Mapping current conditions and modeling the dynamic responses of riparian vegetation and salmon habitat in Oregon.

2010 Annual Project Report

Modeling Component: OWEB # 208-8007-6459

27 December 2010

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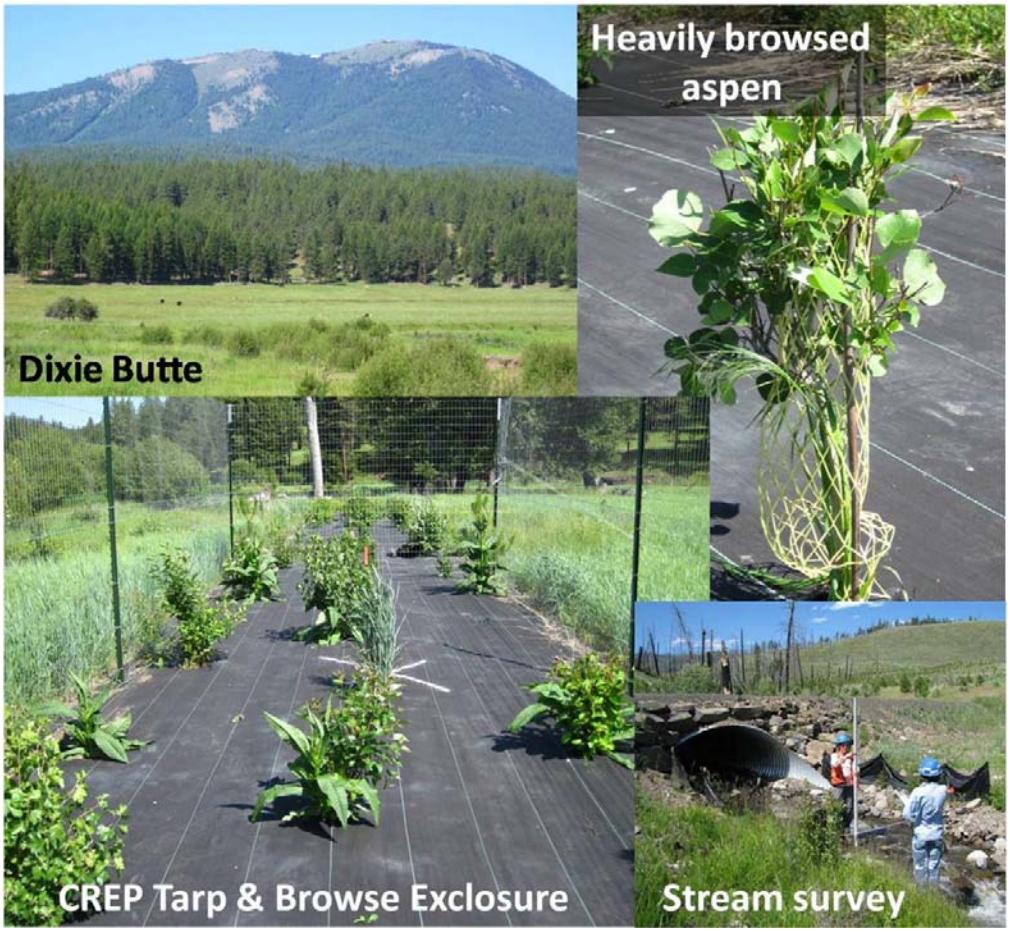


Tasks accomplished – 1 November 2009 to 31 October 2010:

We have completed the following tasks:

1. Completed all VDDT state and transition models for all combinations of potential vegetation types and channel geomorphic types for both the upper Middle Fork John Day and Wilson River study sites.

2. Completed all model documentation for all of the VDDT state and transition models (item #1, above) for both the upper Middle Fork John Day and Wilson River study sites.

3. We have completed the fish-habitat quality attribution for both steelhead and spring Chinook salmon for all of the VDDT models developed for the upper Middle Fork John Day (MFJD). Fish-habitat quality attribution for coastal coho for all VDDT models for the Wilson River is currently in progress and will be completed before the end of the year.

