Lewis River Case Study Final Report

A decision-support tool for assessing watershed-scale habitat recovery strategies for ESA-listed salmonids

Appendix A: DSS Base Data

May 2007

Introduction

In this appendix, we describe methods and sources used to generate descriptions of current conditions in the Lewis River Decision Support System (DSS). We describe how we characterized the landscape and how each data source was used in the analysis.

Stream Network Features

Our first step was to delineate basic stream network features: a routed stream network; stream segment lengths; gradients; and lateral drainage areas. We used NetStream (Miller 2003) to generate a stream network based on a 10m DEM and to segment the stream network. We used spatial data from Salmon and Steelhead Habitat Inventory and Assessment Program (SSHIAP) (WDFW 2004) to determine stream segment lengths and tributary junctions for a routed spatial network. Using NetStream, we also generated indicators of stream connectivity (upstream and downstream segments identified) for each stream segment. Stream channel gradients were estimated by fitting a polynomial to stream reach elevations and slopes and estimating slopes for each channel reach pixel; gradient was calculated by averaging over the pixel values for the entire length of each reach (Miller 2003). We attributed each reach with bankfull width estimates modeled from precipitation, stream gradient, and field measurements throughout the Lewis watershed (Appendix G). Next, we used topographic (DEM) and hydrologic features to delineate the lateral drainage areas (drainage wings) for each stream reach (Figure A-1). Drainage wings are the areas that drain to each stream reach. They represent the smallest landscape summary unit and are essential to the sediment routing model (Appendix F) and the surface sediment model (Appendix E).

Vegetation and Land Cover

Land cover information from previously classified satellite imagery was used to represent current vegetation conditions (Lunetta et al. 1997; USGS 1999; BLM 2001; USFS 1995). Three land cover data sets were incorporated into a current template of land use and vegetation. Multiple land cover data sets were incorporated into the base spatial template, because no single data set contained all the necessary modifiers or the correct attribute resolution (Table A-1).

Vegetation type and land cover are used to characterize upslope and riparian areas in the watershed. Current vegetation and land cover are mainly used in the riparian model (Appendix H) and for selecting areas for riparian restoration and preservation. Riparian vegetation condition also modifies sediment and hydrological inputs to stream segments. Land cover types were determined by creating dominant categories that were compatible with the U.S. Forest Service WEPP model (Table E-1, Table E-2). Vegetation categories used for forested areas are 20-year forest, 5-year forest, shrub, grass, and bare ground (Table A-1).

We replaced areas with clearcuts and light fires with 5-year forest because the clearcut age was not evident from the IVMP classified vegetation. The clearcuts are of varying ages (all <10 years old), but the imagery does not readily provide a way to determine the age differences. Clearcut estimates in WEPP are suitable for recent clearcuts, and the imagery was not recent enough to meet the WEPP clearcut description. The primary source of imagery represents vegetation conditions in 1996. Moreover, when we calibrated our sediment yield estimates with existing sediment yield data for the watershed, the 5-year forest surface erosion estimates more closely matched the field estimates (PWI 1998, PacifiCorp and Cowlitz PUD 2002).

Urban land use comprised less than 1% total area for any 7th field hydrologic unit within the watershed, so it was not originally given special treatment when considering surface erosion. Hydrologic units containing urban pixels in either the USGS or BLM original classified imagery were used to select streams segments with a meta-polygon code of ≥7000. The meta-polygon code for these streams was manually updated to differentiate land cover as urban vs. rock or bare ground.

Table A-1. Classification grouping scheme for vegetation and land use information used in the stratified landscape component of the DSS runoff and sediment yield models. Full references for data sets can be found at the end of this document. LCFRB = Lower Columbia Fish Recovery Board Data – various sources, primarily classified imagery from Lunetta et. al., 1997 (data from 1992 classified Landsat). IVMP = Bureau of Land Management Interagency Vegetation Mapping Project – data from 1996 imagery. USGS = U.S. Geological Survey.

