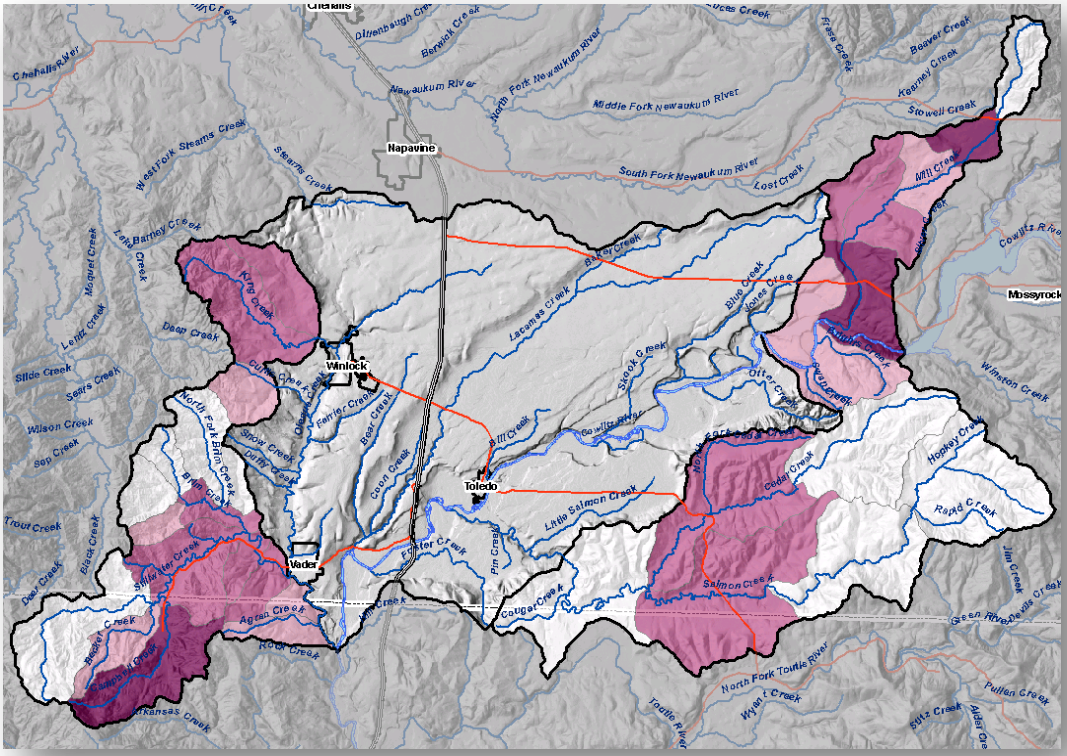

Figure C-4. Rating of Impairment for the Hydrologic Process in the Mountainous Unit. Final Score. Lightest = lowest levels of impairment and darkest = highest impairment. (HI_M2)

Results of Other Watershed Assessments of Impairment

The current characterization for South Lewis County (Toledo, Vader, Winlock) generally concurs with the overall pattern of impairment shown in the Lower Columbia Salmon Recovery Plan (Figure C-5). However, because the current characterization focuses on a smaller analysis area and uses a method of relative comparison of impacts to calibrate the categories of impairment, it shows a greater range in the degree of impairment.

The Lower Columbia Salmon Recovery and Fish & Wildlife Sub-unit Plan (2004), identified the majority of sub-units within the lower Cowlitz watershed as impaired (Figure C-5). The Lower Columbia Salmon Recovery Plan relies on thresholds for non-forest cover, percent impervious surfaces, and road density to calculate the categories of functional, moderately impaired, and impaired. This characterization uses equivalent indicators of impairment.

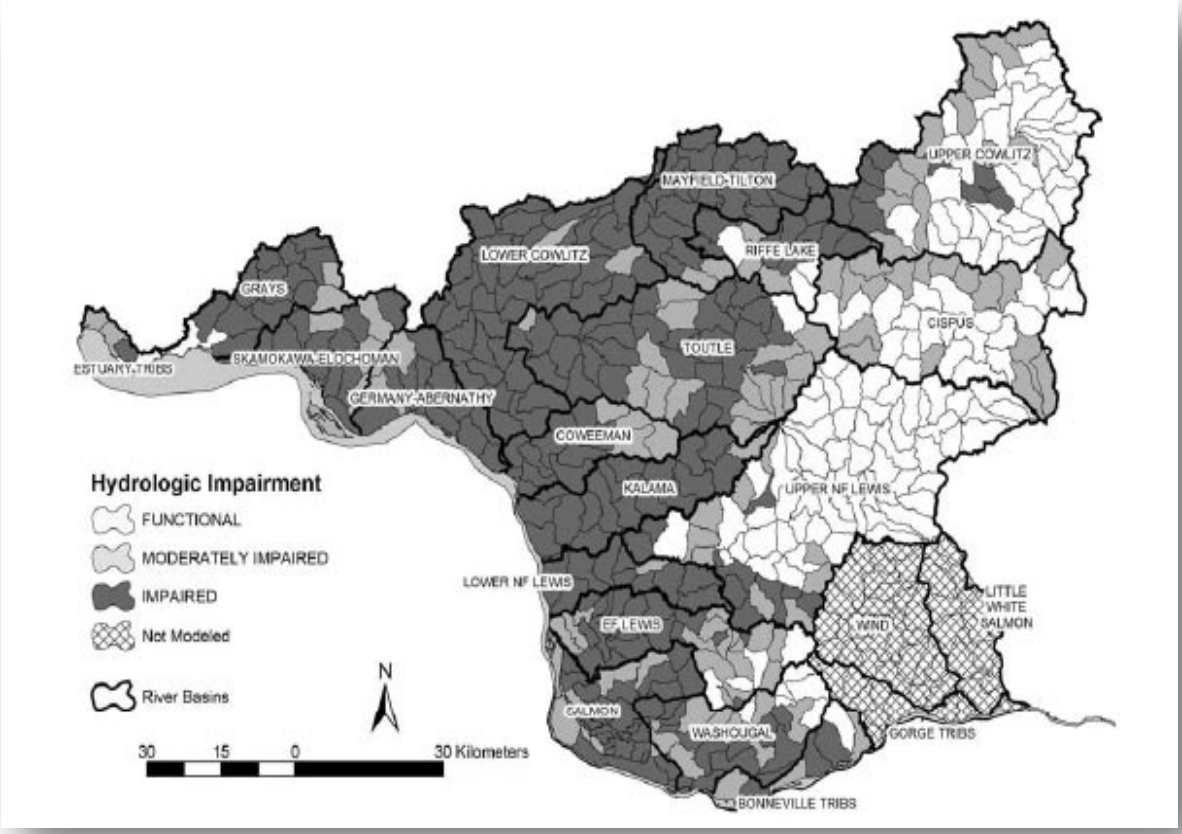

Figure C-5. Hydrologic Impairments for Watersheds in the Lower Columbia Region
(Lower Columbia Salmon and Fish & Wildlife Recovery Plan 2004). The Integrated Watershed Assessment was used by this study to calculate degree of hydrologic impairment (Chapter 3, Limiting Factors and Threats, Figure 2).

Synthesizing Results of Importance and Impairment Maps

Figure C-6 depicts the detailed matrix for synthesizing the results of the importance and impairment maps for the hydrologic process. A matrix is used to create the protection and restoration map (Figure 7)). The matrix is based on watershed-based research indicating that areas with low levels of impairment to watershed processes should be protected and areas with higher levels of impairment to processes with a higher level of importance should be restored (Stanley et al. 2005). Restoration should not have a high priority, however, in areas that have permanently impaired processes (urban areas with buildings and impervious surfaces).

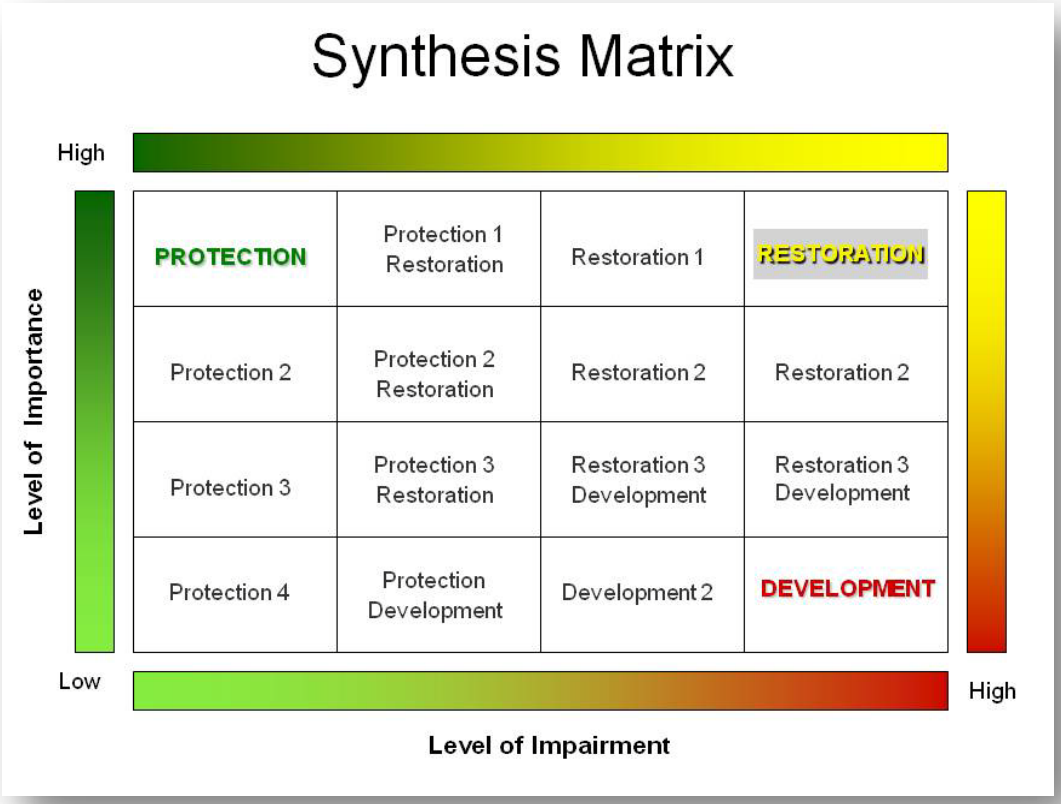

Figure C-6. Detailed analysis matrix for creating final restoration and protection map for the water flow process.

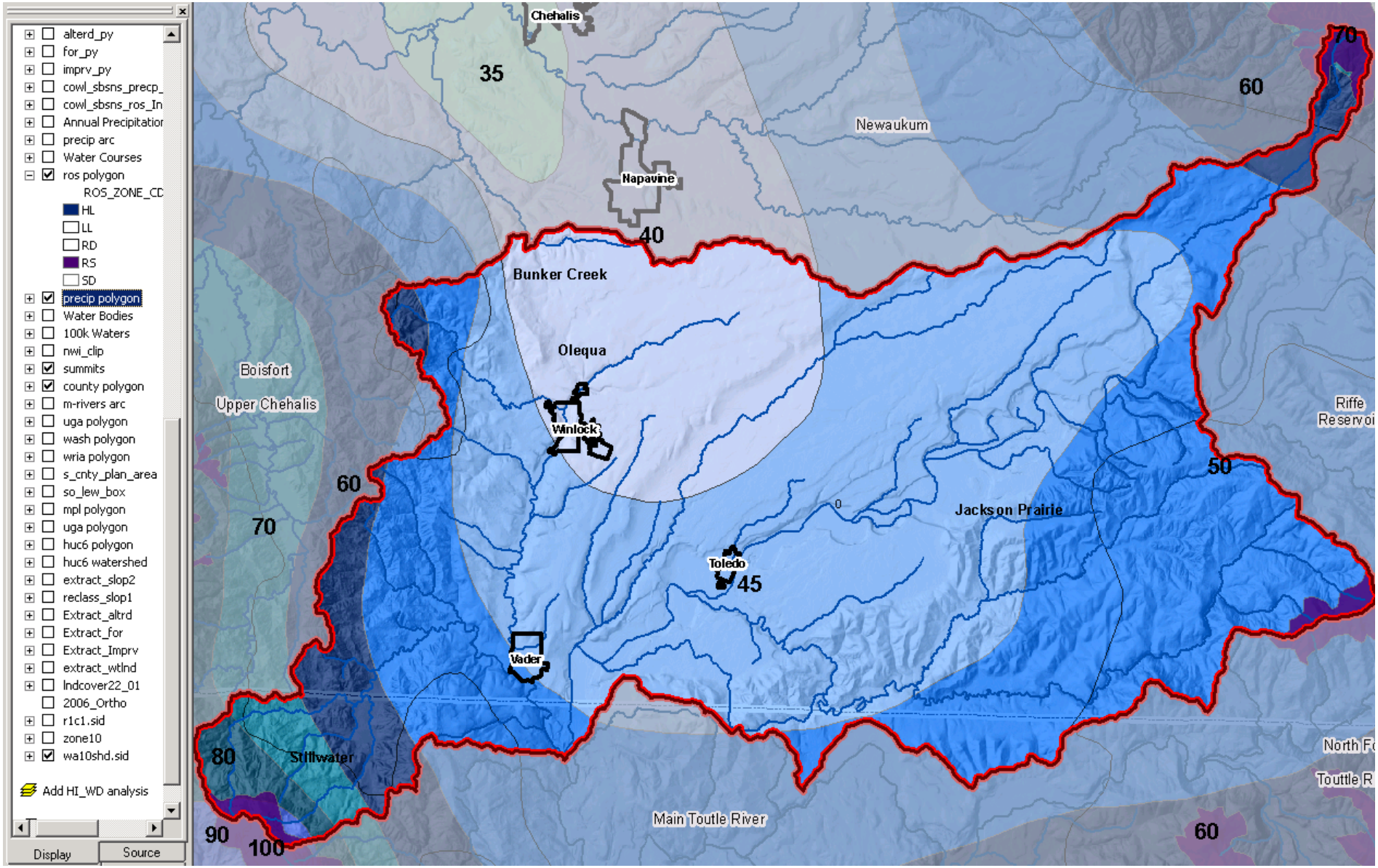

Figure C-7. Precipitation Levels for South Lewis County. Darker colors represent higher levels of precipitation.