4. We have developed a project web site that provides a basic description of the project goals, a description of the methods, examples and discussion of preliminary results using the MFJD as an example, and hotlinks to down load models, model documentation and supporting data. Please see: http://www.fsl.orst.edu/lwm/aem/projects/ar_models

5. We have completed all data entry and QA/QC for all field data collected on this project.

6. Using data collected in the study watersheds over the summer of 2009, and available lidar-based information provided by the Remote Sensing and Mapping component of this project, and other available geo-referenced data sets, we have classified the current conditions for the stream networks in both the Wilson River and the MFJD Rivers.

7. MFJD Browse Study: We initiated a study to monitor effects of wild ungulate browsing on riparian restoration planting of native riparian tree and shrub species. This project is funded by the USFS PNW Research Station, but complements work conducted uner the OWEB-funded project. We are working on the Forrest and Oxbow Conservation Areas in collaboration with Confederated Tribes of the Warm Springs Reservation. We are measuring 40 browsing exclosures and matched browsed plots. We started with pre-treatment measurements in June 2009, and have subsequently made post-growing season measurements in fall of 2009 and again in fall 2010. Data entry is complete and some initial analysis has been conducted.

8. Project Presentations:

Davis, C. R., S. M. Wondzell and A. Przeszlowska 2010 Browsing and growth of riparian shrubs: historic evidence, current condition and restoration, upper Middle Fork John Day River, OR. [poster] Middle Fork John Day Intensively Monitored Watershed, Annual Science Summit. 17-18 February 2010. John Day, OR.

Davis, C. R., S. M. Wondzell and A. Przeszlowska 2010. Browsing and riparian shrubs: historic evidence and restoration, Middle Fork John Day River, Oregon. Northwest Scientific Association, 82nd Annual Meeting, 24-27 March 2010. Centralia WA.

Przeszlowska, A. and S. M. Wondzell. 2010. Projecting riparian vegetation and salmonids habitat responses to alternative land-use and restoration practices. 2010 Joint Regional Conference, Northwest Chapter of the Society for Ecological Restoration and the Washington Chapter of the Wildlife Society. 16-18 February 2010. Tulalip, WA.

Przeszlowska, A., S. M. Wondzell, P. A. Bisson, and M. A. Hemstrom. 2010. A stream network approach for predicting riparian vegetation dynamics and salmonids habitat quality. 2010 Joint Annual Meeting of ASLO & NABS, 6-11 June 2010. Santa Fe, NM.

Wondzell, S. M., A. Przeszlowska, P. A. Bisson and M. A. Hemstrom. 2010. Modeling riparian vegetation, stream channel morphology, and salmonid habitat dynamics in the upper Middle Fork John Day River watershed. Middle Fork John Day Intensively Monitored Watershed, Annual Science Summit. 17-18 February 2010. John Day, OR.

Comparison of actual accomplishments to the tasks and timeline established in the Statement of Work:

The project is generally on time and well within budget. I expect that all funds will be substantially exhausted by the project ending date of 30 April, 2011. Some differences do exist between the original timeline and the actual accomplishments.

Delayed elements and reasons for slippages if anticipated progress was not made:

- The final delineation of riparian polygons and their classification by current condition, and both potential vegetation type and channel morphology is now complete. This step required considerably more time than expected.
    - First, the Remote Sensing and Mapping group provided us with mapped data that was substantially less complete than expected, requiring the Modeling group to expend considerable time and effort to translate the outputs from the Mapping group into a GIS-based database that was sufficient to describe current riparian conditions for initializing VDDT model runs.
    - Secondly, we did not completely foresee all the difficulties in trying to attribute current conditions for a number of important attributes used in the VDDT models, especially the presence or absence of large wood in stream channels and the understory vegetation classes. This required

considerable work to develop a cross-walk table that allowed us to classify riparian polygons into current condition classes as required for our model runs. It also forced us to reexamine the underlying VDDT model structure and make some changes to the already completed models.
    - These problems have now been resolved, but did result is additional delays in meeting overall project objectives.