Category/ Source	Vegetation Type	Description
20-year forest, 100% cover , mid-to-late seral stage		
LCFRB	Late Seral Stage	Coniferous crown cover >70%. More than 10% crown cover in trees ≥21 inches diameter at breast height (dbh).
	Mid Seral Stage	Coniferous crown cover >70%. Less than 10% crown cover in trees ≥ 21 inches dbh.
IVMP	Conifer cover ≥70%	
5-year forest, 85% cover, clearcut regrowth, new clearcuts, light burns, and early seral stage		
IVMP	≤70% coniferous vegetation OR ≥ 70% vegetation but < 30% coniferous vegetation	
	Total forest cover = 0-100%	Includes only forested areas
USFS	Recent wildfires	Fires that occurred within the Lewis River watershed between 1990 and 1994
LCFRB	Early Seral Stage	Coniferous crown cover ≥10% and <70%. Less than 75% of total crown cover in hardwoods tree/shrub cover.
	Other lands in forested areas	Areas in forested lands with <10% coniferous crown cover (can contain hardwood tree/shrubs, cleared forest lands, etc.).
Shrubland, 80% cover		
USGS	Shrubland	Areas dominated by shrubs; shrub canopy accounts for 25-100% of the cover
	Woody wetlands	Areas where forest or shrubland vegetation accounts for 25-100% of the cover and soil/substrate periodically saturated with or covered with water
	Herbaceous wetlands	Areas where perennial herbaceous vegetation accounts for 75-100% of cover and soil/substrate is periodically saturated with or covered with water.
Grasslands/prairie, 40% cover		
USGS	Grasslands/Herbaceous	Areas dominated by upland grasses and forbs
Severe fire 45% (15% true) cover Severe category is recommended for recent, high intensity burns		
USFS	Historical severe burns	General boundaries of historical burn areas from USFS fires history map, includes documented fires of 1902,

		1917, and 1924
Urban use, rocky outcrops, quarries, or bare ground		
USGS	Low Intensity Residential	Areas with a mixture of constructed materials and vegetation that most commonly include single-family housing units.
	High Intensity Residential	Areas with heavily built up urban centers such as apartment complexes and row houses.
	Commercial/Industrial Transportation	Areas with infrastructure (e.g. roads, railroads, etc.) and all highways and all developed areas not classified as High Intensity Residential
	Bare Rock/Sand/Clay	Areas of bedrock, desert, pavement, scarps, talus, slides, volcanic material, or glacial debris
	Quarries/Strip Mines/Gravel Pits	Areas of extractive mining activities with significant surface expression.
	Transitional	Areas of sparse vegetative cover, often because of land use activities.
IVMP	Urban	
	Barren	bare soil, rock, lava, sand, etc.
Agricultural use		
USGS	Pasture/hay, small grains, fallow	Areas of grasses, legumes, grass-legume mixtures, wheat, barley, oats or temporarily barren from tilling
	Orchards, vineyards, and row crops	Areas of crops, such as corn, soybeans, vegetables, or orchards/vineyards
	Urban/Recreational Grasses	Urban vegetation in parks, lawns, golf courses, airport grasses, and industrial site grasses.

Stratification of the Landscape

A primary objective of the DSS is to model changes to landscape features and measure their effect. Three landscape stratifications categories were used: soil texture, land cover (vegetation and land use), and topography (slope). These three stratified parameters were the primary descriptors of upslope landscape characteristics for stream reaches and drainage wing watersheds, determining, for example, surface sediment and runoff data used in the DSS. Vegetation, surface runoff and sediment input to streams are changed to model impacts of restoration and protection actions (Appendix D).

ESRI ArcInfo GRID and polygon spatial data structures were used to analyze and stratify the landscape into discrete units or patches. The grain size of the analysis was $30m^2$, as determined by the dataset with the lowest resolution (i.e., largest cell size) of the datasets used in spatial modeling. Each cell represents soil, vegetation, or slope at the $30m^2$ grain size. Vegetation, soil, and slope grids were overlaid to produce one grid, which identifies unique clusters or patches of co-located features with a grid code, which we call meta-polygons (Table A-2; Figure A-1). These cluster codes correspond to the WEPP surface and mass wasting sediment yield (SY), and the WEPP surface storm runoff (SSR), described in Appendix E. Data were converted to a polygon format, which resulted in a dataset with clusters of polygons, with homogeneous land cover and physical characteristics (hence the name “meta-polygons”).