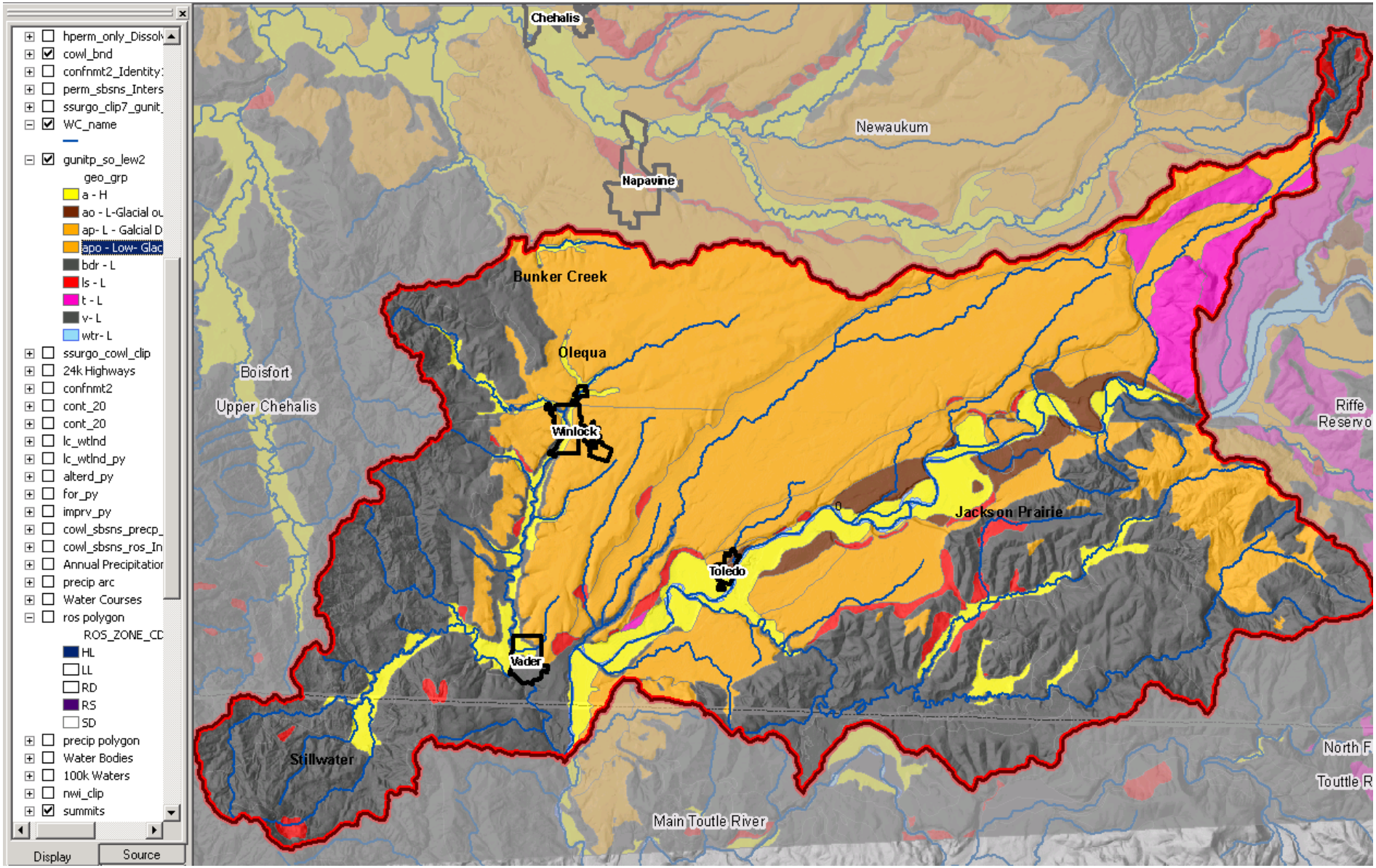

Figure C-8. Geology for South Lewis County. Yellow represents recent alluvial deposits for streams. Orange represents fluvial glacial deposits on intermediate terraces and plain terraces. Brown represents higher permeability outwash deposits. Red represents landslides. Pink represents glacial till deposits. Grey represents bedrock.

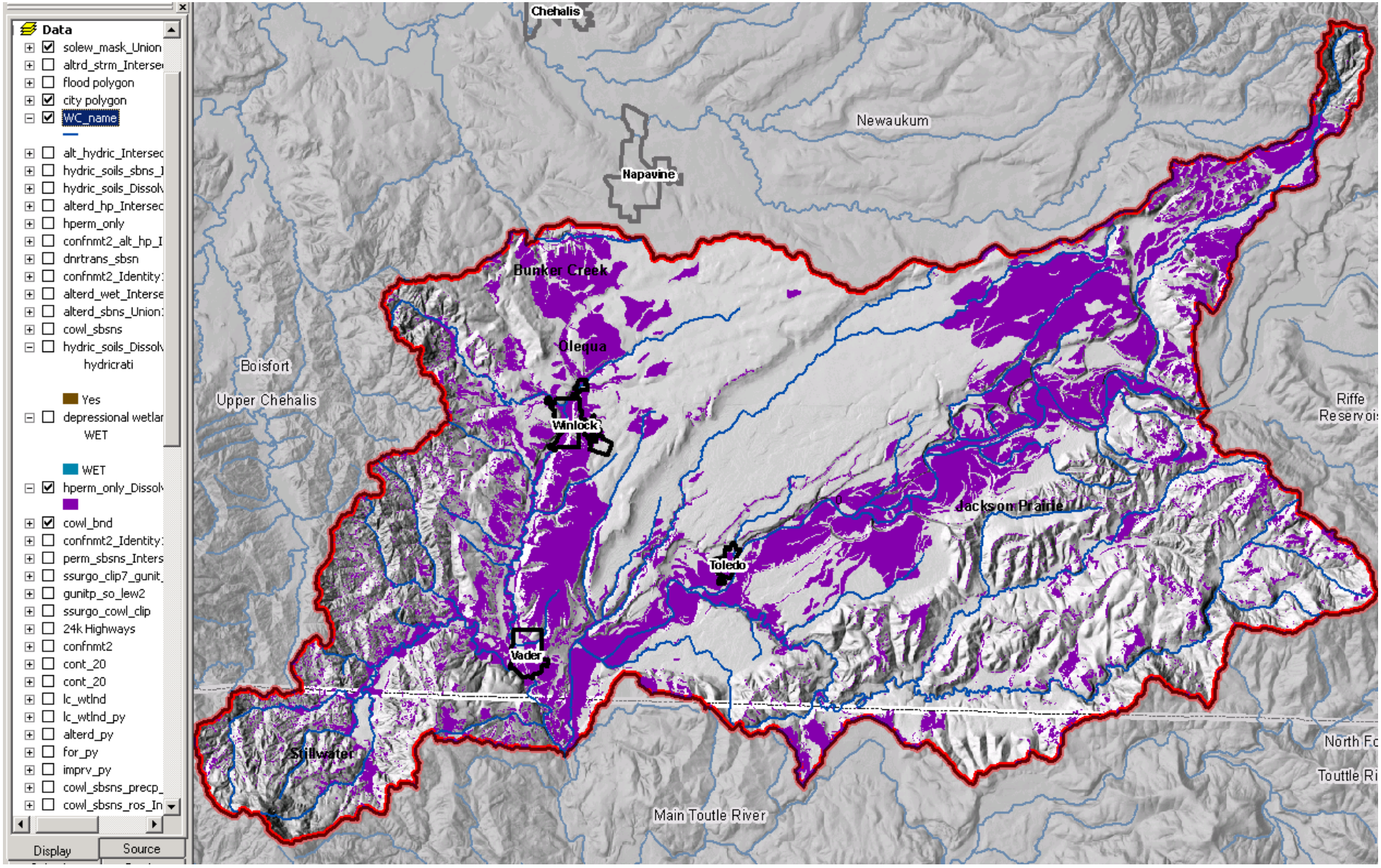

Figure C-9. Deposits With High Permeability. Purple represents the location of higher permeability deposits in South Lewis County.

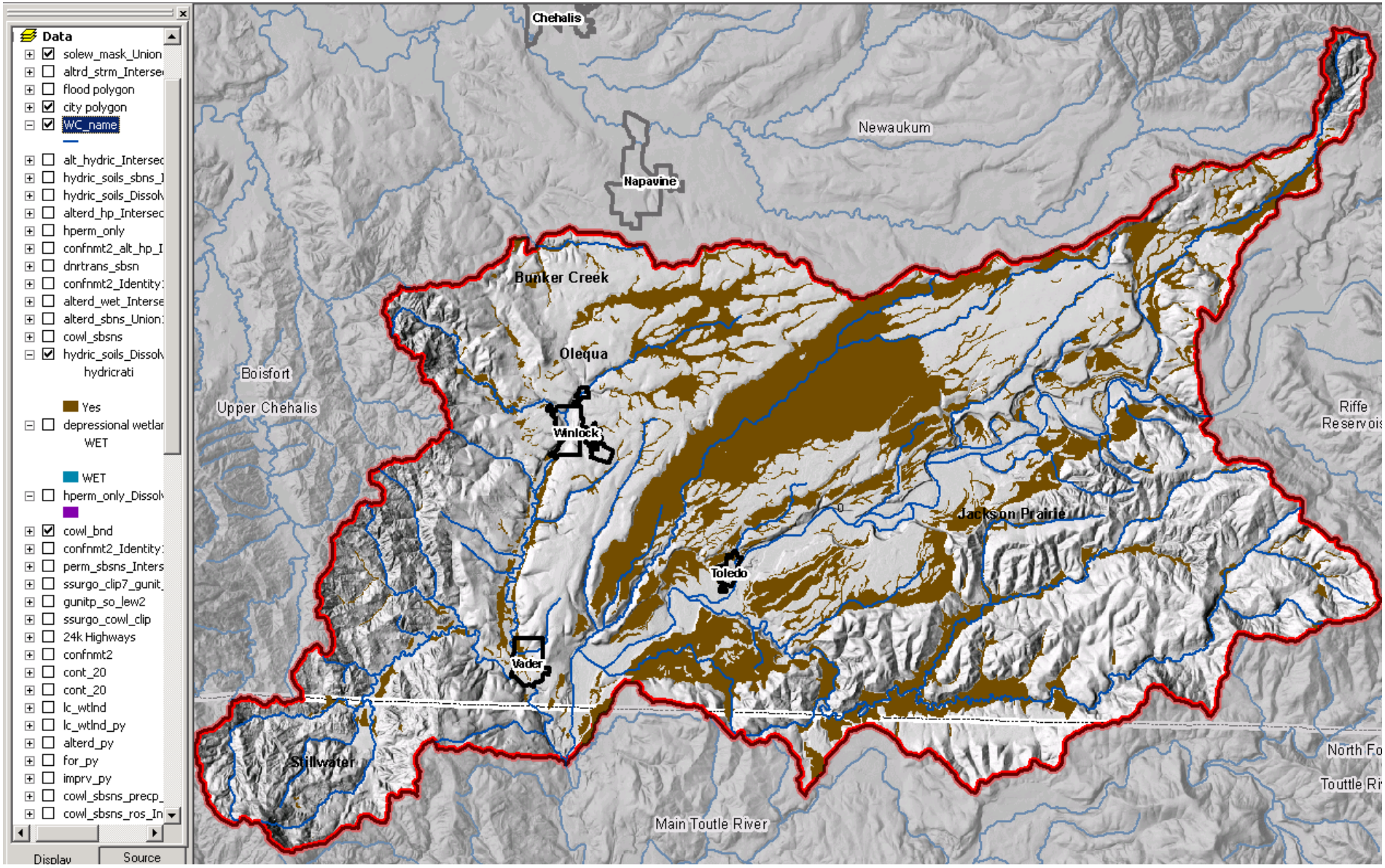

Figure C-10. Area of Hydric Soils in South Lewis County (brown).

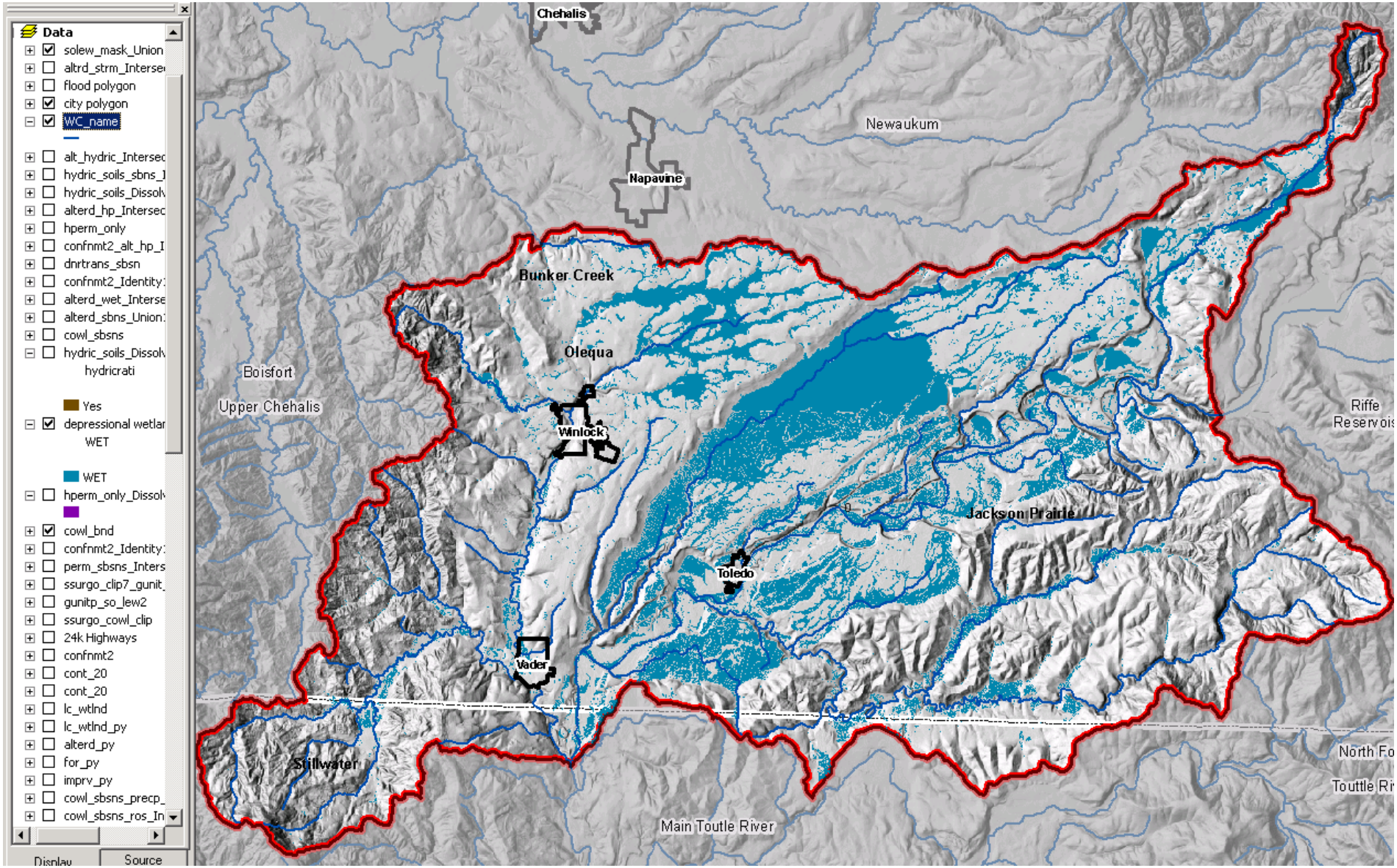

Figure C-11. Depressional Wetlands (includes both potential and existing wetlands)

Appendix D. Wildlife Characterization

Introduction

To inform the South Lewis County Subarea planning process, Washington Department of Fish and Wildlife (WDFW) and Washington Department of Ecology (Ecology) were consulted to analyze habitats and ecosystem processes, respectively, across the local area. The purpose of the two agencies' work is to provide information on natural systems that will allow the planners to accommodate growth while avoiding unintended consequences, such as loss of local biodiversity, or increased flooding. This habitat report is to be incorporated as an appendix to the watershed characterization.