- Although it took much longer than expected, development of all VDDT models is now complete, including model attribution for channel morphologic conditions and fish-habitat conditions for both steelhead and spring Chinook salmon.
    - Development of these models, especially for the upper Middle Fork John Day took much longer than expected because the suite of potential disturbance pathways and the high diversity of vegetation types and conditions present in the watershed resulted in a large number of models. Further, each model required a large number of states classes to track important attributes such as the condition of riparian shrubs and their response to grazing, the presence and amount of large wood in the stream channel, and the spatial complexity of forest composition and structure that typifies riparian forests of the intermountain west.
    - Because our existing aquatic-riparian VDDT models will serve as templates for future model development, we want these models to tailor as closely as possible with existing upland VDDT models. Model codes and abbreviations have recently been extensively revised for the COLA IV upland forest models. Therefore, we back-tracked, and revised our models so that they will remain consistent with the COLA IV models. No further revisions of the model codes and abbreviations is anticipated for the COLA IV models.

Expenditure reports documenting use of project funds:

Please note: The USFS's Albuquerque Service Center (which handles all billing) does not necessarily forward bills on a monthly basis. The budget summary (shown below) is for bills sent to OWEB through the end of November, 2010.

Table 1: Summary of funds originally budgeted by OWEB and funds remaining as of 30 November, 2010.

Budget Category	Funds budgeted by OWEB	Funds spent	Funds remaining
Capital Funds			
In-House Personnel	$226,718.00	$191,349.43	$35,368.57
Travel	$21,187.00	$17,119.85	$4,067.15
Supplies & Materials	$3,000.00	$2,347.07	$652.93
Fiscal Administration	$25,865.00	$21,570.94	$4,294.06
Non-Capital Funds			
Travel	$4,750.00	$4,132.38	$617.62
Equipment	$3,000.00	$1,199.98	$1,800.02
TOTAL	$284,520.00	$237,719.65	$46,800.35

Progress toward meeting matching funds requirements:

Matching funds constitute "in-kind" contribution of salary reflecting the time commitment of permanent, full-time, US Forest Service Research Scientists contributing to this project and related expenses for employee benefits along with the other costs to government (office space, utilities, telephone, etc.) calculated relative to the proportion of their time devoted to this project.

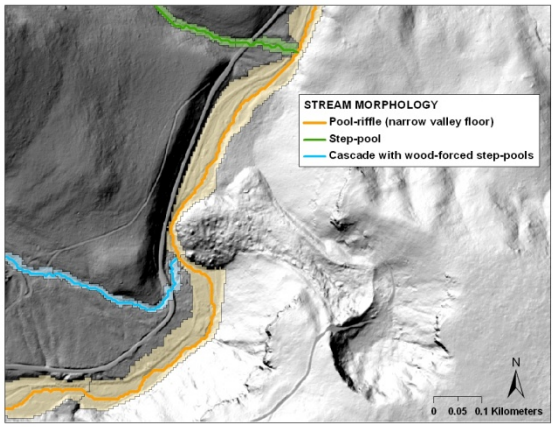
In-kind contributions are meeting projected time commitments for all personnel, except those of the PI, Steven M. Wondzell, who's actual time commitment exceeds that estimated in the original grant budget.

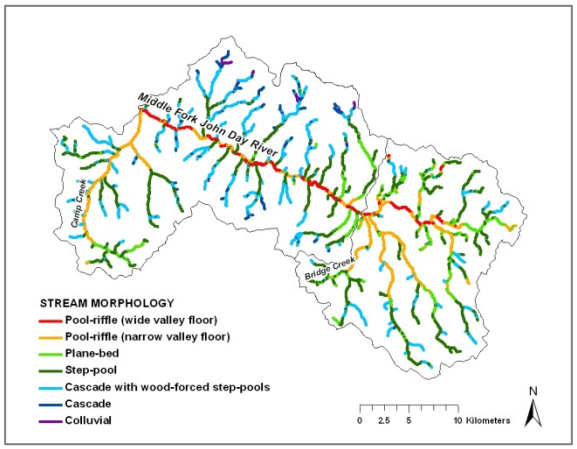
In short, we are fully meeting all matching fund requirements.

