Riparian Restoration Prioritization on Lower Clear Creek

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GEO 544 Remote Sensing

INTRODUCTION

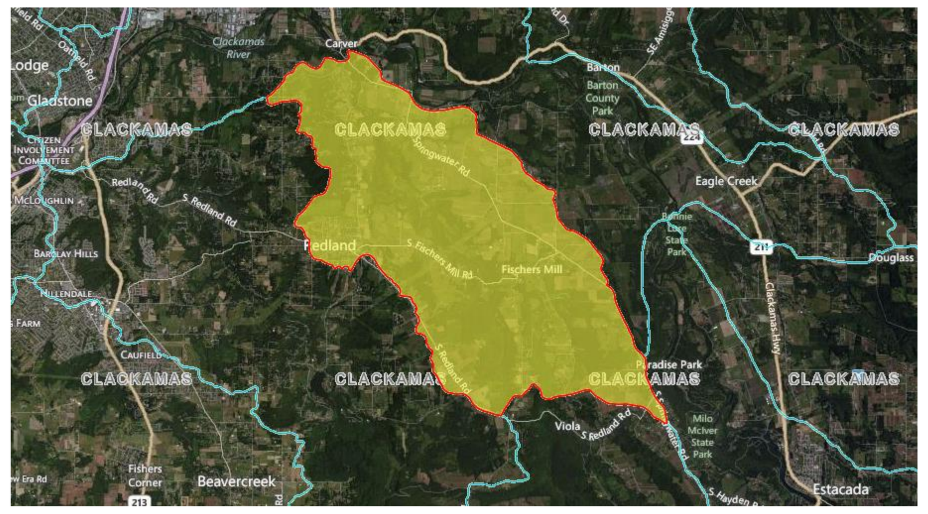

Figure 1. Lower Clear Creek watershed.

Lower Clear Creek is a tributary of the Clackamas River, located east of Oregon City, OR. Clear Creek has historically supported a number of anadromous and resident fish species, including fall chinook, winter steelhead, coho, cutthroat trout, rainbow trout, bull trout, and mountain whitefish. Over the past few decades, fish spawning numbers have plummeted, and some species have been eliminated entirely, but Clear Creek still supports one of the last substantial runs of endangered coho salmon in the Columbia River Basin. Lower Clear Creek, which extends from River Mile 12 near Viola, OR, to its mouth where it drains into the Clackamas River near Carver, OR, contains the highest human population of the three segments of Clear Creek (Middle; Upper). Land use along Lower Clear Creek is predominantly comprised of agriculture, livestock ranging, and forestry. As of 2002, 50% of available water rights for agricultural and other human-related uses had been awarded along Clear Creek, almost all of which are in the Lower Clear Creek watershed. The area around Clear Creek is also one of the fastest growing regions of the state (Watershed Professionals Network, LLC & Clackamas River Basin Council, 2002). The Clackamas River provides drinking water for 400,000 people in Clackamas County.

BACKGROUND AND PREVIOUS WORK

Few studies exist for Lower Clear Creek, although a comprehensive assessment was conducted in 2002 entitled *Clear and Foster Creek Watershed Assessment* (Watershed Professionals Network, LLC & Clackamas River Basin Council, 2002). Clear Creek has been listed on the Oregon Department of Environmental Quality 303(d) list, which includes waters that do not meet state water quality standards (DEQ, 2006). Two water quality parameters for which it has not meet the standard are temperature and dissolved oxygen. These two parameters are highly correlated, as elevated stream temperatures result in lower dissolved oxygen levels. Predominantly on account of human development in the watershed, significant areas within the riparian zone have been devegetated over the past several decades, limiting shade production consequent of late successional riparian forestland and reducing recruitment of large woody debris (LWD) into the stream channel. Although the 2002 watershed assessment report is quite comprehensive in its analysis, LiDAR data were not utilized in the report to quantify riparian vegetation characteristics.