South County Subarea

The south county subarea, shown on the right, was drawn as a rectangular zone incorporating the cities of Winlock, Toledo, and Vader, plus some of the surrounding unincorporated county. As of 2008, population in the subarea was approximately 10,200. Although the three cities have concentrations of residences and businesses, most of the subarea is rural, with agriculture and residential land uses predominant, and with a significant portion of undeveloped land.

Figure 1. *South Lewis County Subarea*

The primary landform feature is a series of relatively flat terraces at increasing elevation, leading away from the Cowlitz River. Forested habitats include conifer and mixed conifer/hardwood; oak woodlands are a minor component. A major portion of the land was historically prairie, now largely converted to agricultural use, although featuring patches of remnant native vegetation. Cowlitz River and several tributaries run across the subarea. Olequa, Lacamas, and Salmon creeks, as well as the main-stem Cowlitz, are important waters for salmonids.

Habitat Analysis Area

Because natural systems are connected – water moves downslope and downstream; animals travel across political and watershed boundaries – both WDFW and Ecology analyses looked beyond the subarea boundary. Ecology's characterization of hydraulically-driven processes is defined by drainages. For this project, all sub-basins affecting the flow of water

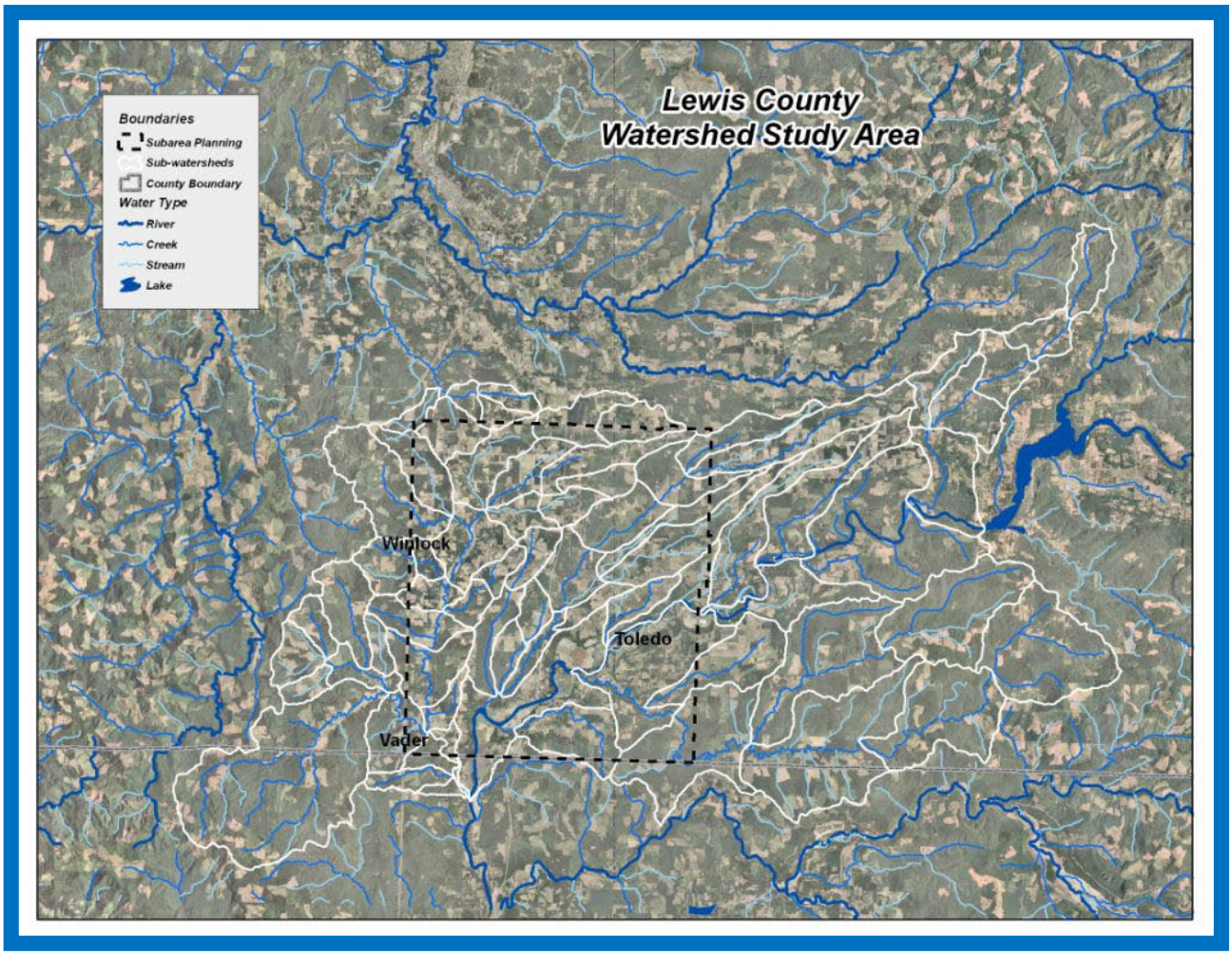

***Figure 2**. South Lewis County Analysis Area*

through the subarea were included, except for those parts of the Cowlitz River system above Mayfield Dam. This served as the basic analysis area for the project, shown below in Figure 2.

Why Plan For Wildlife

Just as wildlife species vary greatly in size and shape, they also show wide differences in the kinds of habitats they use, and in their sensitivity to the effects of human development. Over 280 species of birds, mammals, amphibians, and reptiles exist in Lewis. Some of these thrive in close association with dense human settlements. Most do not do so well, and may fail to persist as human density grows beyond their tolerance threshold. Figure 3, below, shows this relationship between species persistence and housing density.

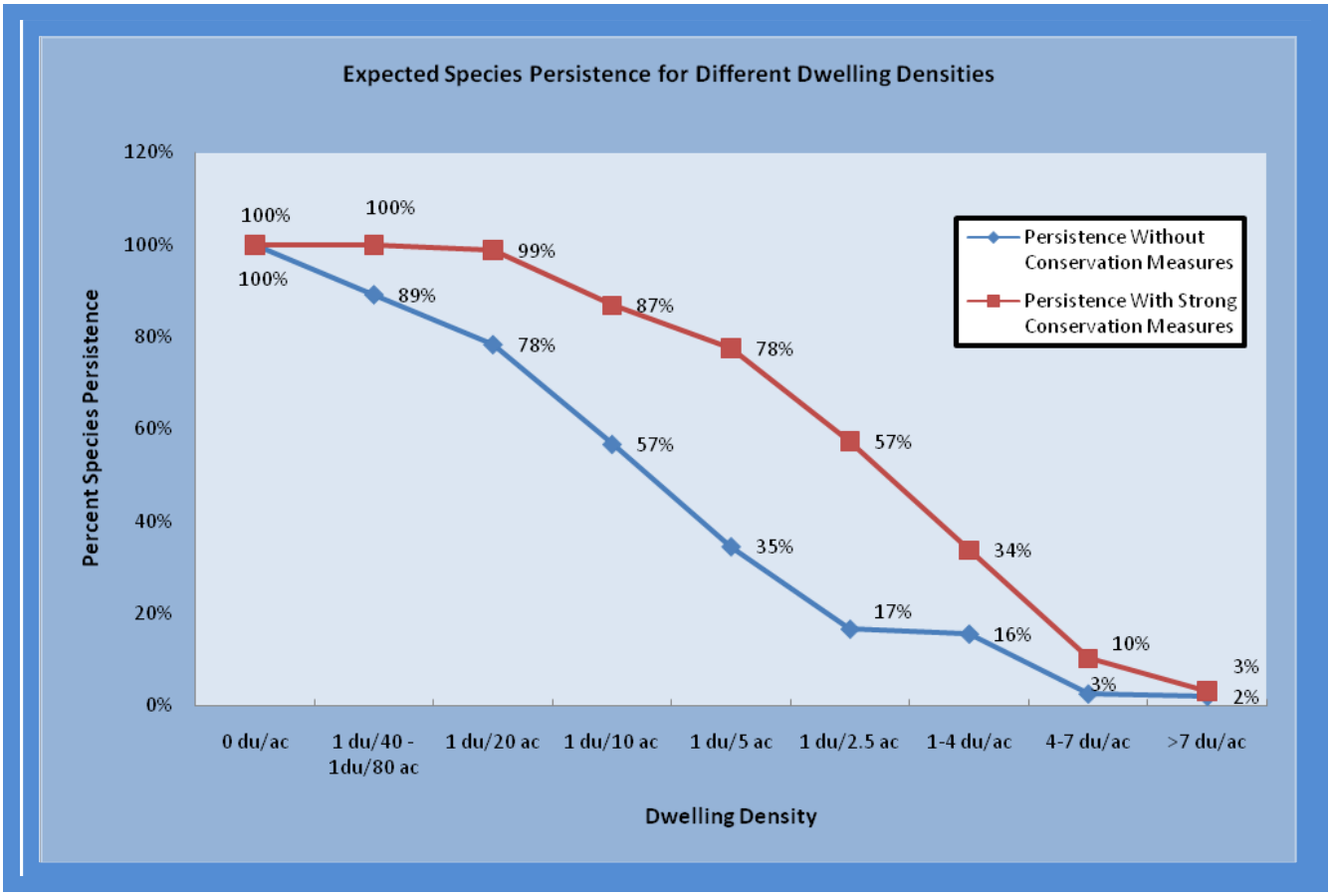

***Figure 3**. Expected species persistence at different housing densities (WDFW 2009 – Planning for Wildlife, in press)*

The numbers on the graph should be considered generally applicable, but not precise. Knowledge about species response is incomplete. In addition, the graph is based on the approximately 65% of Lewis County species for which data are available. However, the trend is correctly depicted, including the very low persistence of species at the highest levels of urban development. The figure also implies that these effects can be moderated with applied conservation measures, as shown by the upper line in the graph. The types of measures needed are discussed later in this document, as habitat conservation recommendations.

Spatial Scale

This report applies the qualitative definition of scale shown in Figure 4, below. The issue of scale is important, affecting the assessment techniques used and the interpretation of results. In particular, for the South Lewis County Project, habitat analyses include both broad and mid-scale techniques. Their results are most accurate at these same scales, and can also provide valuable contextual information at the site scale. However, *actions* taken at the site scale should also be supported by additional site-specific knowledge.

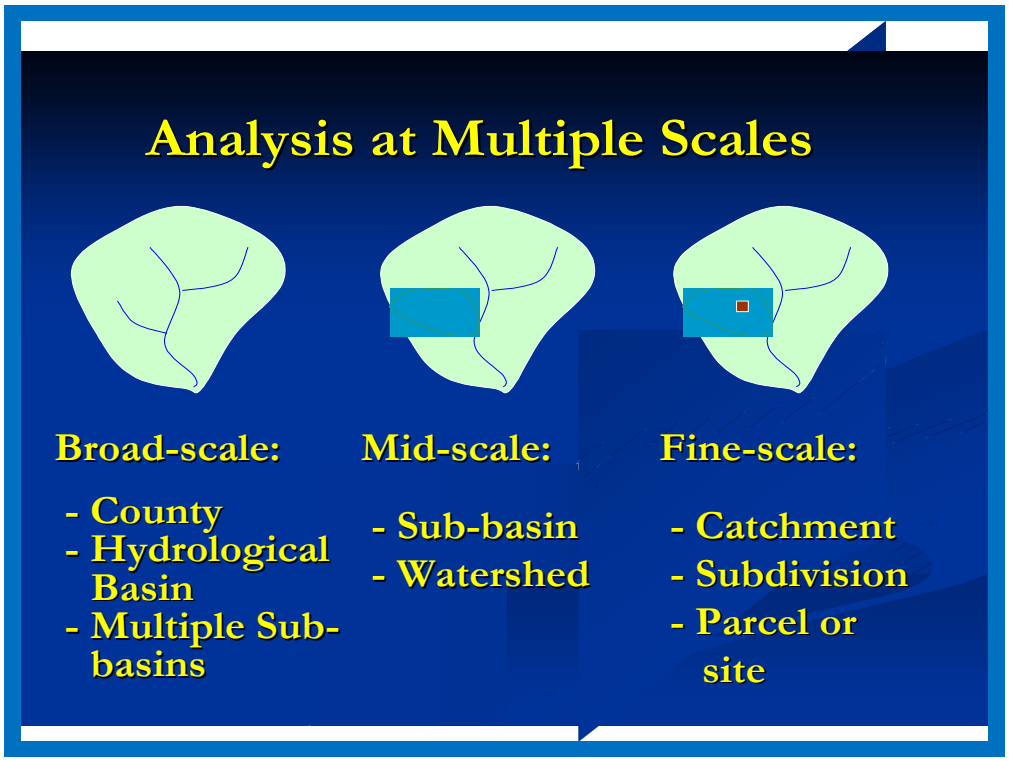

Figure 4. Definition and nesting relationship of spatial scales

Conservation Recommendations

The fundamental reason for bringing the needs of wildlife into land use planning is to avoid the loss of biodiversity while accommodating growth and development. Development activities, such as land clearing, building construction, paving parking lots and roads, cause the direct loss of habitat at the site scale. These changes impact wildlife at the site. Planning at a larger scale allows a basic assessment of current habitat conditions over a wider landscape. What are the abundance and distribution of different habitat types? Does their size and adjacency to other types potentially support use by a broad range of species? Ideally, this kind of assessment brings some understanding of the relative risks to local biodiversity posed by the expected size and location of future development. It can also pinpoint conservation opportunity areas, where voluntary, regulatory, or incentive-based measures can be most effective. Figure 5, below, outlines this type of habitat conservation focus area for the south county. The location of this focus area and the specific recommendations included in this section of the report flow directly from results of the broad and mid-scale analyses described further below.

Summary of Study Results

In broad overview, the assessments reported below indicate that wildlife habitat is in good shape across the analysis area. This is not a pristine wilderness, where human presence is minimal. However, population density is low, even within the subarea boundary. A large portion of the landscape is working forest or agriculture. There are also significant blocks of

undeveloped land. These factors combine to provide widely distributed, large, contiguous patches of open and forested habitats.

The habitat studies indicate that focused economic development within the Winlock Urban Growth Area (UGA) near the intersection of Interstate 5 and State Route 505, and in the immediate area of the airport northeast of Toledo would not significantly reduce the availability of large habitat patches across the analysis area. Similarly, accommodating most of the new residential development within the UGA boundaries of the three cities would minimize the impacts from population growth within the south county. However, growth outside of the UGAs should also be expected, with less predictable location and impact.

Recommendations

The key to preserving current biodiversity within the analysis area and the subarea is to maintain a widely distributed supply of large patches of all habitat types: conifer, hardwood, and mixed forest, open/grassland, and wetland. Valuable, but less common habitat features, such as oak woodland, remnant prairie vegetation, and forest snags should be conserved. Preserving the connectivity of these habitats is important, to accommodate normal seasonal movement between different habitat types, to allow dispersal of maturing animals, and to avoid genetic isolation of species subpopulations.