Table A-2. Coding scheme for meta-polygons. Final cluster codes within the DSS database are an additive combination of vegetation code + slope code + soil code.

Vegetation		Slope		Soil	
Type	Code	(%)	Code	Type	Code
20 year forest	2000	0-10	100	silt loam	1
5 year forests	3000	10-20	200	clay loam	2
Shrubland	4000	20-30	300	sand loam	3
Grassland	5000	30-40	400	ash, pumice subsoil	4
Fire	6000	40-50	500		
Urban	7000	50-60	600		
Agriculture - alfalfa	8000				
row crops	9000				
recreational grasses	10000				
Bare rock	11000				

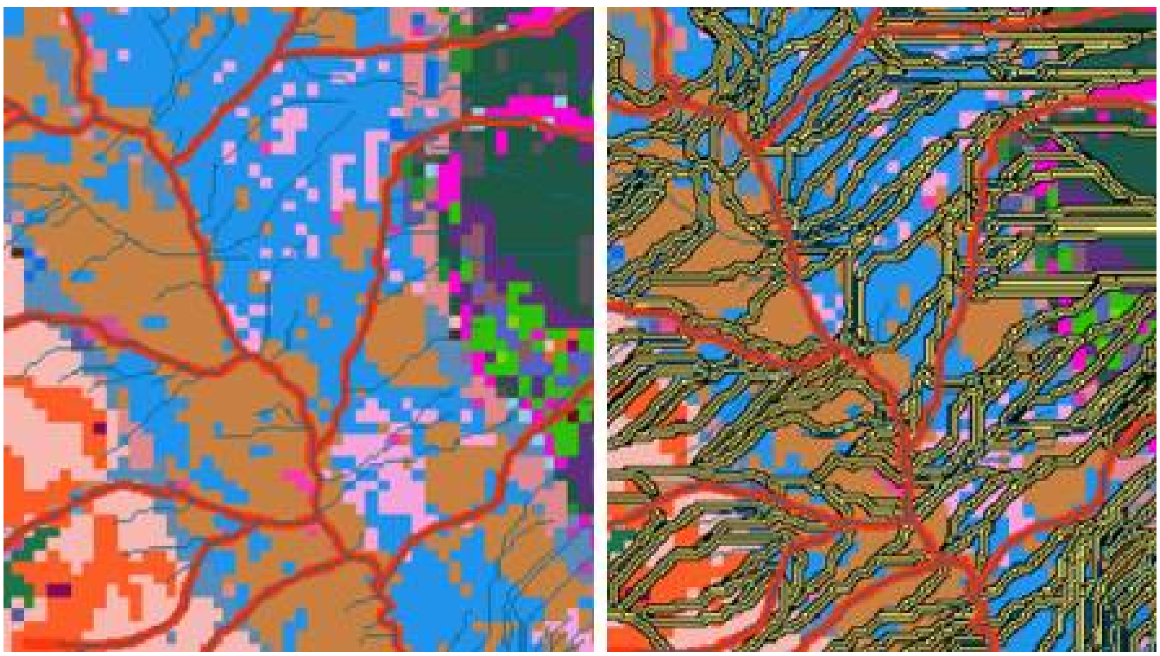

Figure A-1. The image on the left illustrates a section of the meta-polygon data for the Lewis River. Individual colors represent unique pixel cluster codes. Parts of this combined cluster code schema are identified in Table A-1. The image on the right illustrates the "wing code" or lateral drainage wings over which measurements for each reach are summarized. The number of paired drainage wings between tributary junctions is equal to the number of stream reaches.

The base land cover data were then intersected with the drainage wings for each stream segment to split meta-polygons that overlapped between multiple lateral drainages, and to identify the co-located drainage area (Figure A-1). Meta-polygons were further subdivided into riparian and upland zones by intersecting them with a 60m stream buffer per bank. This additional information was necessary for modeling the effects of riparian restoration or protection. Total area for each unique meta-polygon cluster code was then summarized for each lateral drainage zone, and transferred to a tabular database used in the DSS for modeling effects of conservation strategies. The summarized land cover codes, location (riparian or upland), and corresponding areas are stored as an SDE spatial feature dataset, with tabular attribute information and summaries. These data are viewable within a GIS, but the DSS uses only the summarized tabular information for further processing. Only the total area of each unique class of meta-polygon was calculated for the each lateral drainage area. The grain size of the final analyses was dependent on the size of the drainage wing and the proportion of the homogeneous meta-polygon clusters within this wing.