METHODOLOGY

ArcMap was used to perform the following analyses. In order to quantify vegetative structure and tree height, LiDAR data (DOGAMI) was employed and resampled from 1m to 4m spatial resolution in order to aide efficient data processing; 4m resolution was sufficient to capture canopy structure. Orthophotography from NAIP (National Agriculture Imagery Program) was acquired and resampled to 4m spatial resolution. In order to account for directional thermal loading incident from solar radiation, aspect was derived from a Digital Elevation Model (USGS). Because solar radiation is concentrated from the south and southwest, aspect was reclassified into two categories: (1) north/northeast facing slopes (which typically produce shade incident from south/southwest solar radiation) and (2) all other directions. A hillshade model was also derived from the DEM, primarily for reference. Two datasets were acquired from DEQ: (1) Oregon Water Quality Limited Streams (2006) and (2) Oregon Water Quality Limited Streams (2010). Hydrographic data were acquired from USGS. Coho salmon distribution data (2012) were acquired from the Oregon Spatial Data Library. A buffer was applied to the Clear Creek polyline (100ft each side), and LiDAR and reclassified aspect data were clipped to the buffer. Raster calculator was employed to identify the following categories: (1) Highest Priority (N/NE aspect & tree height <= 50') (2) Second Priority (N/NE aspect & tree height <= 80') (3) Third Priority (all directions & tree height <= 50') (4) Fourth Priority (all directions & tree height <= 80') (5) Lowest Priority (all directions & tree height >80').

RESULTS

The results of the analysis provide quantitative data related to successional riparian vegetative characteristics that, when weighted according to aspect, may establish a starting point for prioritizing riparian restoration along Lower Clear Creek. Five categories were established to prioritize revegetation based on current vegetative composition and aspect.