Detailed Description of Specific Accomplishments to Date:

(please note: the section below is essentially identical to the project web page)

Methods Overview:





Stream network classification and delineation: Lidar-based DEMS (Figure 1a) were used to delineate the stream network and valley floors with Netstream and ArcGIS tools. Stream reaches were classified into potential channel morphologies based on channel gradient and reach drainage area derived from Netstream, following the Montgomery and Buffington (1997) classification (Figure 1b). From this initial classification, a stratified random sample of ~30 stream reaches per study watershed was selected for field validation of reach morphologies and valley floor delineation. These data were used to refine channel morphology and valley floor thresholds which were then applied in a final stream network classification and riparian zones delineation. The final classification correctly classified 68% of reach morphologies in the upper Middle Fork John Day River watershed and 86% of reaches in the Wilson River watershed.

Figure 1a *(top) shows a portion of the 5-m DEM overlain with classified stream reaches and their the valley floors.* ***Figure 1b*** *(bottom) shows the classified stream network in the upper Middle Fork John Day River watershed.*

Initial conditions for riparian vegetation: Spatial modeling techniques and high density lidar point data (all returns above bare earth) were used to classify and map current riparian vegetation composition and structure within each riparian polygon in the stream network (Figure 2). Vegetation data collected in the field were used to assess the accuracy of the riparian vegetation attributes mapped from lidar. The lidar data proved poor at distinguishing between young trees and tall shrubs and short statured shrubs (height < 0.5 m) could not reliably be distinguished from the bare earth DEM. Overall, mapped vegetation provided a reasonable fit to current conditions and was used to set initial conditions for model simulations.

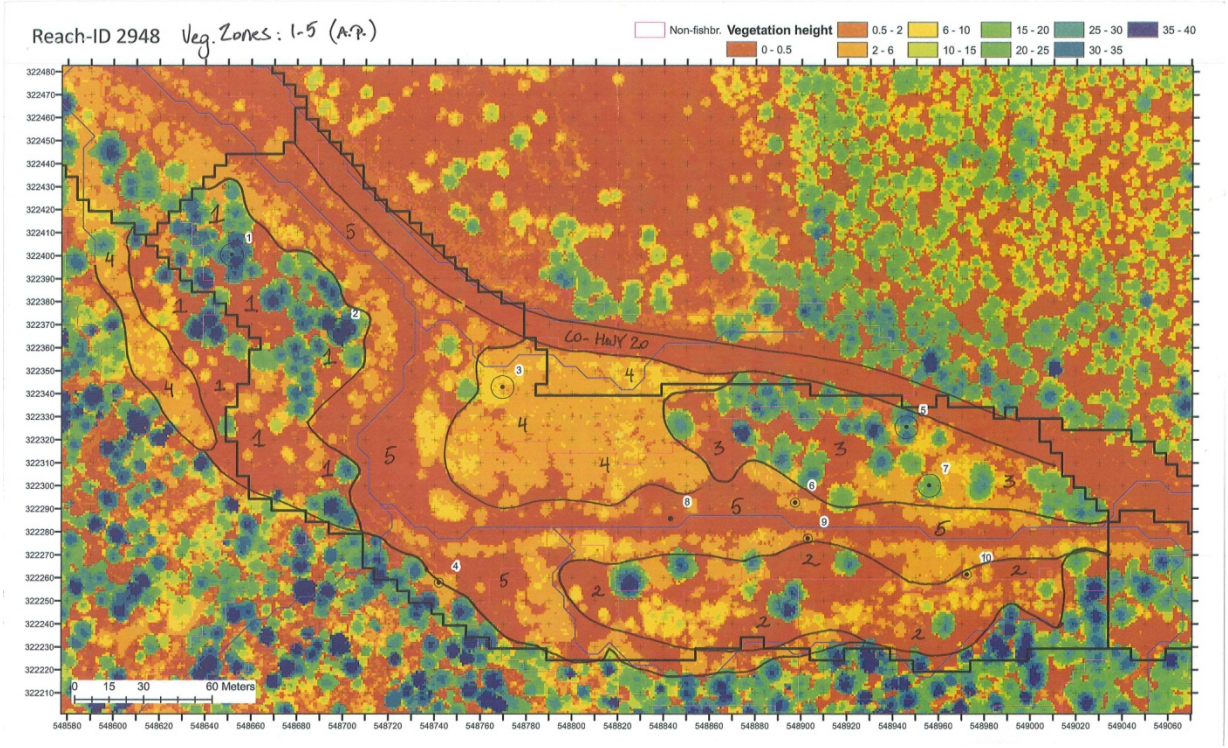


Figure 2. *Example figure showing a lidar-derived canopy height map for a stream reach on the MFJD. Initial Netstream-derived riparian polygons are shown in bold straight lines; field delineations of the valley floor and vegetation patches are shown with curved lines.*