Soil and Topography

Two main sources of data were used to characterize soils in Lewis subwatersheds. Soil information for the Gifford Pinchot National Forest (USFS 1999) was used for federal lands within the watershed. Soil Survey Geographic database (SSURGO) (NRCS 2000) and Department of Natural Resources 1:24,000 scale soil data (DNR 2000, DNR 2002) were used for the remaining non-federal sections of the watershed. The spatial soil information was generalized into a few classes of surface soil texture, and were edge-matched together to create one soil GIS GRID for the entire watershed, since the attributes for each were similar and had similarly described attributes and source scale. A variety of loam-dominated soil textures were present in the Lewis watershed, and we grouped the existing information so it best matched WEPP parameters (Table A-2).

Hillslope was calculated for each cell in a 10-meter Digital Elevation Model (DEM) of the watershed. GRID data were then resampled to match the minimum mapping unit of $30m^2$ cell size. Hillslope is calculated by the maximum rate of elevation change from each cell to adjacent cells. Percent slope was then grouped into six categories to correspond to WEPP interface parameters. Slope categories are split by 10% increments as depicted in Table A-2, and described in Appendix E. Slope categories were based on the general slope classification from the DEM (0%-10%, 11%-20%, 21%-30%, 31%-40%, 40%-50%, and 50%-80%).

Surface Sediment

The DSS sediment routing model (Appendix F) required information on the distribution of soil sediment size. Sediment size distributions for both surface and road sediment yields were obtained from the SSURGO databases and soil surveys for each county in Lewis basin (Clark, Cowlitz, and Skamania) (NRCS 2000; DNR 2000; DNR 2002).

The DSS variable used for estimating in-stream sediment size is derived from proportional estimates of soil size classes for each drainage wing and associated stream reach. Soil horizon estimates based on Washington DNR and SSURGO data were used to estimate the proportions of various sediment sizes (DNR 2000; NRCS 2000). Data were unavailable for a small section of the upper North Fork Lewis, so U.S. Forest Service soil information was used in this section (USFS 1995).

Each soil series type is differentiated by a code named the Map Unit Key (MUKEY) or MapUnit (USFS). Soil series with the same MUKEY are typically spatially disconnected polygons that may be distributed across the landscape. Specific information on the soil sizes within the soil horizon is available at the spatial scale of the MUKEY. The soil size comprising a soil series is called the *soil distribution*, and is determined by percent proportion of sample soils with grain size larger or smaller than a given sieve size (DNR 2000). Data from six to ten size categories were grouped into six size classes and percent of total was calculated for each sieve class by the MUKEY (Table A-3).

County-level SSURGO data was used as extensively as possible. Large sections of the Gifford Pinchot National Forest (GPNF) (upper North Fork Lewis) are outside the spatial extent of the SSURGO soils database. To obtain soil distribution information in these areas, USFS soil type MAP UNITS were calibrated to SSURGO soil series where spatial overlap occurred. The Skamania County SSURGO database overlapped the GPNF in portions of the Upper Lewis watershed, and the Clark County database overlapped a portion of the Gifford Pinchot in the Middle Lewis watershed and East Fork Lewis watershed. After calibrating the data, soil distribution values were extrapolated to the areas with similar soils in the upper North Fork Lewis.

Once the soil distribution summaries for road and surface sediment were complete for the entire watershed, we summarized soil distribution by lateral drainage area for each reach. Soil series polygons were intersected with the lateral drainage area polygons (drainage wings), so that each drainage wing contained multiple patches of each soil series and associated soil distributions. An output summary table was created for each of the six soil size categories. Each table contained the distribution of percent values that occur in each lateral drainage zone, weighted by area. The relative contribution of the particular soil size to the total area of the drainage wing zone was calculated by:

$$S = \sum \left(\frac{A_{mprc}}{A_z} \right) P$$

where

S = proportional sum for size class

A_{mprc} = area (m^2) of MUKEY fraction percent value within drainage zone

A_z = total area (m^2) of drainage zone

P = MUKEY fraction percent value

The resulting value *S* is an area-weighted soil size estimate for the zone.