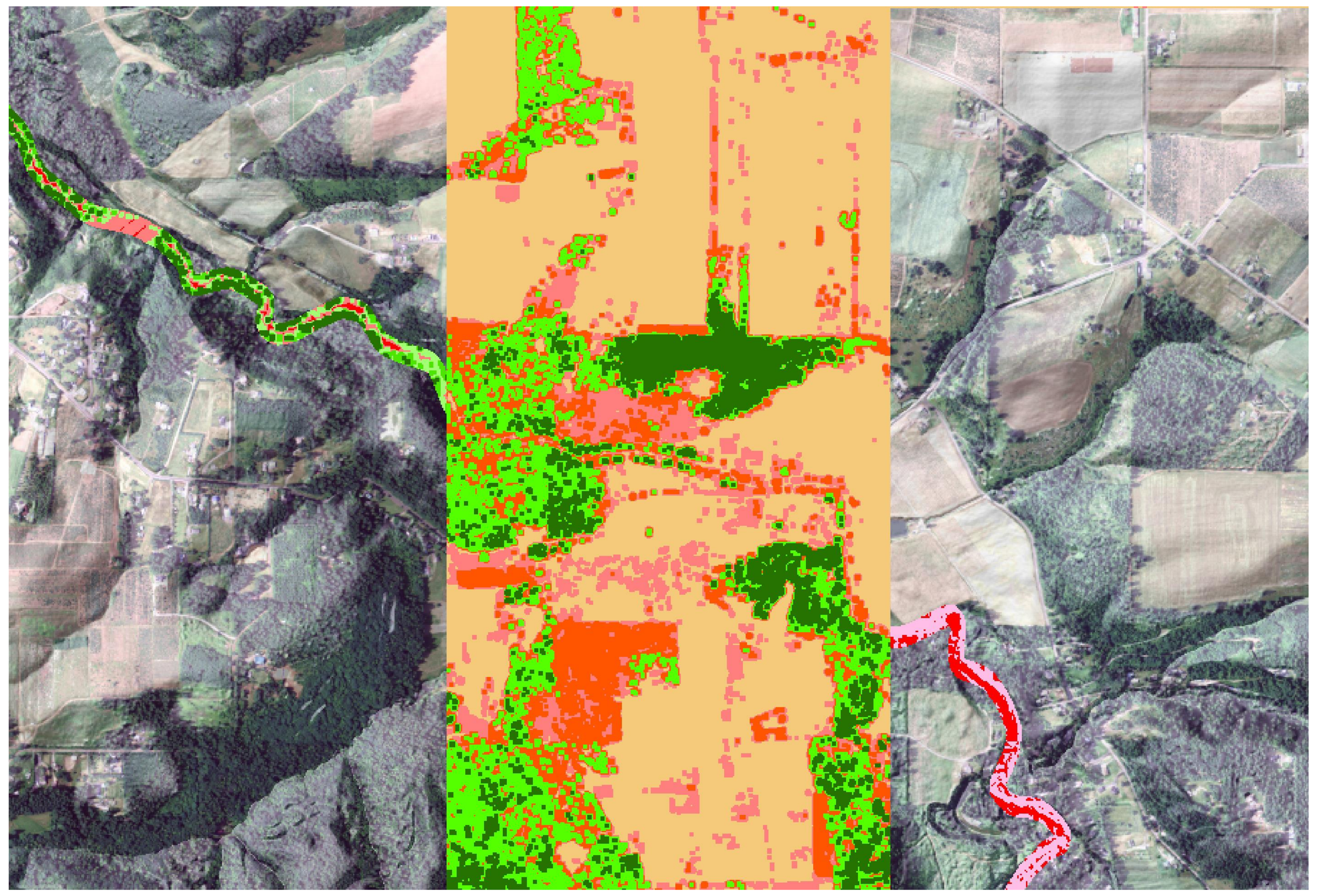

Figure 2. LiDAR clip to 100' Clear Creek buffer (left); LiDAR data (middle); Reclassified aspect clip to 100' Clear Creek buffer (right).

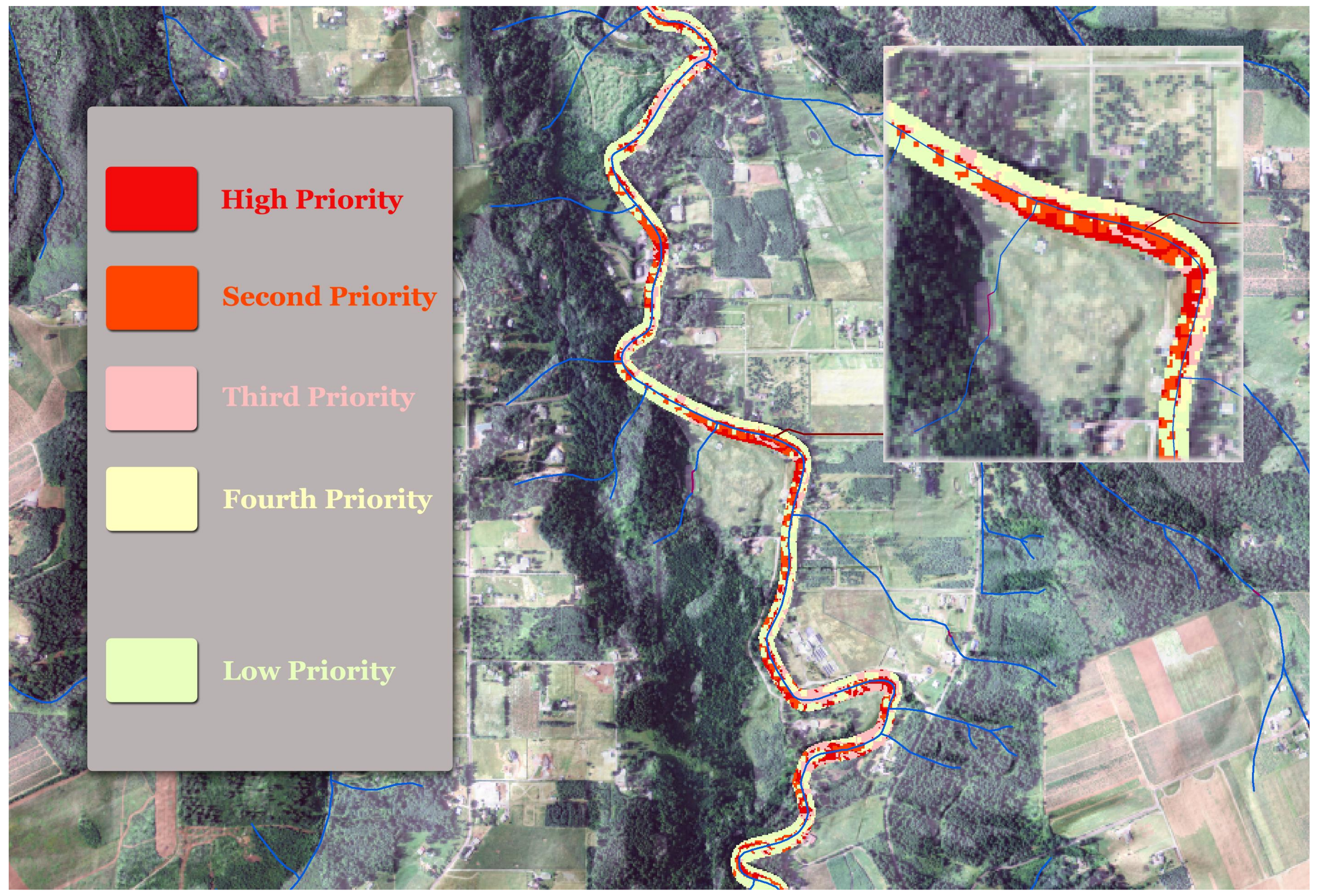

Figure 3. Riparian restoration prioritization along a section of Lower Clear Creek with inset of high restoration priority area. 26.9% of the study area fell in either the High Priority or Second Priority category.