Aquatic-riparian state and transition models: We intersected the classified stream network map with a potential vegetation map of each watershed to identify all possible combinations of channel and vegetation types (strata). We built separate state and transition models for each strata using the Vegetation Development Dynamics Tool (VDDT). These aquatic-riparian VDDT models were based on prototype aquatic models developed for the upper Grande Ronde River, OR (FIg. 3) and upland forest VDDT models developed for eastern and northwest Oregon. We modified these models to include riparian shrub and hardwood state classes, effects of herbivory (grazing and browsing), hydrogeomporhpic processes, and riparian restoration practices. We also expanded the pathways and transition probabilities to characterize the historic and current land-use activities present in each watershed. The completed models simulate all possible states of a stream reach, from highly disturbed states resulting from disturbances such as logging, grazing, landslides or wildfire to relatively pristine states where major disturbances have not occurred.

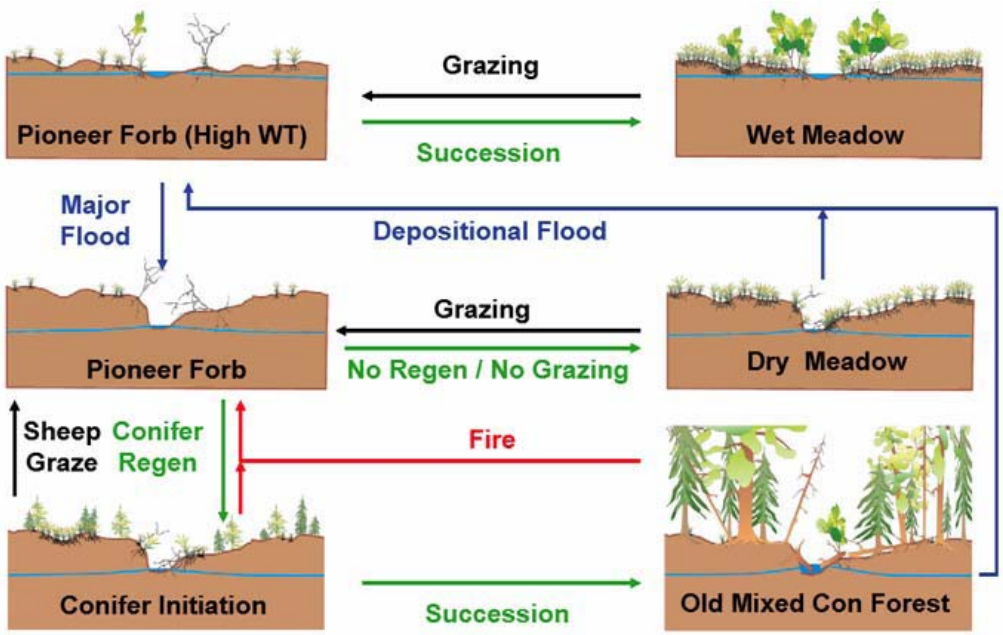


Figure 3. *The figure shows a highly simplified example of a wet-meadow aquatic-riparian VDDT model illustrating some of the dominant transition pathways. Intermediate state classes and most transition pathways are not shown in order to keep the figure readable.*

Channel conditions and aquatic habitat quality: We qualitatively rank channel morphologic conditions on a 4-factor scale for each state class in the models. Morphologic condition variables included: shade, erosion, undercut banks, large wood, pools, large pools, off-channel habitat, width-depth ratio, and riparian shrub abundance. These variables were then used in an expert systems model to rank the habitat quality for key life-history stages of spring Chinook salmon and steelhead in the upper Middle Fork John Day River and coho salmon and steelhead in the Wilson River.