The SSURGO database does not provide information to estimate sediment sizes from mass wasting. The sediment size distribution was estimated from mass wasting assessments from the Tilton and East Fork Lewis watershed (Appendix F, Miller, 2004 pers. comm.). The mass wasting size distributions were converted to volume per unit area and then combined with *S* to calculate total soil size estimate per unit area. The results were tested for consistency, and *S* for the size classes summed to 1 in most cases. The drainage zone and associated adjusted soil size fraction were imported into the DSS database, for use as a base input in the sediment routing procedure.

Table A-3. Sample table showing sediment size distribution classes by map unit key. Sediment size distributions (mm) for surface and road sediment yields were obtained from the SSURGO databases and soil surveys for each county in Lewis basin (NCRS GIS database). In the database, each soil series (MUKEY in the database) has a distribution based on percent of size greater or less than a given sieve size. Sediment sizes were distributed into 6 size classes that were then incorporated into the DSS Access database.

MUKEY	> 78mm	>4.8-78mm	1.0-4.8mm	<1.0-0.5mm	<0.5-0.25mm	<0.25mm
	Cobble	Coarse gravel	Very Coarse sand to gravel	Coarse sand	Med sand	Fine sand and less
	GT78_PRC	GT4.8_LT78	LT4.8_GT1	LT1_GT.5	LT.5_GT.25	LT.25_PRC
71952	0.0	28.0	2.5	3.6	5.0	60.9
71953	0.0	28.0	2.5	3.6	5.0	60.9
71954	2.7	22.7	10.0	12.4	11.7	40.5
71955	4.7	23.7	0.0	0.1	0.5	71.0
71956	0.0	0.0	0.1	0.4	1.0	98.5
71957	0.0	0.0	2.8	3.6	5.9	87.8
71958	0.0	0.0	2.8	3.6	5.9	87.8
71959	0.0	13.3	3.5	6.8	7.1	69.2
71960	0.0	13.3	3.5	6.8	7.1	69.2
71961	0.0	13.3	3.5	6.8	7.1	69.2
71962	0.0	13.3	3.5	6.8	7.1	69.2
71963	0.0	13.3	3.5	6.8	7.1	69.2
71964	0.0	13.3	4.2	6.1	6.4	69.9
71966	0.0	0.0	0.1	0.4	1.0	98.6
71967	1.7	38.3	2.2	3.0	4.2	50.6
71968	1.7	38.3	2.2	3.0	4.2	50.6
71969	1.7	38.3	2.2	3.0	4.2	50.6
71970	0.0	1.3	4.8	14.2	19.0	60.8

Roads

The forest road information was determined using the Washington Department of Natural Resources (DNR) GIS roads data and spatial data for roads in the Gifford Pinchot National Forest (DNR 2000; USFS 1995). The DNR roads were the primary source for the roads analysis. The USFS data was used to fill in gaps within the watershed, and to determine which DNR roads were decommissioned. Decommissioned roads were removed from the analysis. Road surface type was determined using multiple sources of information (BLM 1999; USFS 1995) and estimated from local knowledge where surface type was unavailable.

Road data were intersected with DNR and USFS soil data, and coded with the local soil type. The distance from each road segment to the nearest stream channel was calculated by further intersecting the roads with a GRID representing Euclidean distance from the stream channel.

Riparian Data

Estimates of riparian condition are used in DSS models (fish response, runoff and sediment models) that focus on reach-related measures of stream habitat. Remotely-sensed riparian data were combined to estimate shade, pool-forming conifers, and large-woody debris recruitment in the riparian model (Appendix H).

Land cover information from IVMP classified satellite imagery was used to estimate three measures of riparian conditions for each stream reach in the DSS (BLM 2001). Resolution of the IVMP data is $30m^2$. IVMP data includes estimates of tree size (as dbh) and percent vegetation cover for deciduous and coniferous forests in a series of GRID GIS data structures. It was the most appropriate data available to estimate vegetation cover in the absence of extensive field data, because of the time period and indicated accuracy of classification of this data set (BLM 2001).