Figure 5, below, shows a recommended habitat focus area where conservation measures may be efficiently applied. Shown within the dashed lines, the area encompasses the Lacamas Creek corridor as well as some adjacent habitats. Lacamas Creek is one of three salmon-bearing creeks in the south county area. In the individual focal species analyses that follow, this area appears repeatedly as a zone that currently provides forested, open, and wetland habitats. It also contains areas of remnant oak (see Figure 13) and prairie. The focus area currently features a relatively high degree of connectivity, interrupted primarily by the major roads that cross the corridor. In addition, it lies mostly within the subarea; the benefits of successful conservation would be experienced adjacent to areas where growth is likely to be the greatest. Location of the habitat focus area would also help satisfy designated open space needs under the Growth Management Act.

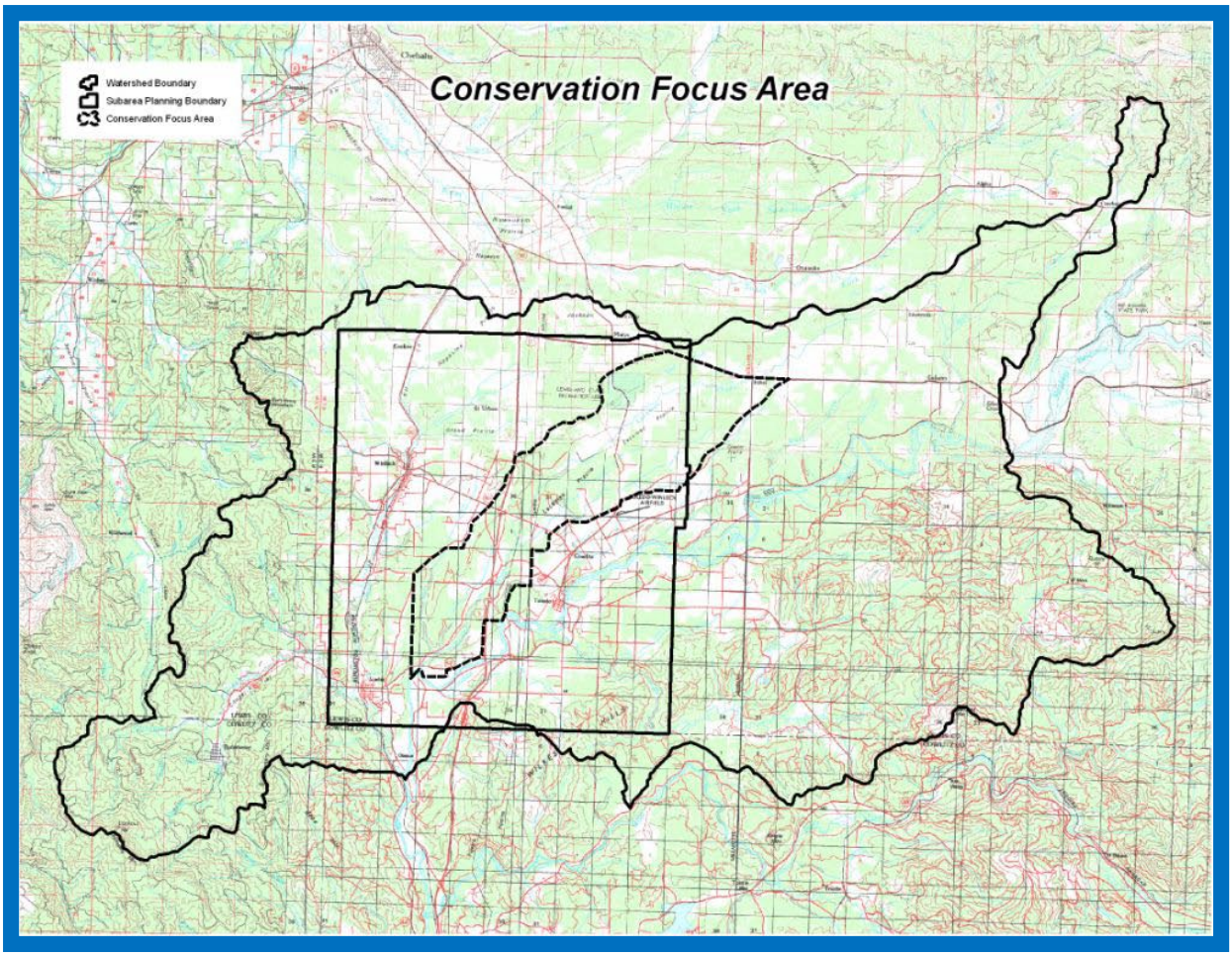

Figure 5. *Recommended habitat conservation focus area within the dashed lines*

Successful conservation within this focus area does not require a complete lack of development or economic activity. The recommended goal would be to limit fragmentation of existing habitats within the zone and to enhance connectivity, when possible. Farmlands are currently serving as part of the effective habitat mosaic in the area; protecting these working lands from conversion to residential, commercial, or industrial uses can also support conservation. Specific recommendations include:

- Minimize new road mileage, especially in the interior of the focus area.
- Preferentially locate new buildings near existing roads and on the periphery of existing habitat patches.
- Cluster residential development to minimize the footprint of new construction.
- Protect and/or enhance native riparian buffer vegetation.
- Consider use of incentive-based programs, such as trading or purchasing of development rights (TDR, PDR) to protect core blocks of habitat, and provide value to landowners willing to forego development.
- Compatibly locate mitigation/restoration projects to enhance habitat values.
- Take advantage of opportunities to soften or remove barriers to animal movement.

- These recommendations can be accomplished by a combination of regulatory and incentive-based techniques, as well as voluntary actions by local landowners. The recommendations can also be applied more widely, as appropriate.

Road Management Recommendations

To accommodate economic and population growth, increased road capacity will be needed, and, in fact, the south county subarea planning process includes a transportation element. Roads fragment habitat, partially or fully inhibit species movement, and cause direct mortality, especially for small animals. Recommendations for limiting road impacts and restoring connectivity follow.

- Limit new road mileage.
- Locate new roads away from stream corridors.
- Minimize stream crossings by new roads. Where crossings are necessary, bridges are preferred.
- During road construction and maintenance, or when installing or replacing culverts, use a design that will accommodate passage by mammals, reptiles, and amphibians in addition to fish (Bates, et al. 2003, Clarkin, et al. 2005, Cavallaro, et al. 2005).
- Focus through-traffic onto a few main roads.
- If road mortality occurs in focused areas along local roads, consider use of warning signs and lower speed limits as traffic softening measures.
- Within the habitat conservation focus area, inspect culverts shown as having an unknown effect on fish passage (Figure 6, below). Prioritize replacement based on findings.
- Work with Washington State Department of Transportation to enhance wildlife connectivity as opportunity arises, for example, when Interstate 5 is widened. Particular attention should be paid to the Lacamas Creek crossing.

Fish

The GIS-based assessments that follow characterize habitat by analyzing conditions on the land. As such, they do not look directly at instream habitat. However, fish are an important resource in the analysis area. Currently, the Lower Columbia Fish Recovery Board, the salmon recovery lead entity for the south county area, is developing a habitat work schedule, that will involve a prioritized list of site scale restoration projects for salmonid habitat. The Board has also negotiated a reservation of instream flow for area waters. These elements should be considered part of a road map for protecting fish in the face of growth. At a more general level, healthy watershed hydrology leads to healthy fish habitat, so Ecology's recommendations, prioritizing sub-basins for restoration of hydrologic processes, should provide guidance supporting fish conservation. When opportunities arise, protection and restoration of native riparian vegetation can be important elements for improving fish habitat, even within the incorporated cities.

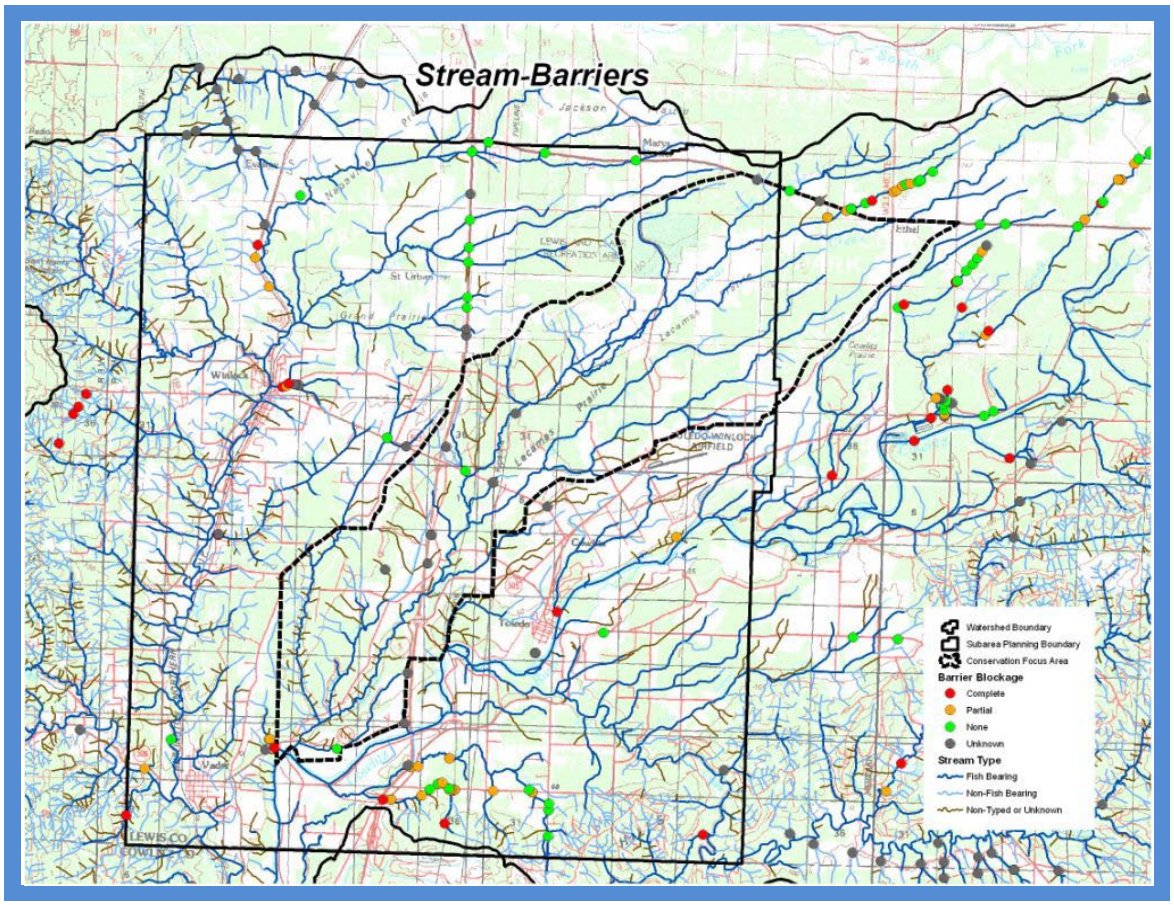

Figure 6. *Fish passage at culverts (Source: WDFW)*

Finally, Figure 6, above, shows WDFW's current knowledge of fish passage problems at culverts in the south county. Replacement of blocking culverts within the areas of fish presence, and assessment of culverts lacking data within the same zone should be priorities for fish protection and enhancement.

Elk

Elk are listed as a species of local importance in the Lewis County critical areas ordinance. The south county analysis area has a number of resident elk, in addition to the regular presence of wintering elk. Elk damage is a regular occurrence in part of this area. WDFW's elk management plan for the Mt. St. Helens herd emphasizes localized control hunts to reduce damage, together with working with forest landowners to develop forage enhancement plots away from local farms (WDFW 2006). Consistent with the herd plan, there may be opportunities for local forage enhancement projects. Design and location of such projects should be coordinated with WDFW District Wildlife Biologists, either directly, or through the Vancouver Regional Office (360-906-6700).

Study Results

Broad Scale Habitat Analyses

For the South Lewis County Project, the first analyses used WDFW's Local Habitat Assessment (LHA) methodology, which gives a relative value ranking of all parts of an area as general wildlife habitat, without regard to particular species. The LHA method uses agency records of known wildlife occurrences and biodiversity hotspots, together with indicators of habitat value and human development, to characterize each part of the map (Neatherlin, et al. 2007). Although both scoring and mapping are based on 900 m^2 unit areas (approximately ¼ acre) and appear quite detailed, LHA is a broad scale application. Appendix A of this report contains a more detailed discussion of the methodology.

Separate LHAs were developed for all of Lewis County (Figure 7) and for the south county analysis area (Figure 8). Both maps included a buffer area beyond the county or analysis area boundary, to give an idea of how habitat continuity may be maintained outside of the prime area of interest.

The pattern of habitat values across the whole county is evident in the map in Figure 7. A large block of high-value habitat makes up the eastern half of the county, interrupted only by larger roads and the settlements adjacent to them. The western half appears somewhat more impacted, holding most of the human settlement and a higher density of roads in the working forest lands. Impacts are highest along the Interstate 5 corridor in the Chehalis/Centralia area. By contrast, the south county subarea shows moderate to high value over much of its area, and far less concentrated impact around its small cities than around those to the north.

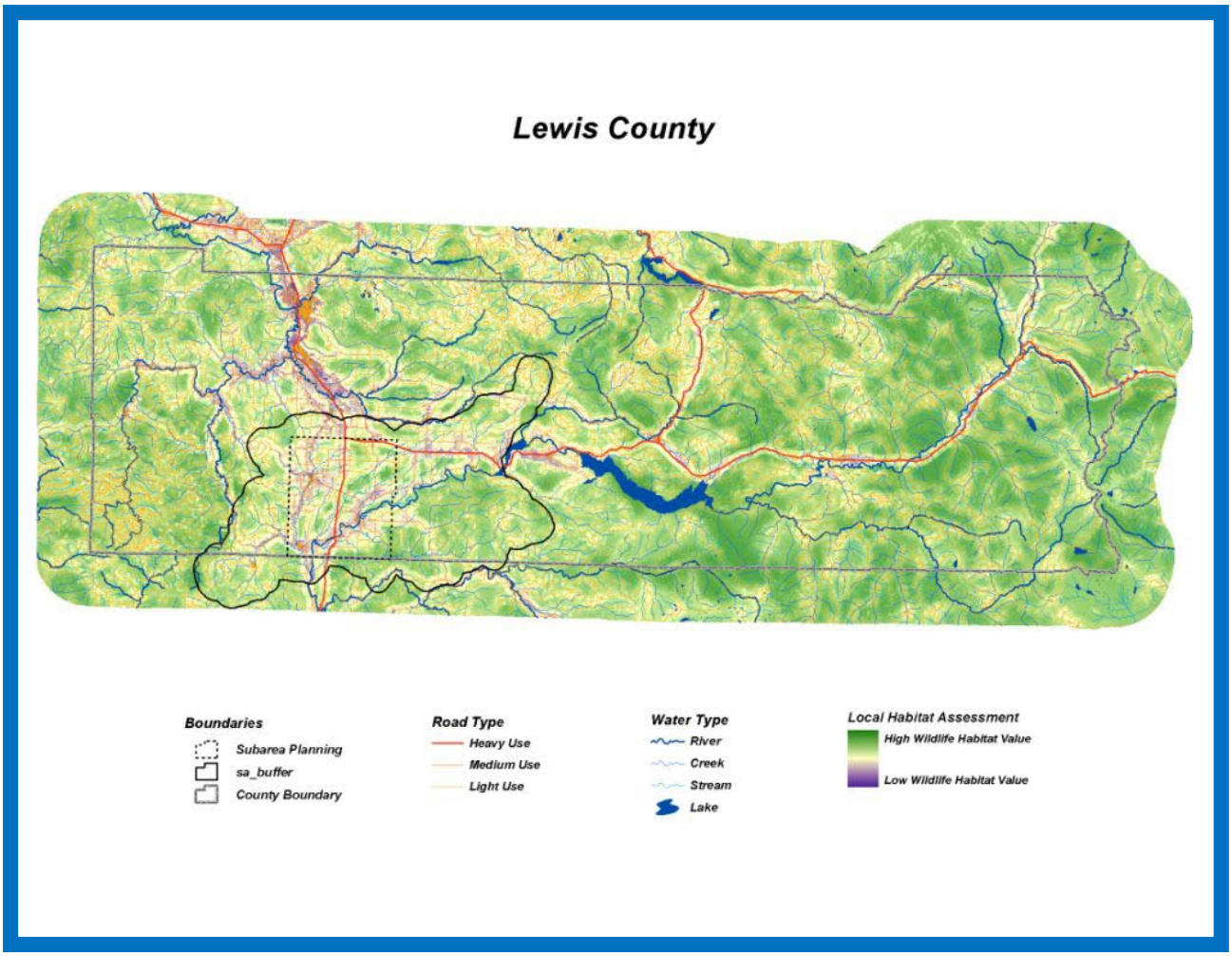

***Figure 7**. Lewis County Habitat Assessment*

The assessment of the south county analysis area, shown in Figure 8, below, gives a closer look at habitat patterns within and surrounding the subarea. In this more focused view, the habitat values appear to feature greater extremes, both high and low, than showed in the county map. This difference occurs because the LHA gives a relative ranking; the map below does not consider other parts of Lewis County.

