Lewis River Case Study Final Report

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

Appendix I: Chinook Spawner Suitability and Potential Capacity Estimates

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Introduction

To estimate spawning suitability of each stream reach for chinook salmon, and to calculate potential capacity of adult spawners per reach, we adapted methods developed in the Puget Sound region (Lunetta et al 1997; Beechie et al. 2006, Sanderson et al. In Prep.). These analyses used remotely sensed data to estimate habitat conditions over a large spatial extent in the absence of field measurements. Data required for this approach included stream gradient, bankfull width, and riparian seral stage (as an index of habitat complexity). Stream channel gradients were estimated following methods in Miller (2003) using 10-m digital elevation model and stream network data. We used bankfull width estimates modeled from precipitation, stream gradient, and field measurements throughout the Lewis watershed (Appendix G). The analyses developed in Puget Sound used a predominantly conifer-dominated classification of riparian seral stage. Below, we describe how we derived seral stage information that incorporated riparian conditions dominated by hardwood and shrub riparian species such as those found in lowland regions in the Lewis River watershed.

Riparian Seral Stage

Initially, we obtained seral stage information for streams in the Lewis River watershed under current conditions from Wade (2000); hereafter, the “original dataset.” This information was derived from the same source data and approach as the Lunetta et al. (1997) study (Table I-1), and indicated the proportion of each stream reach in coniferous late, mid, and early seral stage, as well as land cover categories of deciduous, non-forested, and water. We also summarized this information into dominant seral stage values for each reach in the watershed. We determined dominant seral stage by assigning the seral stage or cover type covering >60% of the reach. Reaches without a dominant seral stage class were considered “mixed.”

To estimate potential future habitat spawning suitability and capacity resulting from each management strategy, it was necessary to develop a method for estimating seral stage for each reach after we altered the underlying vegetation dataset to represent effects of actions (i.e., riparian restoration) (Appendix D). We derived seral stage values from a vegetation dataset composed of canopy cover class and conifer tree diameter from the Interagency Vegetation Mapping Project (IVMP; BLM 2001). We chose this dataset because we also used it for all other vegetation components in the Decision Support System (to develop land cover classes used in sediment and hydrology models (A) and to derive riparian function ratings (Appendix H). We summarized the pixel-based IVMP dataset into reach-specific metrics of percent canopy cover, canopy cover type, and average conifer size (Appendix A).

We developed a simple model to classify tree cover and conifer size from the summarized IVMP dataset into seral stage categories (Table I-1). To determine appropriate thresholds for IVMP information that best approximated seral stage categories in the original dataset, we compared dominant seral stage values for each reach in the original dataset to summarized metrics for corresponding reaches in the IVMP dataset under current conditions. In the model fitting stage, we initially set threshold parameters of cover class and conifer size in the IVMP dataset to those used to create the original dataset using the Lunetta et al. (1997) approach. For example, we distinguished between late and mid-seral stage categories based on requirements for the proportion of the reach in conifer cover and on conifer size (Table I-1). We then adjusted the parameters based on how well the metrics in the summarized IVMP dataset (e.g., average conifer size, percent conifer cover, percent total tree cover) fit into original dataset seral stage categories. To do this, we plotted each IVMP metric against each original seral stage category to determine the best threshold value. For example, the apparent best cutoff between mid-seral and late seral for average conifer size measured in diameter at breast height (dbh) was 20 inches (most of the records with sizes >20 inches fell into the original dataset category ‘late seral’ and vice versa). Finally, we adjusted parameters using MS Excel Solver to optimize the number of matched results classified by our model (using summarized IVMP metrics) and by the Wade (2000) approach used to create the original dataset. We used this model to develop seral stage values for each reach in the watershed for each management strategy. Results of the two methods under current conditions were spatially similar (Figure I-1).

Habitat Suitability

We estimated suitability of each reach for chinook spawners following methods developed by Sanderson et al. (In Prep.) and classified each reach as not suitable, poor, fair, or good for spawning (Table I-2). Stream reaches with gradients >4% or <5 m bankfull width were considered not spawnable by chinook salmon (Lunetta et al. 1997; Beechie et al. 2006). Streams 5–25 m wide were assumed to be predominantly forced pool-riffle, pool-riffle, and plane-bed habitats (Montgomery et al. 1999). Stream channels of this size are likely influenced by riparian conditions; hence we used seral stage as an indicator of potential stream habitat complexity. We calculated habitat suitability for chinook for each reach in the watershed for current conditions and under each management strategy.