Model Application:

The models are being applied to two intensively monitored watersheds – the Wilson River in the Oregon Coast Range and the upper Middle Fork John Day River in eastern Oregon's Blue Mountains to examine: 1) current conditions relative to the historic range of variability; 2) likely trajectories of aquatic and riparian habitats given current and expected land-use practices; 3) the potential of passive restoration to meet recovery goals; and 4) the potential of active restoration to accelerate recovery.

The models can be run without anthropogenic disturbances to recreate historical conditions (pre-Euro-American settlement) as shown in the example, below (Figures 4a & 4b). Alternatively, the models can be initialized to current riparian and channel conditions in the watersheds and then run forward to project likely outcomes of alternative management scenarios. Realistic management scenarios were developed based on current policy and land management issues faced by managers within each watershed.

The effects of policy decisions can be reflected in the models by either changing the rates of selected disturbances (e.g., decreasing grazing intensity), or by either adding or removing selected disturbance pathways from the models (e.g., removing all forest harvest treatments from riparian areas or adding fuels treatments). Consequently, decision makers could use these models to evaluate changes in habitat conditions under alternative management scenarios at sub-basin to regional scales.

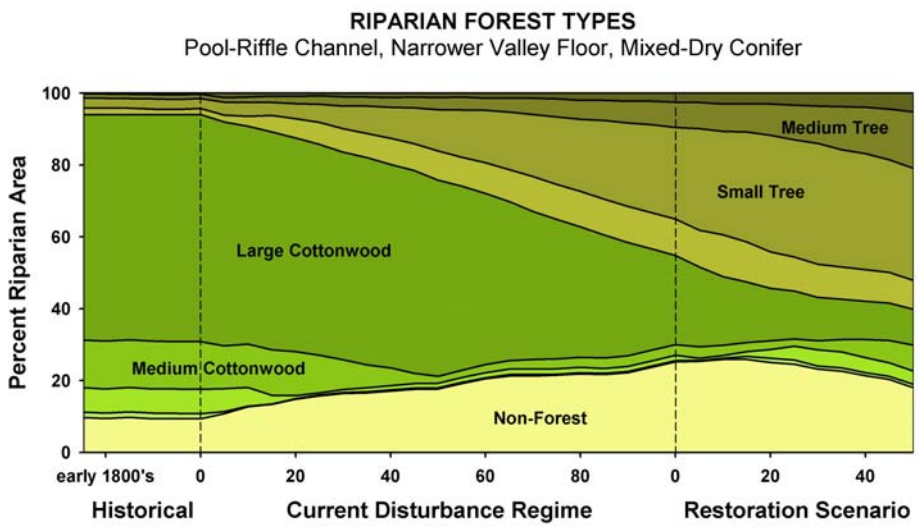


Figure 4a. *Example model output showing the change in vegetation structure and composition over time under three management scenarios, starting with historical conditions prior to Euro-American settlement in the upper MFJD*

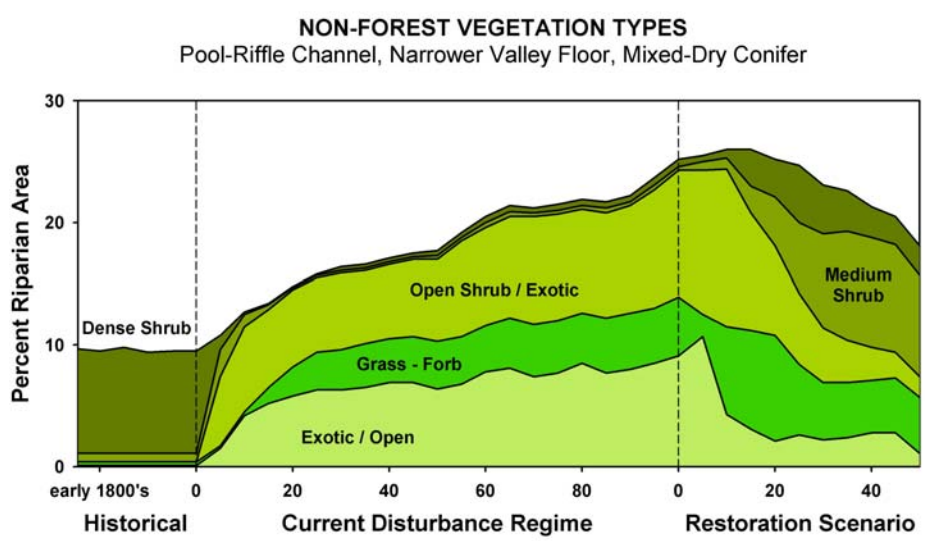


Figure 4b. *Detail of the changes in composition and structure of the non-forest riparian vegetation from the example shown above.*