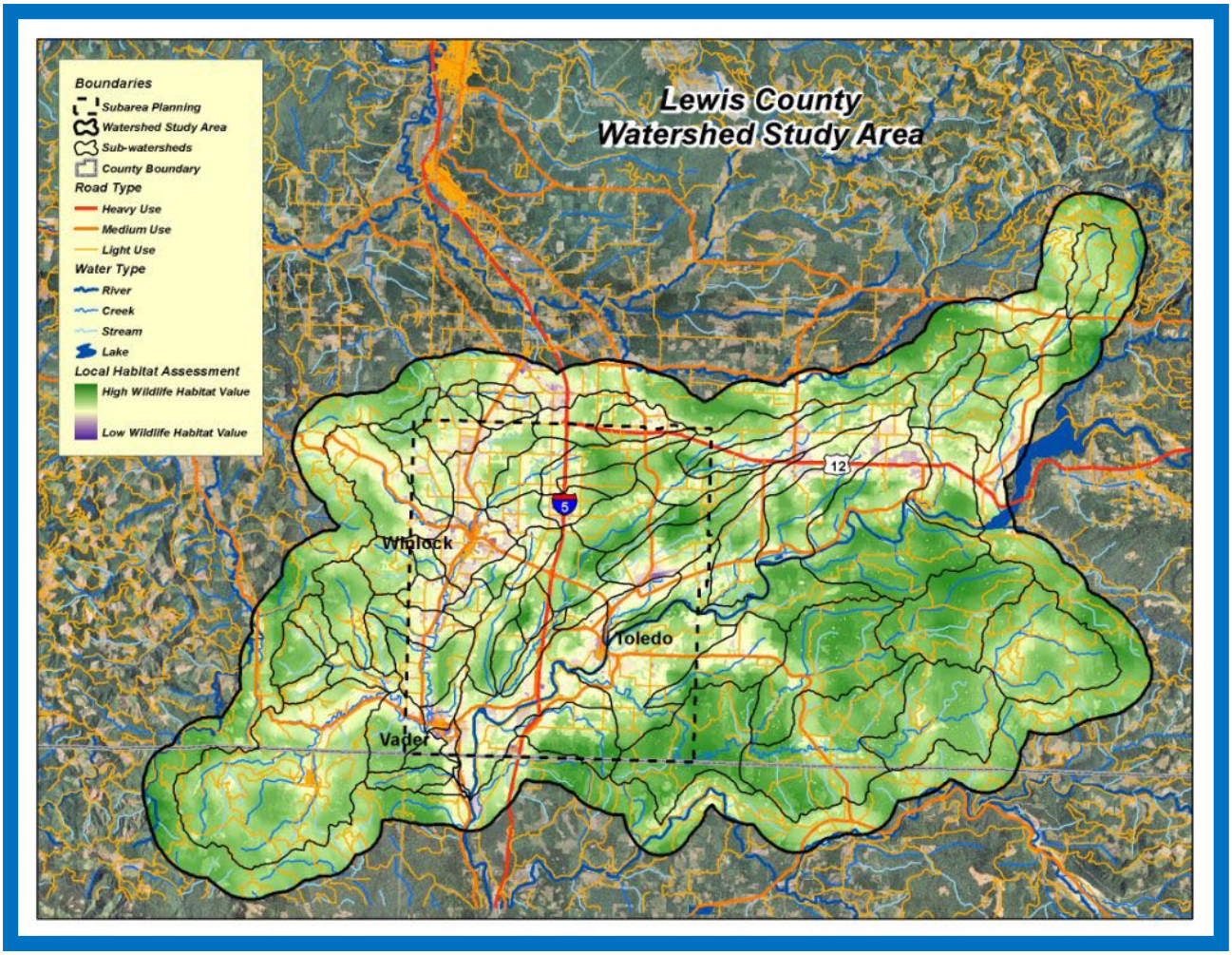

Figure 8. *South Lewis County Analysis Area Habitat Assessment.*

Figure 8 shows the application of a broad scale analysis technique to a mid-scale area. Results indicate that wildlife habitat is in relatively good shape over most parts of the map. Habitat connectivity, both inside and outside of the analysis area, appears to be good, especially within the working forest lands on the west, northeast, and southeast. Major roads in the area, including Interstate 5, U.S. 12, and the state highways, represent the strongest connectivity barriers for wildlife.

Mid-Scale Habitat Analyses

To derive a more integrated perspective on how well habitats in the analysis area are functioning, WDFW developed a number of mid-scale analyses, based on a limited list of focal species or species groups. A South County Habitat Advisory Group was formed to provide local knowledge of animal presence and importance, and to assist in the selection of focal species. For generating the list, information sources included a number of scientific publications, as well as consultations with and internal review by agency biologists. Appendix C of the original report, contains an explanation of the focal species selection process and descriptions of the basic habitat needs of those on the final list.

Wildlife species differ in their habitat needs and in their sensitivity to development. Habitat features that come into play are the types of vegetation, patch sizes and shapes, how different habitat types align with one another, and how connectivity has been maintained or interrupted. In the course of development, vegetation is cleared; roads are built; noise, light, and domestic animals are introduced. These changes lead to smaller, more fragmented habitat patches, and increased barriers to wildlife movement.

Collectively, chosen focal species are intended to represent all of the major habitat types in the analysis area. Most of the selected species were considered to be relatively sensitive, either because of the demanding nature of their habitat requirements or their avoidance of human development. Figure 9, below, contains the focal species list.

Taxa	Representation	Species
Birds	Open/grassland habitats	Short-eared Owl
		Western Meadowlark
		Merlin
		Oregon Vesper Sparrow
Birds	Forest interior	Hermit Warbler
		Townsend's Warbler
Birds	Forest edge	Hutton's Vireo
Birds	Forest snags	Pileated Woodpecker
		Hairy Woodpecker
Mammals	Forest-associated, small to mid-sized	Common Porcupine
		Northern Flying Squirrel
Mammals	Mid-sized predators	Bobcat
Reptiles and Amphibians	Still water-associated, scale of movement extensive, small-sized	Northern Red-legged Frog
		Western Toad
		Common Garter Snake

***Figure 9**. Focal species for mid-scale analyses*

A basic assumption of these analyses is that species needing smaller habitat patches or showing less sensitivity to human development will thrive in a landscape that accommodates animals with more demanding habitat needs. There is also an important disclaimer that should be noted. Although the mapped habitat patches in the following graphics can in a general sense be considered potential habitat for the focal species, the mappings do **not** imply that the mapped territories will be occupied. There could easily be physical, biological, or temporal factors which preclude occurrences of particular animals. Those factors may be currently unknown, or may be beyond the scope of the data sets used to generate the maps. As an example, forest stand age information was not incorporated into the analyses, potentially leading to over-representation of currently available habitat for species with preferences for mature and old growth forest. What can be said is that the size of the habitat patch and its vegetative composition conform to what is known about the needs of the species. Base maps used for the analyses that follow are a number of years old: yellow denotes Washington Department of Natural Resources ownership, the red line marks the Mt. St. Helens impact zone. Neither of these features is a direct part of any analysis.

Open/Grassland Birds

Short-eared Owl

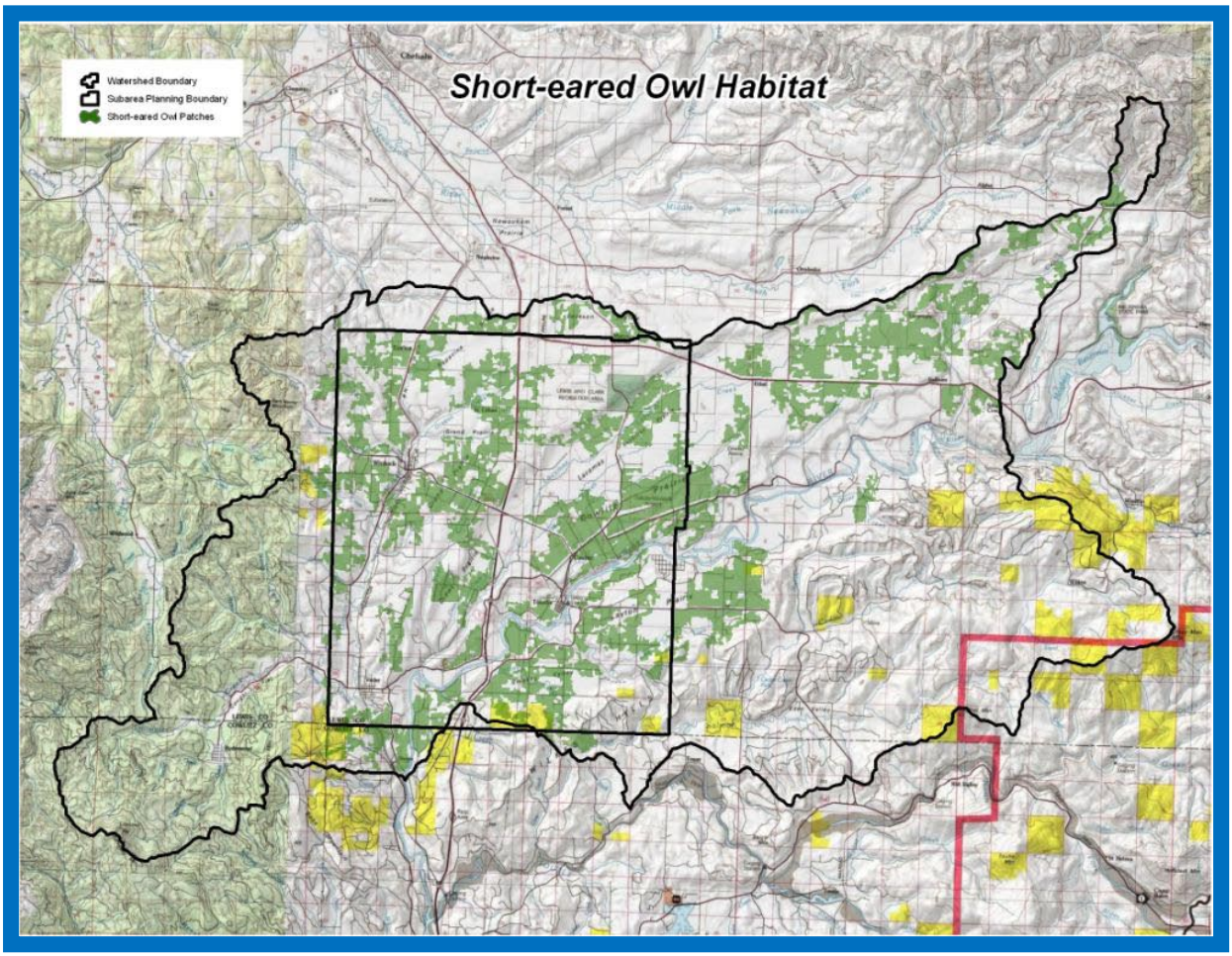

***Figure 10**. Availability of habitat patches for Short-eared Owl*

Short-eared Owls are primarily winter residents in this part of Washington. They are mid-sized owls, closely associated with wetlands and open grasslands (Johnson & O'Neil 2001). Territory size can exceed 200 acres (Brown 1985), and, depending on prey availability, these birds may defend their winter feeding habitat (Erlich, et al. 1988). Figure 10, above, shows the distribution of habitat patches consisting of open/grassland areas and wetlands, which exceed 200 acres.

Western Meadowlark

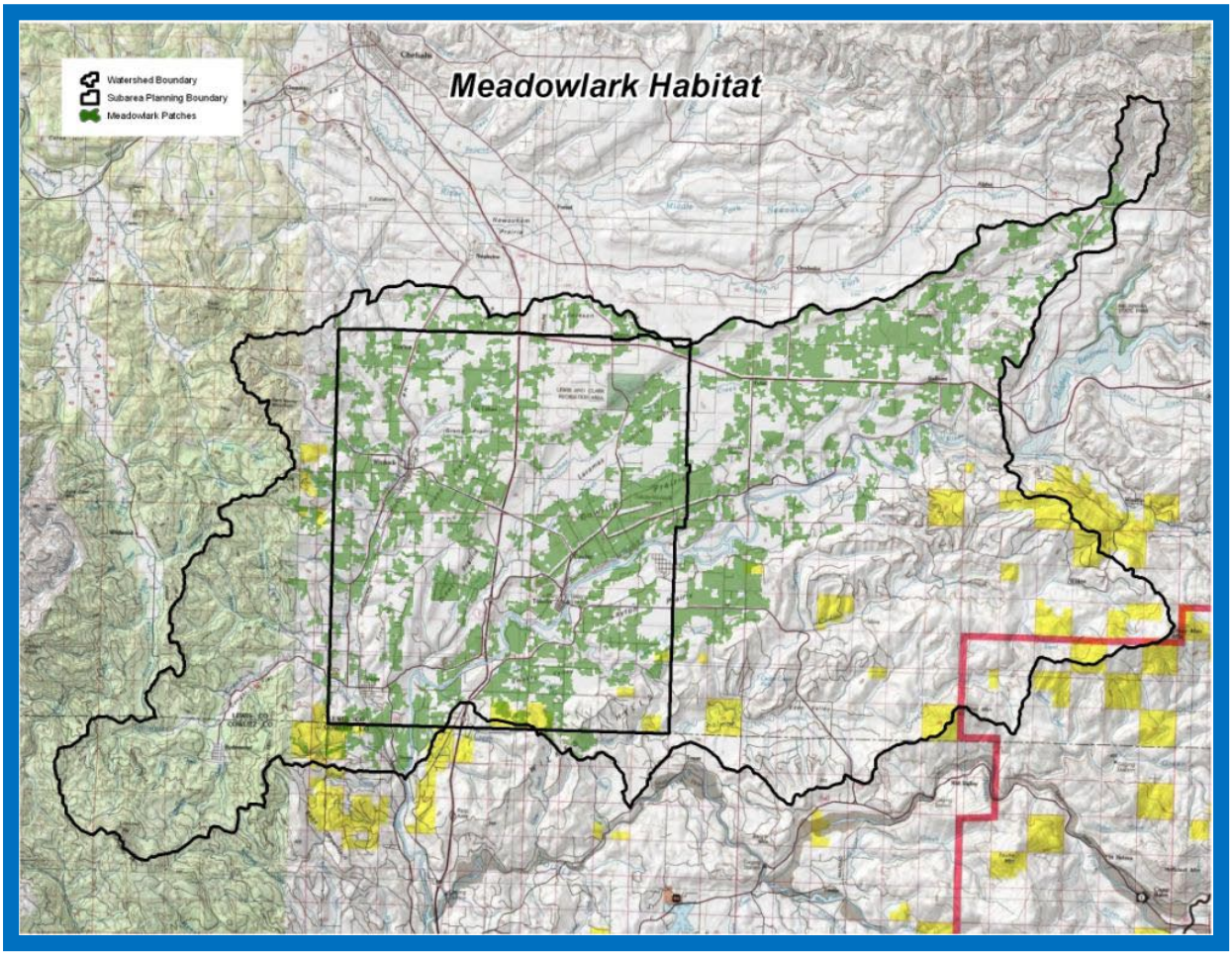

***Figure 11**. Availability of patches for Western Meadowlark*

Western Meadowlarks are present, but considered uncommon within the south county area. Also associated with open/grassland habitats, meadowlarks feed primarily on insects and seeds (Erlich, et al. 1988). Patch size requirements for these birds are on the order of several tens of acres. The map in Figure 11 shows the availability of open habitat patches 50 acres or larger.