Potential Capacity

We calculated potential capacity of reaches throughout the watershed suitable for spawning by chinook salmon based on bankfull width, stream gradient, and riparian seral stage (Table I-3) (Beechie et al. 2006; Sanderson et al. In Prep.). Values for equation parameters are from published studies (Table I-4). Equations used to calculate capacity estimates (N) for each reach (Table I-3) are:

Equation 1

$$N = ((\text{stream area} * \%\ \text{spawnable})/\text{redd area}) * (\text{spawners/redd})$$

where stream area = reach length * bankfull width.

Equation 2

$$N = \text{stream length} * \text{spawners/redd} * \text{redds/km}_{FPR/PR}$$

Equation 3

$$N = (\text{stream length} * \text{proportion FPR/PR} * \text{spawners/redd} * \text{redds/km}_{FPR/PR}) + (\text{stream length} * \text{proportion PB} * \text{spawners/redd} * \text{redds/km}_{PB})$$

where FPR = forced pool-riffle, PR = pool riffle, and PB = plane-bed habitat

Table I-1. Seral stage categories described by Lunetta et al. (1997) and by our model using summarized IVMP (BLM 2001) metrics.

Model	Late seral	Mid seral	Early seral	Deciduous	Mixed	Other (vegetated)	Non-forest
Lunetta et al. (1997)	>50% conifer trees with DBH >20”	<50% conifer trees with DBH >20”	<75% of land cover deciduous forest, remainder conifer	NA	NA	>70% of land cover deciduous forest	>70% of land cover non-forest (agriculture, urban, or barren)
Our model (IVMP data)	≥69.8% conifer cover and DBH >22.5”	≥69.8% conifer cover and DBH >6.8”	≥69.8% conifer cover and DBH ≤6.8”	>39.3% deciduous cover	<69.8% conifer cover and <39.3% deciduous		total tree cover ≤24.2%

Table I-2. Components that determine reach-specific habitat suitability ratings for chinook spawners (after Sanderson et al. In Prep.).

Bankfull Width	Stream Gradient	Riparian Seral Stage	Suitability Score
any	> 0.04	any	not suitable
< 5 m	any	any	not suitable
5 – 10 m	< 0.01	any	fair
	0.01 – 0.04	late	good
		mid	fair
		not late/mid	poor
10 – 25 m	< 0.01	any	good
	0.01 – 0.04	late	good
		mid	fair
		not late/mid	poor
> 25 m	< 0.01	any	good
	0.01 – 0.04	any	fair

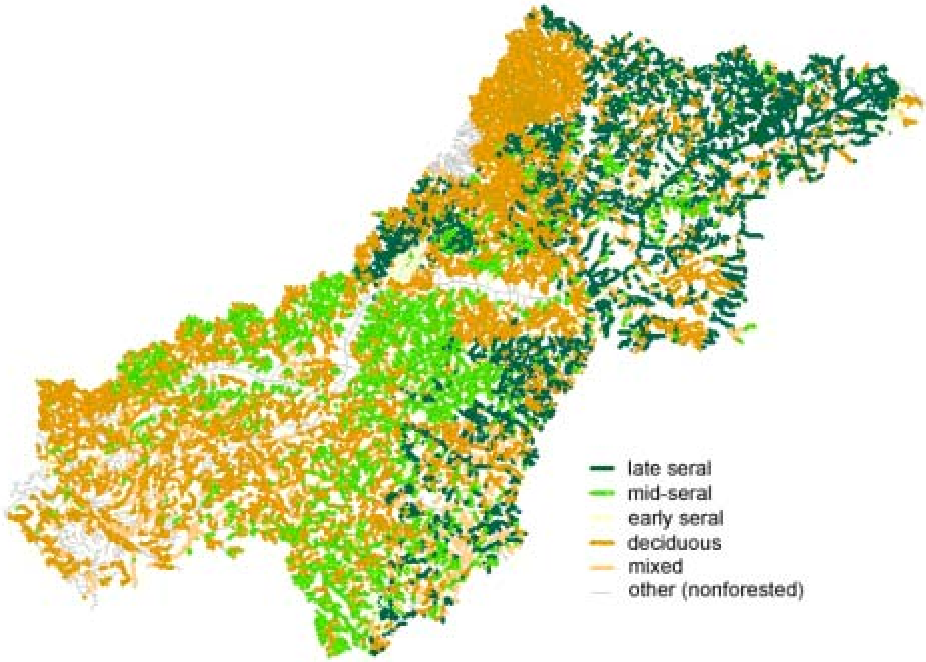
Table I-3. Equations used to determine reach-specific potential capacities for chinook spawners (after Sanderson et al. In Prep.).