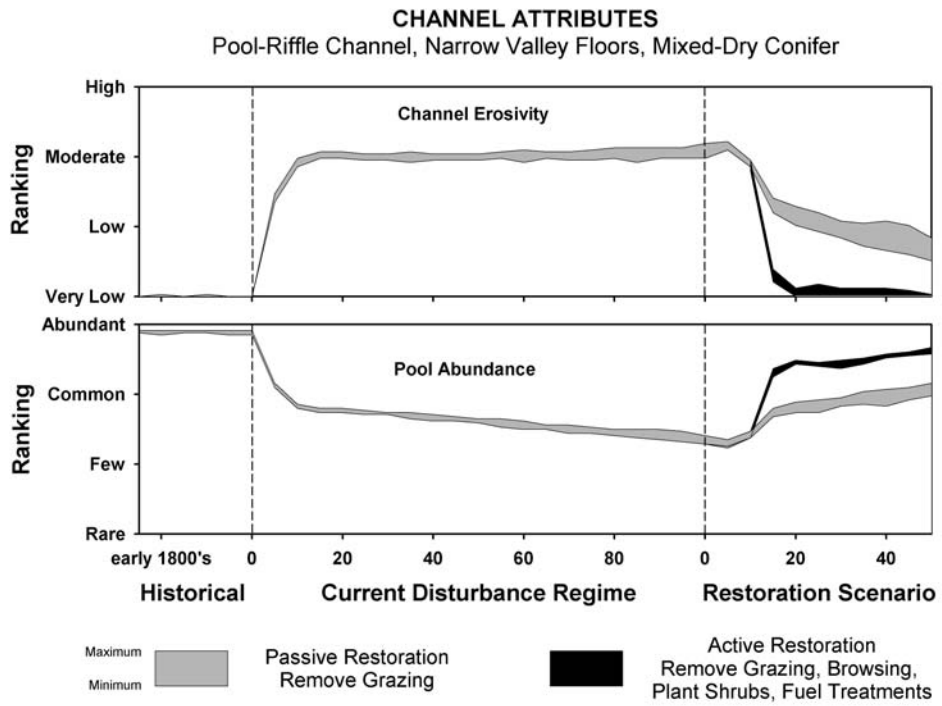


Figure 5. *Example of changes in two channel morphologic attributes under two different restoration scenarios. Time periods and model runs match the examples for riparian vegetation condition shown above.*

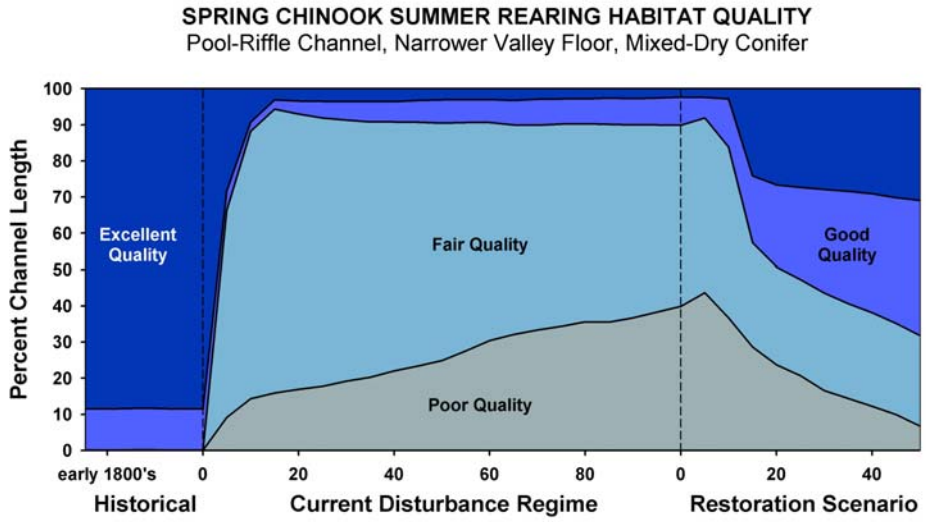


Figure 6. *Example of the changes in the amount of summer rearing habitat for spring Chinook salmon in each habitat condition class.*