Merlin

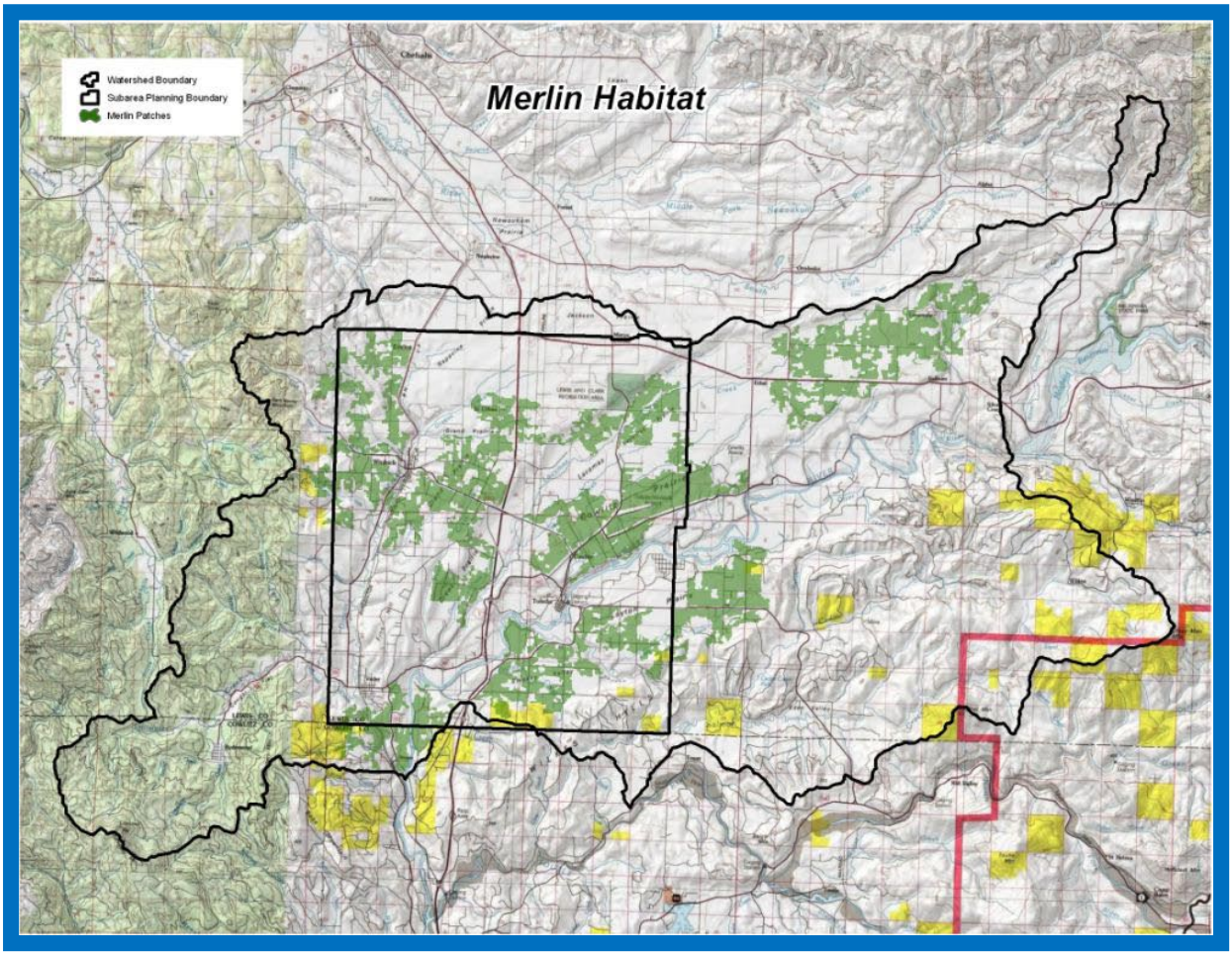

***Figure 12**. Availability of habitat patches for Merlin*

These medium-sized birds are associated with open/grasslands including agricultural use areas, forest edges, and open stand forests. Merlins prey on other birds, small mammals, and insects. They can have home ranges that can exceed 1500 acres, depending on prey availability, though they do not generally defend hunting territory, so overlap is possible (Konrad 2004). The analysis in Figure 12 shows the distribution of habitat patches of 1500 acres or more.

Oregon Vesper Sparrow

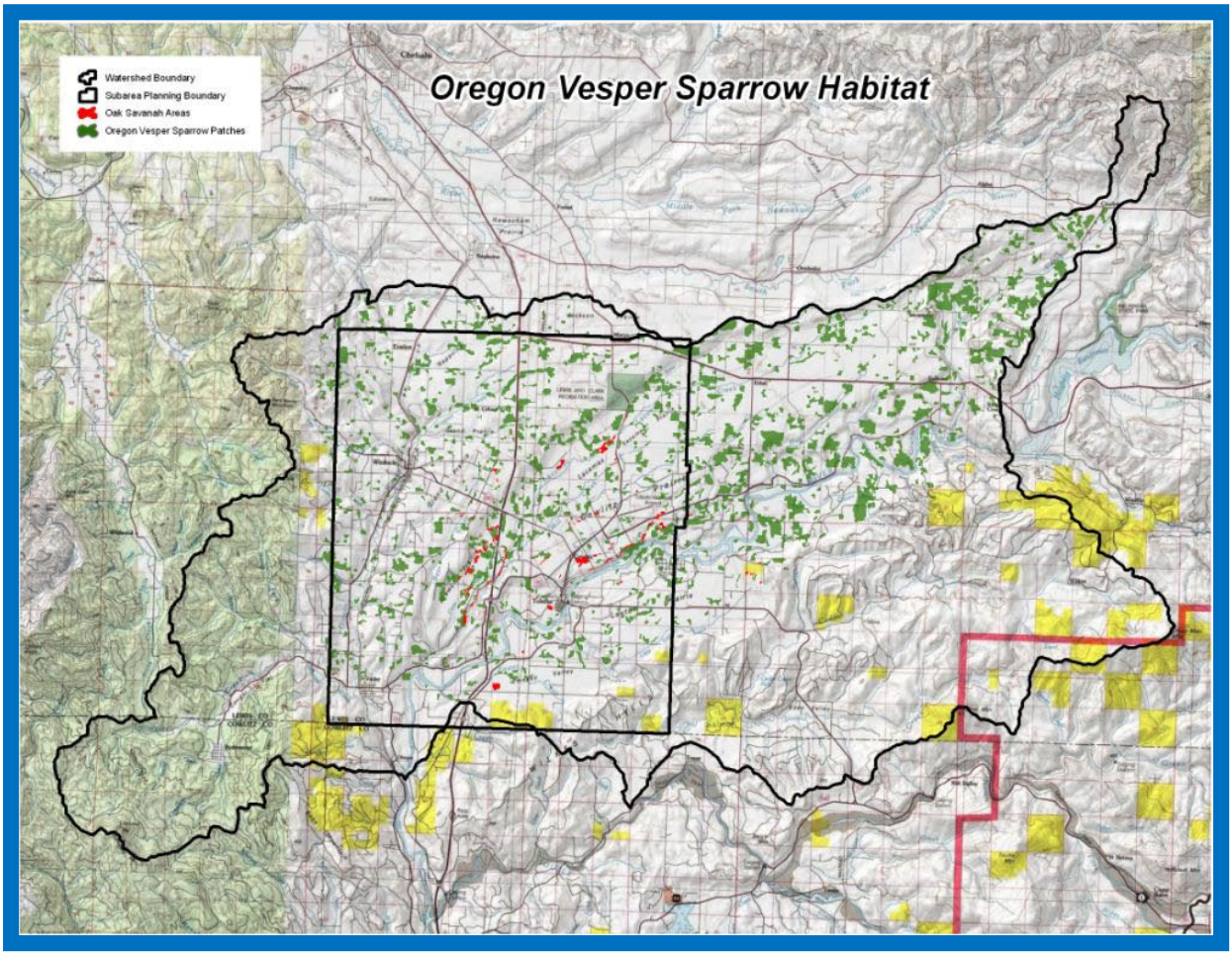

***Figure 13**. Suitable habitat for Oregon Vesper Sparrow*

Oregon Vesper Sparrow is considered a Species of Greatest Conservation Need in *Washington's Comprehensive Wildlife Conservation Strategy* (WDFW 2005). These birds are ground nesters associated with dry grassland and shrub habitats, remnant prairie, and oak savannah (Brown 1985, Sibley 2000, COSEWIC 2006). Active agricultural use can disturb Oregon Vesper Sparrow nests, so hayfields are either avoided, or can become population sinks (Erlich, et al. 1988). Diet consists of insects and seeds. Habitat mapping in Figure 13 focuses on open patches of at least 50 acres, set away from urban edges. Patches marked in red are oak woodlands.

Forest Interior Birds

Hermit Warbler, Townsend's Warbler

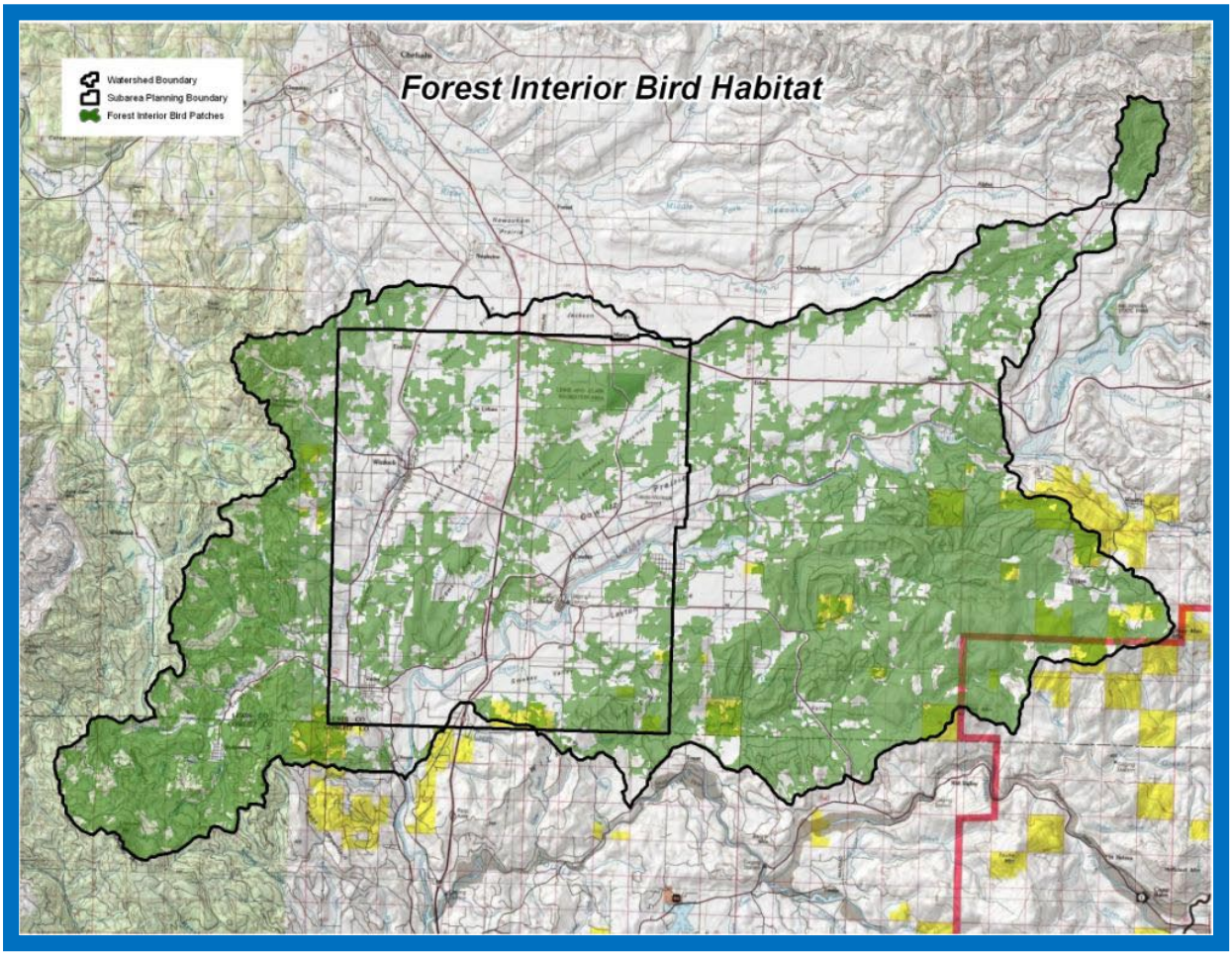

***Figure 14**. Suitable habitat for forest interior birds*

These warblers are forest interior specialists, requiring large wooded patches, and generally avoiding forest edges (Brown 1985). Insects are the main food source for both species; Townsend's Warblers are also known to eat seeds and plant galls (Erlich, et al. 1988). Both species are found in conifer, mixed conifer/hardwood, and hardwood forests. Townsend's Warblers may be more closely associated with closed stand conditions and forested wetlands; Hermit Warblers are associated most closely with mature and old growth stand age (Brown 1985). Figure 14 maps suitable habitat for these birds with patches of at least 500 acres in all forest types.