Bankfull width	Stream gradient		
	<1%	1-4%	>4%
>25 m	Equation 1	Equation 1	Not suitable
10-25 m	Equation 2	Equation 3 (influenced by riparian seral stage)	Not suitable
5-10 m	Equation 2	Equation 2	Not suitable
<5 m	Not suitable	Not suitable	Not suitable

Table I-4. Parameters used in Equations 1-3 for estimating capacity of a reach for adult chinook spawners (after Sanderson et al. In Prep.). Values are means with 10% and 90% confidence intervals in parentheses.

Equation Parameter	Value	Reference
% spawnable	6.24%	Beechie et al. In Press (data for the Skagit and Stillaguamish Rivers in Puget Sound)
redd area	15.25 (27.90, 4.90)	Beechie et al. In Press (D. Hendricks, WDFW unpublished data)
spawners/redd	2.33 (1.35, 3.50)	Beechie et al. In Press (D. Hendricks, WDFW unpublished data)
redds/$km_{FPR/PR}$	36.40 (7.97, 61.30)	Montgomery et al. 1999
redds/km_{PB}	1.77 (0.0,6.0)	Montgomery et al. 1999
proportion forced pool-riffle/pool-riffle	late seral conifer riparian: 1.0	Lunetta et al. 1997
	mid seral conifer riparian: 0.78	
	early seral conifer, mixed conifer/deciduous or deciduous riparian: 0.74	
	non-forested or other riparian: 0.35	
proportion plane-bed	1.0 – proportion forced pool-riffle	Montgomery et al. 1999

A. Wade (2000)



B. Our model

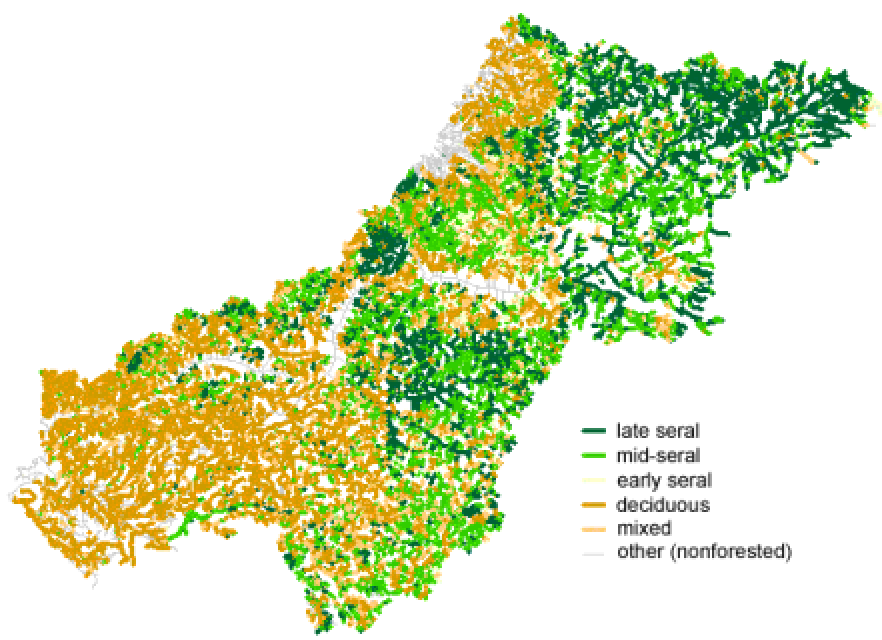


Figure I-1: Spatial comparison of seral stage-classified reaches. (A) Dataset described by Wade (2000), classified using the approach of Lunetta et al. (1997), and (B) our seral stage model using summarized IVMP data (BLM 2001).

References

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