This analysis can be correlated with cadastral data to aid restoration professionals in reaching out to public and private landowners to convey the importance of riparian vegetation to specific water quality parameters, including those for which Clear Creek has not met state standards for fully supporting aquatic life. The application of LiDAR in this analysis provides a quantitative dimension to the analysis of vegetation characterization in the Lower Clear Creek watershed that can supplement existing assessments.

SOURCES OF ERROR

There are several potential sources of error in this analysis. Riparian areas often contain steep slopes, which can create sources of error in the LiDAR data. Ideally, *in situ* checkpoints should be employed to assess the accuracy of the LiDAR returns. Additionally, the Geospatial Accuracy Standard should be utilized to quantify the accuracy of the LiDAR data.

This analysis assumes north/northeast facing slopes shade south/southwest incident solar radiation. This is not always the case, and *in situ* audits should be conducted to compute the accuracy of that assumption. Aspect derivatives from the DEM should also be assessed *in situ* to assess the general accuracy of the aspect analysis.

While late successional forests are generally considered to maximize shade production and LWD recruitment for streams in the Pacific Northwest, smaller native shrubs are also capable of producing significant shade and reducing turbidity along streams. This analysis does not include variables for considering the impact of shade from understory vegetation along Lower Clear Creek.

Finally, the impact of slope on riparian shading is not included in this prioritization, which would potentially affect the prioritization parameters and outcomes. An extension of this analysis should include slope as a variable in shade production of incident solar radiation.

DISCUSSION

This analysis is not meant to be a definitive resource for restoration prioritization on Lower Clear Creek. The analysis is meant to provide an initial prioritization resource for further study. Ideally, this analysis would be accompanied by other tools and methods, including DEQ's *Heatsource* model (specifically the sub-routine *Shade-a-lator*), which employs additional variables that impact incident solar radiation and concomitant stream temperature impacts and models solar radiation offsets. An inventory of existing restoration projects in the watershed should also be collected and included in a larger analysis. It is possible to model present solar radiation offsets (in kilocalories) from existing vegetation, as well as estimate future offsets of existing or planned riparian restoration vegetation using the *Shade-a-lator* subroutine of the *Heatsource* model.

CONCLUSIONS

While previous assessments of riparian vegetation composition, shade production, and LWD recruitment are extremely useful, they are predominantly based on photographic interpretation and *in situ* data interpolation. LiDAR facilitates a method of quantifying riparian vegetation characteristics which is lacking in previous analyses. Because it provides returns on vegetation canopy heights, an analysis of successional riparian vegetation composition can be performed, extrapolating classifications of vegetation that allow one to provisionally assess restoration potential. When combined with aspect derivatives, this analysis can be further focused to weigh areas with higher solar radiation offset potential and prioritize those areas for further study.

Because of the centrality of salmon economically, culturally, and ecologically in the Pacific Northwest, analyses such as this are vital to supporting high-impact restoration projects that address potentially fatal conditions in historically salmon-supporting streams. Prioritization mechanisms help direct limited financial resources toward stream reaches that would disproportionally benefit from restoration activity.

References

Watershed Professionals Network, LLC & Clackamas River Basin Council, "Clear and Foster Creeks Watershed Assessment" (September, 2002; https://nrimp.dfw.state.or.us/web%20stores/data%20libraries/files/Watershed%20Councils/Watershed%20Councils_268_DOC_ClackRBC_ClearCreekAssess.pdf).

Matthew Boyd & Brian Kasper, "Analytical Methods for Dynamic Open Channel Heat and Mass Transfer: Methodology for the Heat Source Model Version 7.0 (Oregon Department of Environmental Quality, 2007; http://www.deq.state.or.us/wq/tmdls/docs/tools/heatsourcemanual.pdf).

Oregon Department of Environmental Quality, "Oregon's TMDL Priority and Schedule" (2006; http://www.deq.state.or.us/wq/assessment/docs/tmdlpriorities0406.pdf).