The simulated changes in both riparian vegetation (Figure 4a & 4b) and channel morphology (Figure 5) result in large simulated changes in habitat quality within the stream network (Figure 6). It is important to note that, while some improvement in habitat quality is apparent relatively quickly, even after 50 years with complete protection from most anthropogenic disturbances, the condition of habitat within the watershed is far from fully recovered.

Discussion:

The model results (Figures 4, 5, & 6) suggest that both riparian vegetation and channel morphology can be highly dynamic for many attributes. A notable exception is the time needed to grow large trees as well as the recruitment of large wood from stream-adjacent riparian forests. In general, the rapid dynamics simulated by the models agree with observations made within the watersheds. For example, growth of riparian hardwoods has been very rapid in the Camp Creek (upper MFJD) livestock grazing and deer and elk browsing exclosure (Figure 7). Similarly, a study of changes in channel conditions in grazing exclosures located throughout the western United States documented relatively rapid changes in channel conditions through time (Figure 8).

Matched photographs from the interior of the Camp Creek grazing/browsing exclosure located within the upper MFJD study site.

Figure 7a (top) *was taken in 1977 (photo from the Umatilla National Forest), at the time the exclosure was established.*

Figure 7b (bottom) *was taken 32 years later (photo by Rick R. Stiner, 2009). The photos document rapid changes in both vegetation and channel conditions.*

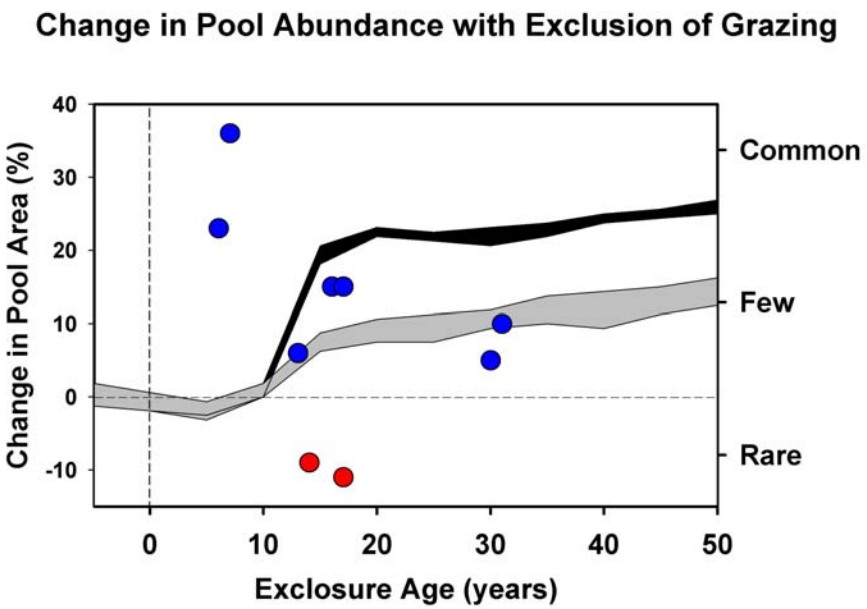


Figure 8. *Comparison of projected changes in pool abundance predicted by the models under two different restoration scenarios with measured changes in pool abundance in grazing exclosures (data from McDowell and Magilligan 1997).*

The VDDT model results shown above compare favorably with results from studies of livestock and wildlife exclosures (Figure 8). Note that each point represents data gathered from a single, fenced exclosure compared to an adjacent reference reach and graphed against the age of the exclosure. Pre-exclosure data were not available so the trajectory of change within the exclosure cannot be illustrated. Further, grazing prescriptions have changed considerably over the last decades so the results from McDowell and Magilligan (1997) are likely confounded by channel recovery that has occurred outside the exclosure. At anyrate, the available data suggest that changes in channel morphology can be relatively rapid and occur at the time scales projected by our models.

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