Forest Edge Birds

Hutton's Vireo

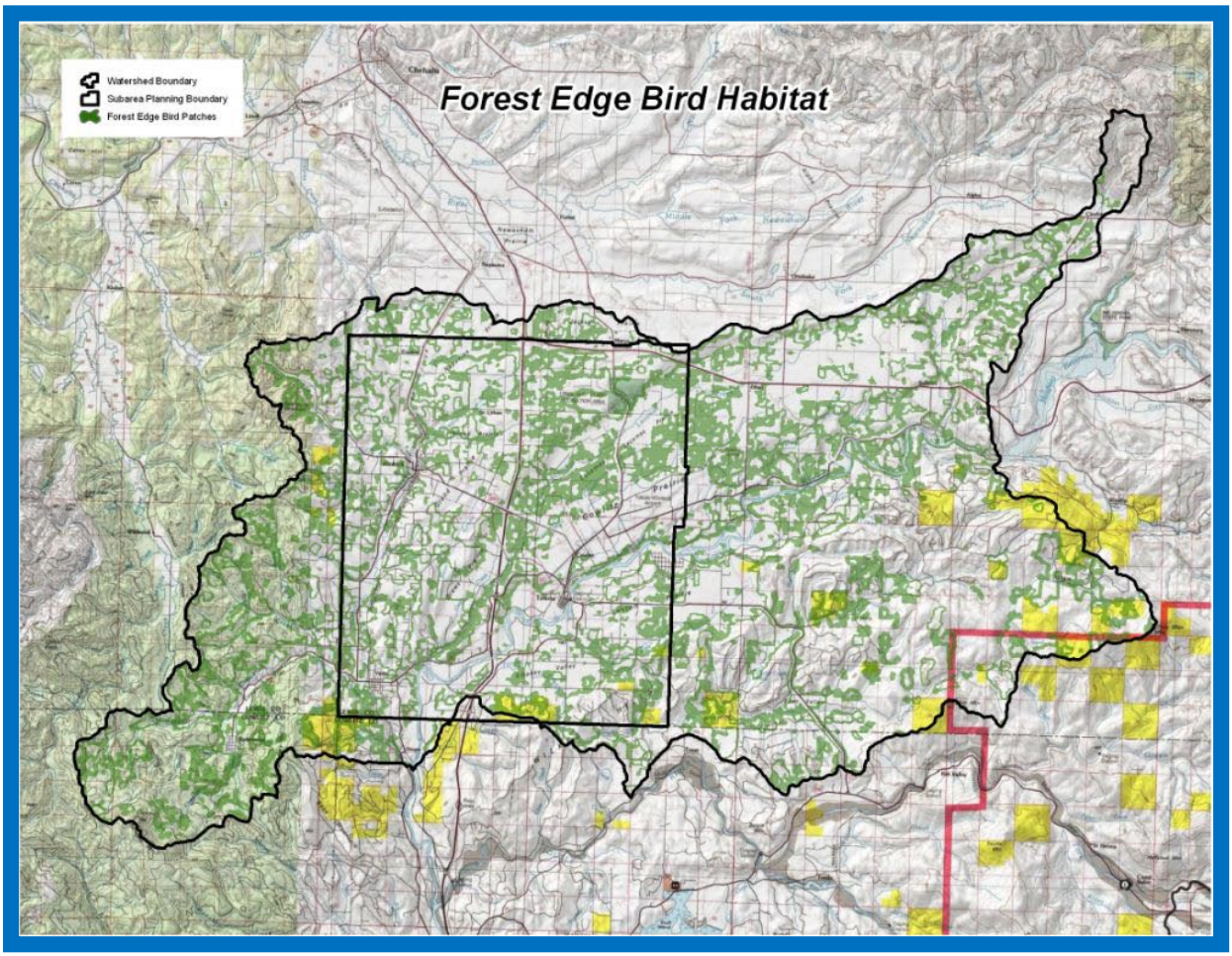

***Figure 15**. Suitable forest edge patches*

Hutton's Vireo is small bird, associated with shrub/forest and wetland/forest edges, and riparian areas of all forest types. These birds prefer open pole forest stand condition, but have a secondary association with mature and old growth age classes (Brown 1985). Their diet mainly consists of insects, spiders, and berries (Erlich, et al. 1988). Patch size needs likely exceed 12 acres, and may be larger during breeding season.

Forest Snag Birds

Pileated Woodpecker, Hairy Woodpecker

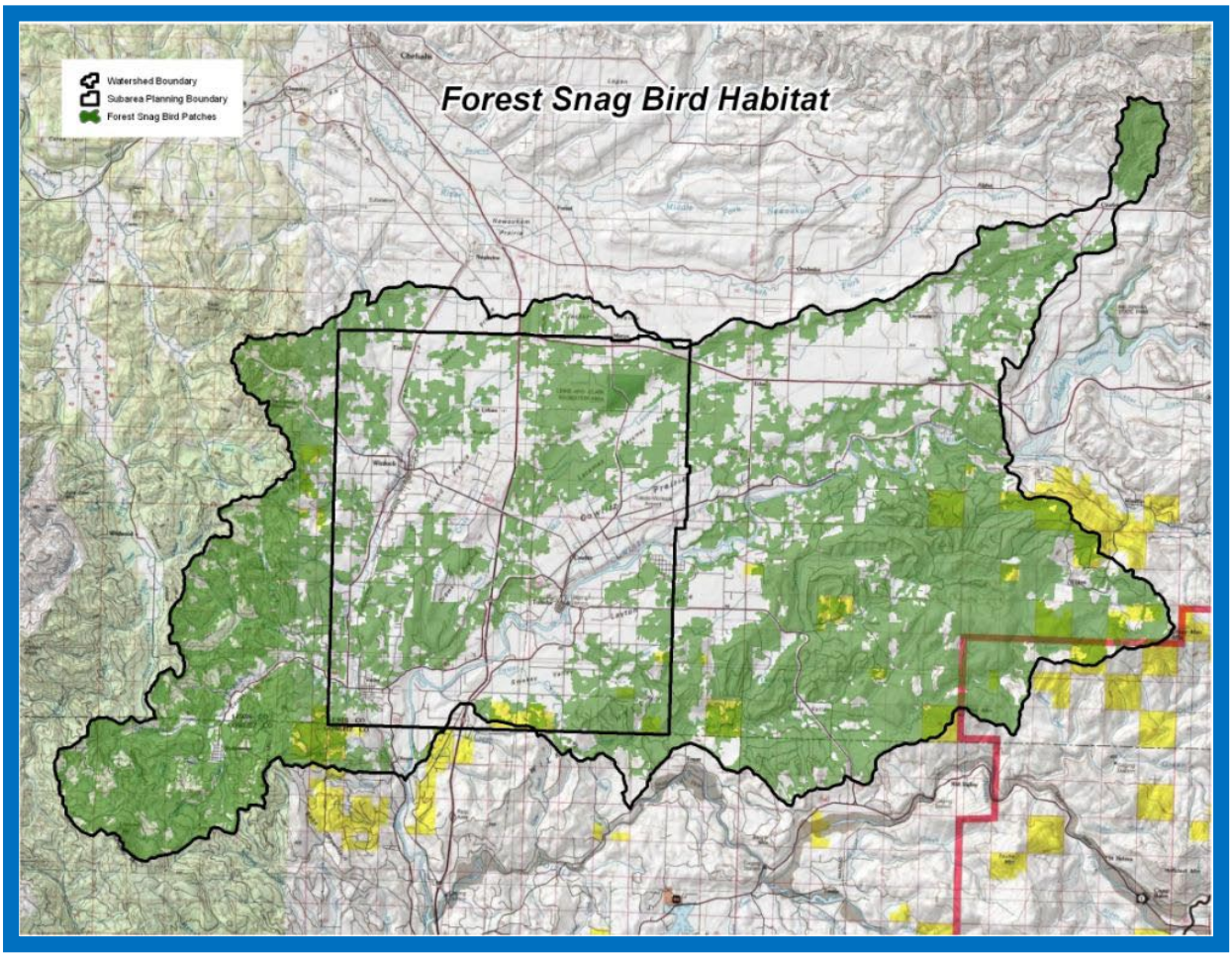

***Figure 16**. Habitat patches for Pileated Woodpecker and Hairy Woodpecker*

Both these species depend on snags and have primary and secondary associations with conifer and mixed forest types. Insects are the main dietary source for both species, supplemented by sap and nuts (Erlich, et al. 1988). Pileated Woodpeckers are the largest woodpeckers in the Pacific Northwest (Sibley 2000), and have home ranges that can exceed 300 acres (Brown 1985). Hairy Woodpeckers require patches generally larger than 12 acres. Habitat for the two species can overlap; Hairy Woodpeckers have been observed feeding in snags where Pileated Woodpeckers, with their stronger beaks, have removed the bark, leaving the wood uncovered (Erlich, et al. 1988). Patches large enough for Pileated Woodpeckers, in Figure 16 can also accommodate Hairy Woodpeckers.

Small to Mid-Sized Forest Mammals

Common Porcupine

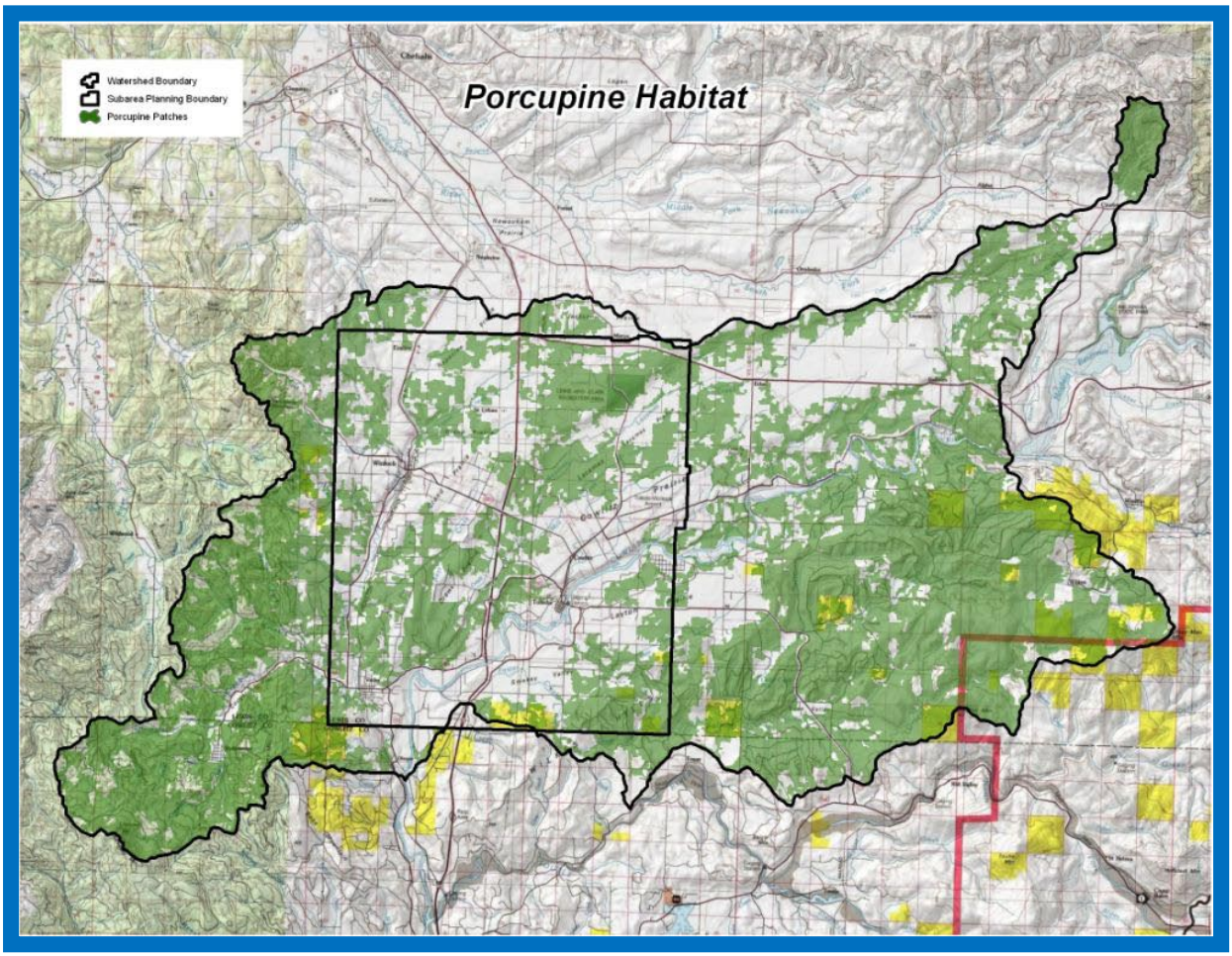

***Figure 17**. Available habitat for Common Porcupine*

Common Porcupines are mid-sized mammals associated with all forest types in the analysis area. Important habitat features include down wood, snags, and caves (Brown 1985). Home ranges can exceed 250 acres, although these needs may be lower in winter (Johnson & O'Neil 2001). Healthy subpopulations may require several territories to be embedded in a forest matrix as large as 6400 acres (Brown 1985). These are slow-moving animals whose quills can injure domestic pets, and whose foraging behavior can damage trees in working forestlands. Roads and deep water can be movement barriers for Common Porcupines.