The base riparian habitat for each segment was determined by summarizing the dominant canopy cover, stand type, and tree size within a 60 m zone from either side of the stream. We used a modified riparian buffer for streams with larger wetted widths and ponds and lakes, which were identified as those stream segments or lake segments with double-banked streams in the SSHIAP waterbodies spatial data set (WDFW 2004). In these cases, the 60 m riparian zone started at the edges of the wetted width boundary edge of the stream or lake, as defined by the edge of the double-banked stream polygon (WDFW 2004). Tree size estimates in the data were limited to conifers with >30% cover per cell. Due to the cell size of the source land cover information, riparian summaries include 3-4 land cover analysis GRID cells per thirty meters of stream, depending on the sinuosity of the segment.

Original GRID data were summarized into 10% bins for tree cover, and a series of bins for average conifer size. This information was summarized for each stream reach into the following fields that were used in DSS models: percent total tree cover; percent of trees that are coniferous; percent of trees that are deciduous; and average conifer size. We translated the GRID data into summarized percentages per stream reach as follows.

To calculate tree cover categories, we summed the median percent for each bin:

$$P_{cc} = \sum_{1}^{10} Mb\left(\frac{Vb}{C}\right)$$

$$P_{tt} = P_{cc} + P_{cd}$$

$$P_{tc} = P_{cc} / P_{tt}$$

Where:

P_{cc} = percent cover that is coniferous

P_{cd} = percent cover that is deciduous (calculated exactly as for coniferous)

P_{tt} = percent of cover that is in trees (a.k.a. total tree cover)

P_{tc} = percent of total tree cover that is coniferous

P_{td} = percent of total tree cover that is deciduous (calculated exactly as for coniferous)

M = median value in a bin (e.g., we used 15 as the median value for the 11-20% bin)

V = the GRID cell value in a given percent cover bin

C = count of the total cells associated with a stream reach

b1 = 0-10% bin; b2 = 11-20% bin; b3 = 21-30% bin … b10 = 91-100% bin

To calculate the average conifer size, we summed the median size for each bin:

$$S_c = \sum_{1}^{6} Mb\left(\frac{Vb}{C}\right)$$

Where:

S_c = average conifer size; diameter at breast height, in inches

V = the GRID cell value in a given size class bin

C = count of the total cells associated with a stream reach

b1 = 0-4.9" bin; b2 = 5-9.9" bin; b3 = 10-19.9" bin; b4 = 20-29.9" bin; b5 = 30-49.9" bin; and b6 = >50" bin. Bins identifying non-vegetated areas (cells with <70% vegetation) and cells where conifers were not >30% cover were not included in the average size calculation.

These data were used in the riparian function model (Appendix H) and were also used to estimate seral stage for the remotely-sensed spawner capacity model (Appendix I).

Barriers

Our base barriers information was from SSHIAP-WDFW WRIA 27 barriers spatial datasets (WDFW 2003, 2004) (Figure A-1). Because of the difficulty in differentiating the sensitivity of fish species to moderate barriers, we omitted partial blockages from the analysis and used only barriers that completely blocked fish migration, as indicated by the source information or historical accounts (Wade 2000). Barriers with questionable status were double checked with personnel from WDFW to assure data accuracy. We modified the status of a barrier on Brezee Creek based on input from the public works department of the City of La Center.

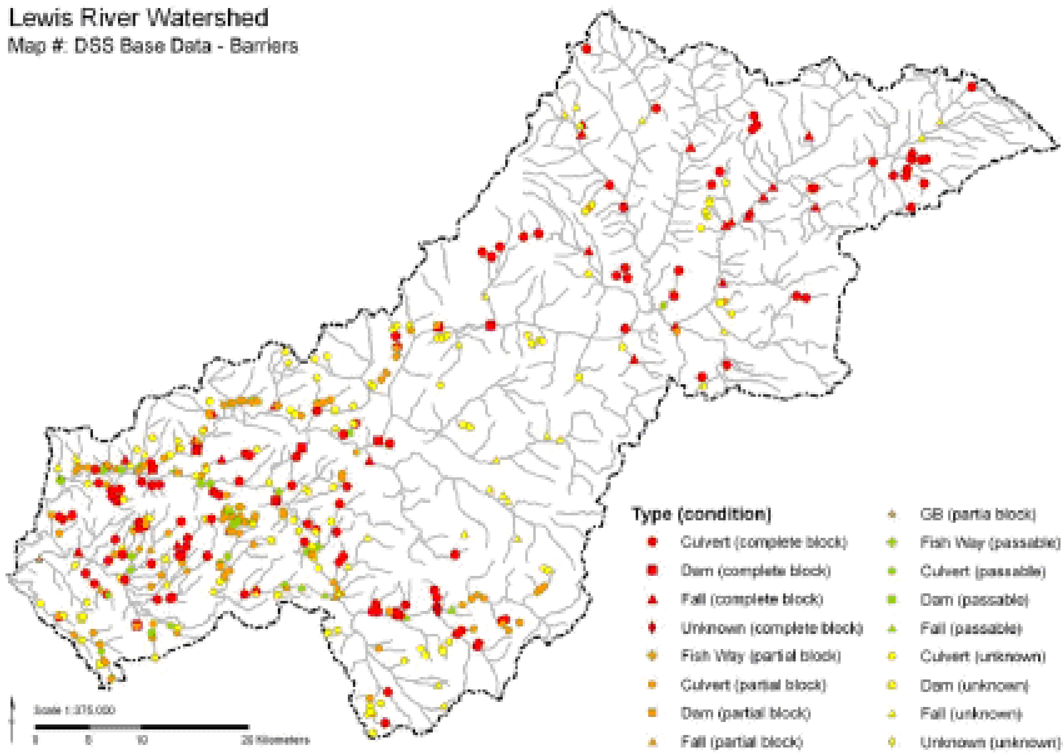

Figure A-1. Fish Barrier distribution in the Lewis River.

Fish Distribution

Distribution of salmon presence and potential spawning or rearing areas in the Lewis River watershed was delineated using SSHIAP documented fish distribution data (WDFW 2003) as our base data source (Figure 6 of the main report). Potential distribution (WDFW 2003) was defined by data on migration barriers, stream gradient, bankfull width, and other distribution information. Physical stream reach information was based on modeled stream network variables, as well as from the WDFW 2003 dataset. Actual fish distribution of fall chinook, spring chinook, winter steelhead, summer steelhead, coho, and chum includes aquatic habitat documented by Washington Department of Fish and Wildlife (WDFW) and local biologists as currently being used by each species or run-type, either for migration, spawning, or rearing (WDFW 2003). Based on WDFW documentation, distribution information is based on published sources, survey notes and first-hand accounts.

We also delineated potentially useable streams, streams with no documented use, but that are physically accessible to the particular species based on modeled physical reach variables. All streams were designated with a descriptive code that identified the stream segment as upstream or downstream of in-stream anthropogenic or natural barriers (Table A-1). The currently accessible documented and potential distribution for each species includes the WDFW (2004) documented tributaries and reaches, and all streams downstream of waterfalls, high gradient cascades, and manmade barriers to migration. The historical potential distribution includes all streams downstream of waterfalls and high gradient streams. Historical presence/absence documentation was also used to create the historical distribution (LCFRB 2004, Wade 2000) (Figure 6 of the main report).

Table A-1. Definition of codes used for classifying fish distribution and barrier distribution. These codes were combined with the SSHIAP-WDFW distribution guidelines and spatial fish distribution for each species to determine for each species what is currently accessible, what was historically accessible, and areas are naturally in accessible.

Code	Description	Distribution
A	generally accessible, currently	Current
H	historically accessible	Historical
IUCULV	Impassable section, upstream of culvert	Historical
IUCULV+DAM	Impassable section, upstream of impassable culvert and a dam	Historical
IUCULV+HYDRO	Impassable section, upstream of impassable culvert upstream of HYDRO facility	Historical
IUCULV_CONFLICTS	Impassable section, upstream of impassable culvert - using this in fishdist. likely will conflict w/ SSHIAP-WDFW fish distribution	Historical
IUDAM	Impassable section, upstream of impassable non-HYDRO dam	Historical
IUHYDRO	Impassable section, upstream of impassable HYDRO dam	Historical
IUNA	Impassable section, upstream of impassable natural barrier	None