Northern Flying Squirrel

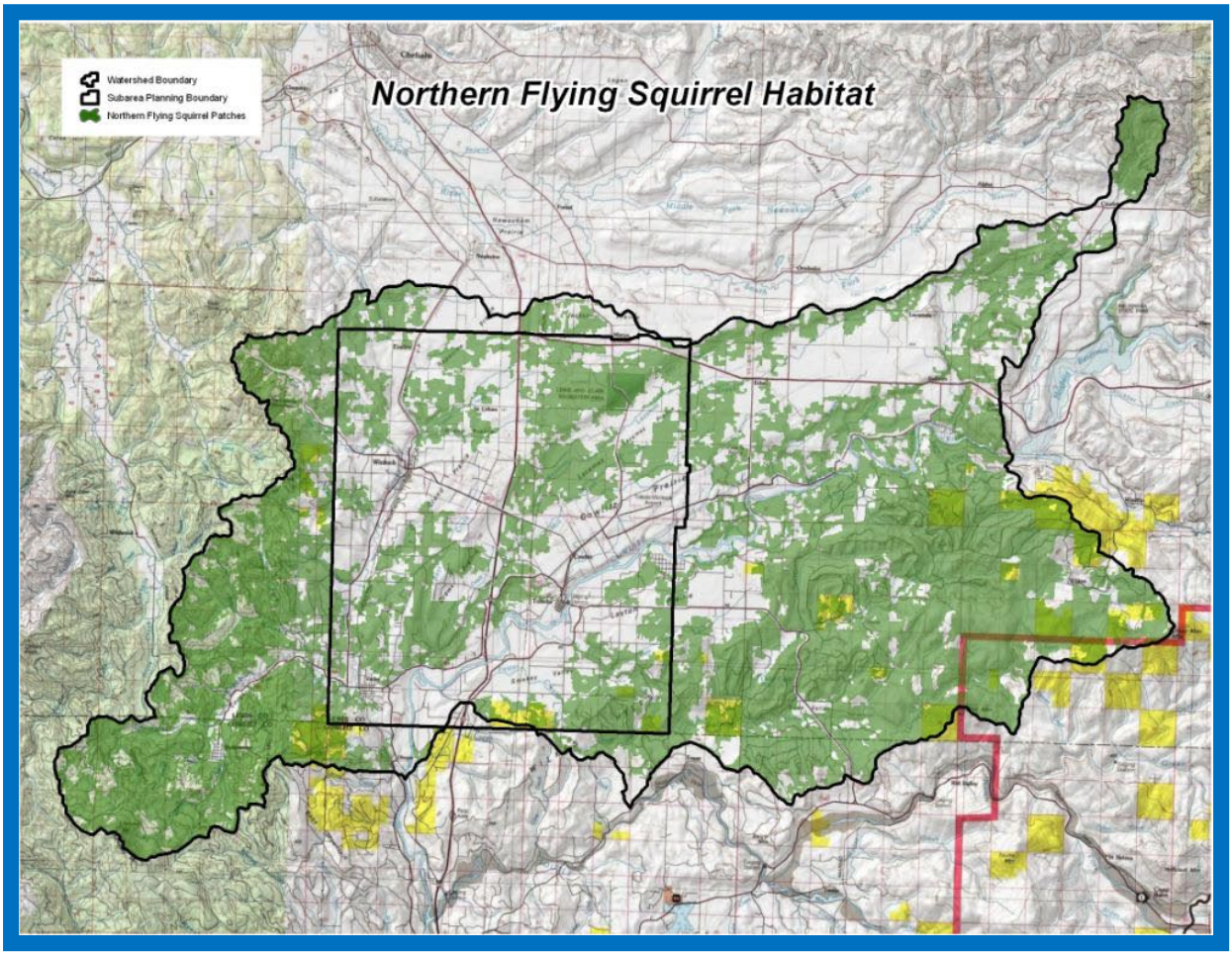

***Figure 18**. Available habitat for Northern Flying Squirrel*

Northern Flying Squirrels are small mammals associated with conifer, mixed, and hardwood forest types, as well as forested wetlands. Secondary association is with grassland/forest edge. Snags are important habitat features for these squirrels. Primary territory sizes can be small, on the order of five acres, but healthy subpopulations may require a 360-acre matrix of forest supporting multiple individuals (Brown 1985). Northern Flying Squirrels will generally avoid crossing forest openings greater than 400 ft. wide, preferring to travel around the outside of the opening (Johnson & O'Neil 2001).

Mid-Sized Predatory Mammals

Bobcat

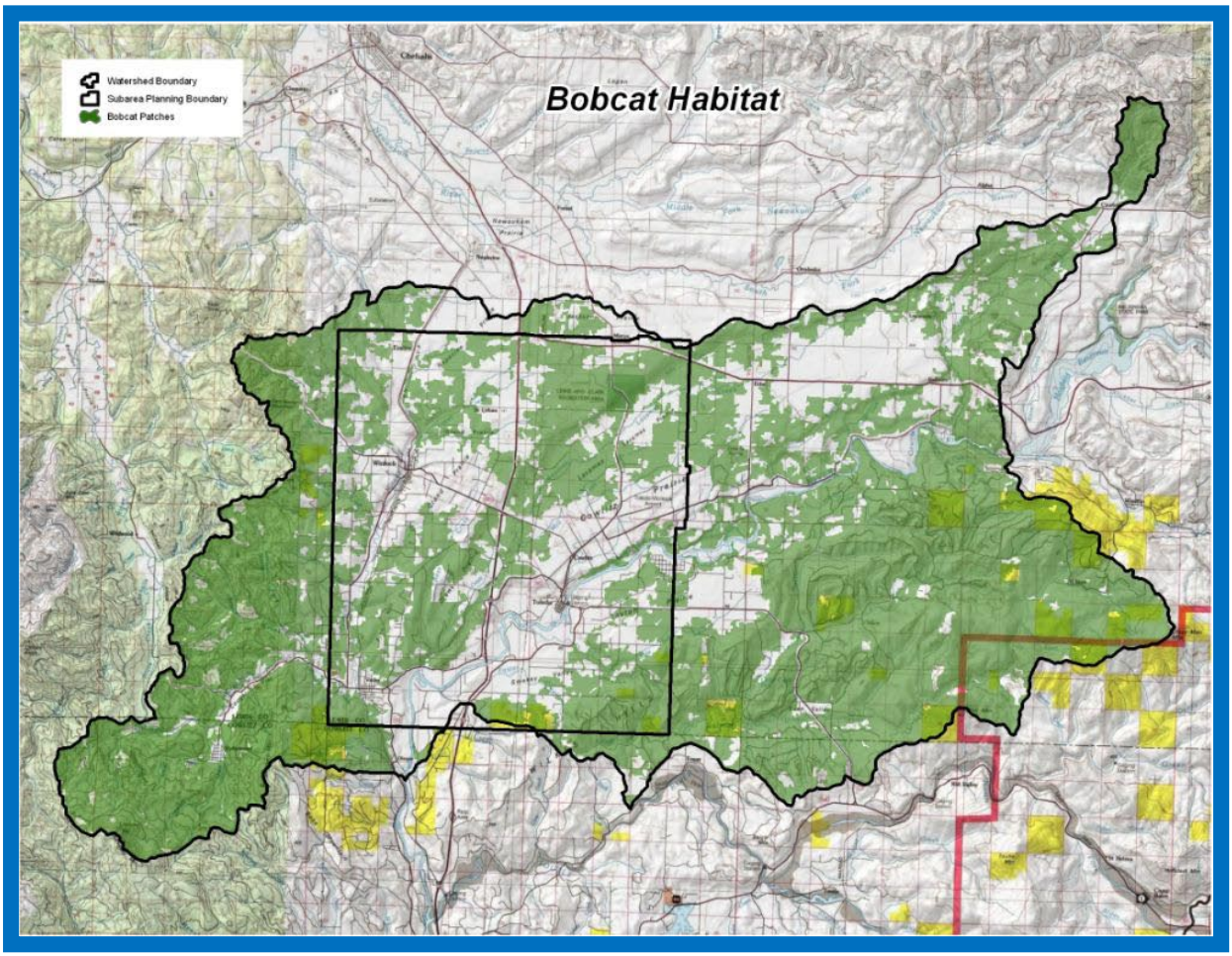

***Figure 19**. Available habitat for Bobcat*

Bobcats are mobile, mid-sized predators that can use a variety of different habitats. Primary and secondary associations are with all forest types, shrub-dominated, and open habitats, including wetlands. Important habitat features used by Bobcats are down wood, cliffs, talus slopes, and caves. Edge habitat holding at least some shrub cover can be valuable for these cats (Brown 1985). Home ranges can exceed 800 acres, but patches of this size can accommodate three or more denning territories occupied by female Bobcats (Crooks 2002).

Still Water Associated Reptiles and Amphibians

Northern Red-legged Frog, Western Toad, Common Garter Snake

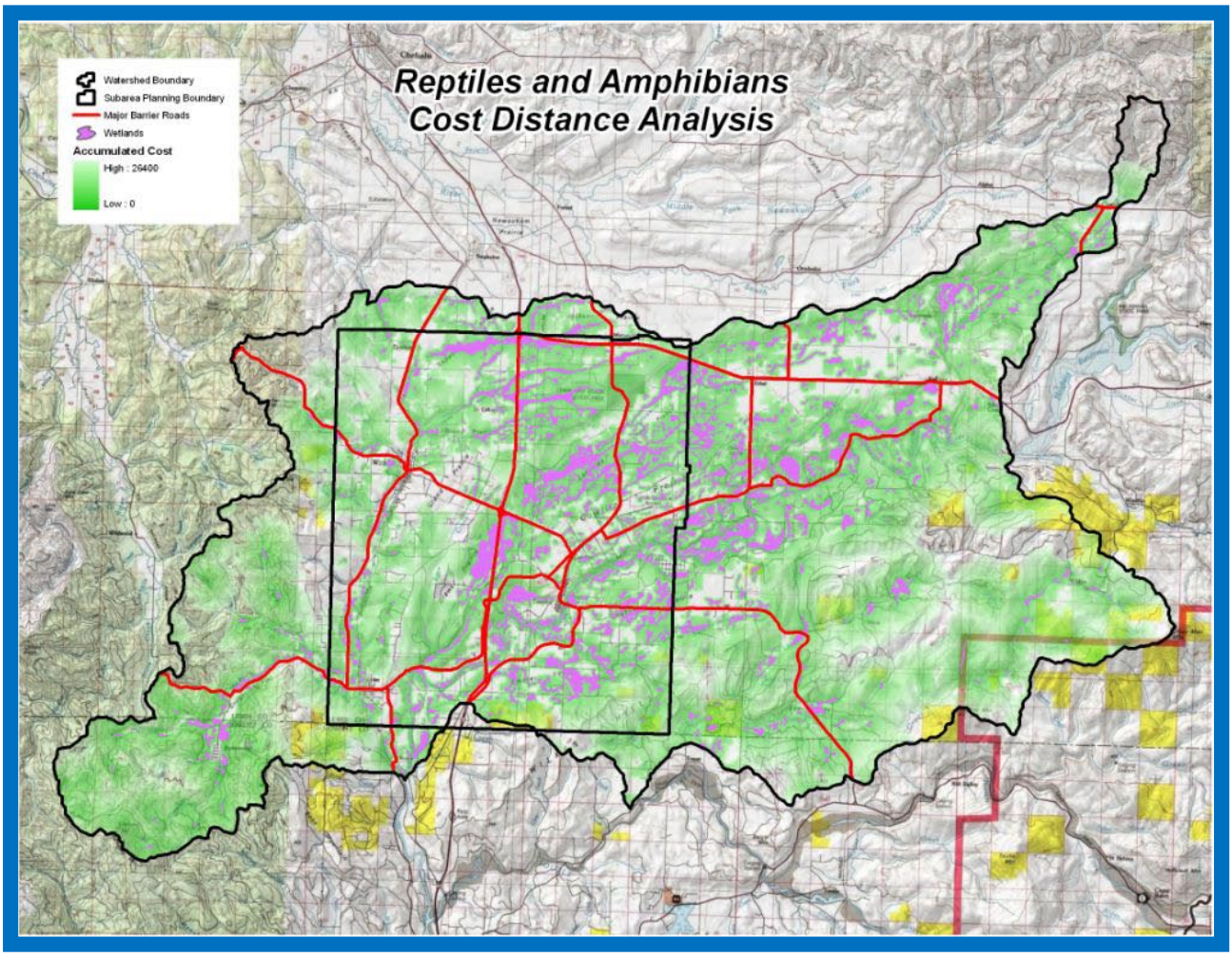

Figure 20*. Connectivity mapping for Common Garter Snake, Northern Red-legged Frog, and Western Toad. All shades of green are accessible to these animals. In the absence of adequate crossing structures, highlighted roads are considered complete barriers to movement.*

All three of these species are closely associated with still water, such as ponds and wetlands. Northern Red-legged Frogs and Western Toads breed in these habitats, and Common Garter Snakes feed there – amphibians are a major food source for them. All three species move seasonally to different habitats, and the distances they travel can be large compared to their body size: typically a mile or more (Hayes, et al. 2008). Because of their size and travel speed, roads can be significant barriers to this natural movement. Even relatively low traffic intensity can lead to high direct mortality for these animals. The analysis in Figure 20 models habitat permeability for this species group. It shows where complexes of wetlands are

relatively well connected. In the absence of special crossing structures, roads colored red are considered complete barriers to movement.

Summary of Analyses

Taken together, the preceding habitat analyses show that the south county area currently has an abundance of wildlife habitats, arrayed as relatively large, contiguous patches. These appear to be capable of accommodating the territories of wildlife species with high need for space and isolation from human development, as well as those animals with less demanding needs. Within the central part of the analysis area, the Lacamas Creek corridor and adjacent lands appear repeatedly as providing open/grassland, forested, and wetland habitats usable by all of the focal species. This recommended habitat focus area also contains occurrences of important but less common habitats, such as oak woodland and remnant native prairie. The location of the corridor within the planning subarea further emphasizes its potential as open space between urban growth area boundaries. Treating the corridor as a habitat focus area, through limiting fragmentation and other development-related impacts, would help insure that the subarea continue to support abundant and diverse wildlife populations.

Considerations for Implementation

Successful implementation will likely require a number of elements. First, and most importantly, successful implementation depends on community residents and local decision makers deciding that focusing most new development away from the most valuable habitat is a high priority. This decision would be formalized most effectively through designating the habitat focus area within the final subarea plan, and then adopting the subarea plan as part of the county comprehensive plan. Secondly, a combination of regulatory, incentive-based, and voluntary actions can contribute to successful implementation. A number of policy or regulatory changes would likely be needed to allow some of these actions to occur. Existing implementation tools include Lewis County's Critical Areas Ordinance (CAO), Public Benefit Rating System, rural/natural resource lands zoning, and annual transportation project planning/ranking process.

Some ideas for implementation:

- Provide additional points under the Public Benefit Rating System (PBRS) for lands in the Lacamas Creek habitat focus area to foster land conservation through favorable property tax rates.
- Encourage the use of cluster development on lands zoned R 1-5, -10, and -20 within the habitat focus area. Some density incentives, combined with permanent protection of large, contiguous habitat patches, would reward landowners for developing in a way that best protects wildlife habitat connectivity.
- Adopt policies in the comprehensive plan supporting the need to plan for wildlife habitat and connectivity and to consider impacts to local biodiversity for rezone/land use change proposals.
- Change mitigation provisions of the CAO to allow for and encourage, in appropriate circumstances, off-site mitigation for unavoidable fish and wildlife habitat impacts.

The habitat focus area should be considered a priority location for off-site mitigation projects.

- Project location for hydrologic process and water quality impacts (i.e., wetland fills) should be guided by Department of Ecology restoration priorities. When consistent with Ecology guidance, the habitat focus area can be considered a priority location for these projects, to gain additional resource benefits from the required mitigation.
- Given the importance of connectivity between the habitat focus area and the greater surrounding rural areas, individual land use/rezone proposals in outlying rural areas with comparatively high fish and wildlife conservation values could be limited, while development in or close to urban centers could be encouraged or offered incentives.
- Culvert and bridge maintenance or replacement projects within the Lacamas Creek habitat focus area could be prioritized for public funding under the Lewis County Department of Public Works annual transportation improvement program (TIP). By linking road infrastructure development with the reopening and upgrading of fish and wildlife migration crossings, this would provide incentives for rural redevelopment that also improves connectivity for fish and wildlife movement.
- Enable a trading of development rights (TDR) program through a new county ordinance. Such an incentive-based program would allow willing landowners within the habitat focus area (and other areas throughout the county) to gain financial benefit for foregoing development and providing the community with protection of wildlife habitat and working lands.
- Consider adding oak woodlands and remnant native prairie as habitats of local importance under the CAO. This action would require project review that would allow state agency biologists to assist landowners with ideas for managing these important habitat features.
- Consider expanding county riparian buffer requirements to match those within Winlock or Vader. As a second option, consider requiring wider buffers within the habitat focus area.

This list is not exhaustive, but does provide examples of the kinds of planning actions and policy changes that can be successful in implementing wildlife habitat protection.