Passable channel conditions for both current and historical distributions were defined as having channel width greater than 4 feet and channel gradients less than: 20% (winter and summer steelhead), 16% (spring and fall chinook, coho), or 5% (chum) (WDFW 2000). Distribution potential does not account for changes in water quality or habitat that may limit stream accessibility or productivity. Only totally impassable manmade barriers were considered to block upstream or downstream migration of salmon in the current distribution; streams with high concentrations of partially passable manmade or natural barriers may have limited migration and accessibility potential (Figure A-1).
Since there was not enough information above Lucia Falls when the original distribution data were created, literature was used to make corrections to fish distributions using the rules previously described. Occasional chinook and coho were seen above Lucia Falls but blocked at Sunset Falls whereas steelhead could go above Sunset Falls (LCFRB 2004, Washington State Department of Ecology 1999).

Adding recent restoration actions

To update our baselayer describing current conditions, we modified the GIS datalayers to reflect the restoration actions that occurred between 1998 and 2001. Completed restoration projects between 1998 and 2001 were collected from a variety of sources (Table A-1). Actions for each project included increasing habitat complexity, instream barrier removal, improving riparian forest, restoring floodplain connectivity and road decommissioning. After each project was identified, line and polygon data were converted to points and placed approximately at the center of each project. Some of the restoration actions were placed where base data displayed no changes. These were not included in our analyses.

The most current anthropogenic barrier information was obtained from WDFW in May 2004. Only barriers that are within 30 meters from streams were selected and snapped to the base stream layer, and our base barrier data was updated accordingly. Completed barrier restoration projects from SRFB and GP were already incorporated into the

WDFW's data. A modification to the mainstem of the East Fork Lewis River above Copper Creek was made based on literature (Clark County 2005; LCFRB 2004; WDFW 1999). Where barriers were opened up for fish access, fish distribution was also updated for each species without breaking the original rules of gradient, BFW, and potentially impassible waterfalls.

Road decommissioning data came in line, point, and polygon format. Existing roads were marked as decommissioned if the existing road lines overlapped with the decommissioned road lines. When data did not include decommission distance or did not intersect with the road, a 60-meter buffer was applied to them, and the road within the buffer was removed. If point data had a decommissioned distance, it was assumed that the point was located in the center of the restoration and half of the total restoration distance was removed on both sides of the point.

Stream segments for habitat structure restoration were selected based on the SRFB's project descriptions. REO's point data were converted to lines using stream miles indicated in the dataset. We applied a 30 m buffer from the point when there was no indication of distance. Spatial data were used where line data (REO) and project description did not match.

Riparian projects were not included in the update of current conditions because of obscure spatial information and lack of detailed project information.

Restoration activities and data sources are listed in Table A-2.

Table A-1. Restoration data sources. These data were collected between 1998 and 2001.

Organization	Source	Data Type
Gifford Pinchot National Forest (GP)	http://www.fs.fed.us/gpnf/forest-research/gis/	Point, Line, Polygon
NOAA	NOAA restoration center database in Sand Point, WA.	Point
Regional Ecosystem Office (REO)	http://www.reo.gov/restoration/	Point, Line, Polygon
Salmon Recovery Funding Board (SRFB)	http://www.iac.wa.gov/oiac/prism.htm	Point

Table A-2. Types of restoration activity and steps in the process.

Restoration Type	Data Source	Restoration Action
In Stream Barrier Removal	SRFB, GP	Barrier Removal, Barrier Update
Habitat Structure	SRFB, GP, REO	Boulders, Channel Connectivity, Deflectors, Gravel Placement, LWD, Off Channel, Rootwads, Weirs, Restored for Spawning
Riparian Forest	SRFB, GP, REO	Planting, Revegetation, Fencing, Restore Slide Areas, Streamside Revegetation, Streambank Stability, Riparian Thinning, Invasive Plant Control
Road Density	GP, REO	Road Decommission
Forest Cover	GP, REO	
Off-Channel/ Edge Habitat		

References

BLM (Bureau of Land Management). 1999. Unpublished data, transportation road network.

BLM (Bureau of Land Management). 2001. Interagency Vegetation Mapping Project – Western Cascades (version 2.0) and Western Lowlands (version 1.0) Spatial Data, 1996. Available at: http://www.or.blm.gov/gis/projects/vegetation.

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