Riparian Extent and Status Tool (REST)

OWEB Technical Assistance (TA) Project: "Rogue Basin Riparian Assessment and Restoration Prioritization Project" June 2015 - August 2016

CONTENTS

INTRODUCTION

By summer 2013, conservation groups in the Rogue began partnering on a planning effort that was to comprehensively address restoration needs throughout the Rogue Basin. The Rogue Restoration Action Plan (RRAP), completed in 2015, identified in-stream, near stream, and upland priorities for the future recovery and preservation of the basin's ecological health.

The Freshwater Trust (TFT) has been engaged in a number of riparian restoration projects since 2012, and has used the past four years of programming to develop prioritization and design protocols for a full manner of projects. In 2015, the RRAP committee charged TFT as a lead entity for building out a prioritization strategy for riparian revegetation for the whole basin. This project, the buildout of the Riparian Extent and Status Tool (REST), has become the vehicle for that effort.

REST Background

Previous Rogue Basin assessments all describe poor riparian health as a limiting factor for the recovery of target species such as salmonids and lamprey. While the means to execute effective riparian restoration is well understood among Rogue conservation partners, the pace of riparian recovery has been slow because current efforts aren't resourced to match the size of the problem. To develop a funding strategy that begins to address this large-scale problem, the first step is a site prioritization strategy. As noted in recovery plans for the federally listed Southern SONCC Coho "a silvicultural prescription should prioritize regions with the most degraded forests conditions and those immediately adjacent to fish habitat," (pp 6-13: NMFS, 2014), the approach TFT used for this project.

REST uses a combination of LIDaR and ArcGIS to establish a uniform apples-to-apples assessment of equal area units along both banks the Rogue and its major inland tributaries. This is similar to the approach TFT uses when assessing the thermal benefits to water quality that result from riparian shade. Having a framework already in place and staff familiar with the region meant REST was ready to be shaped for maximum benefit by local expertise rather than a drawing board exercise.

Four technical advisory committee (TAC) meetings over the course of nine months helped to locally customize a conceptual version of REST for all the LIDaR-covered areas of the inland Rogue (Little Butte, Big Butte, Elk, Bear, Walker, Applegate, Williams, Thompson and Little Applegate). By overlaying other RRAP layers with the REST prioritization tool in a web based viewing platform, this project produced a tool public users can use to identify where riparian restoration best combines with the planning priorities of Rogue conservation partners.

REST will benefit salmon and steelhead by prescribing effective, coordinated, fish-focused restoration in the Rogue Basin. Since the threat to salmonids in Oregon was first identified, the Rogue Basin has been seen as an important refuge for some of the healthier salmon, steelhead, and lamprey runs in the Pacific Northwest. Efforts to preserve, protect, and restore these populations, while successful in isolation, have fallen short of facilitating contiguous restoration basin-wide. In partnership with other conservation efforts (e.g. RBP barrier removal, 2014) REST is an important step toward connecting the different pieces of the Rogue restoration puzzle.

Technical Advisory Committee

In the spirit of the original RRAP planning process led by Bonneville Environmental Foundation, the involvement of local expertise was seen as an important component of REST. What makes sense on a computer screen in Portland is not necessarily an intuitive decision for the Rogue. Fortunately, the Rogue is home to a number of well-respected experts who have many combined years of local experience with natural resource protection, salmonid recovery and habitat restoration. Those involved were able to inform the project with a good mix of fish, water quality, riparian vegetation, and general ecological knowledge. Table 1 (below) includes the TAC members, their involvement, and expertise.

The TAC's involvement was key to guiding REST's development, ensuring tool development decisions were consistent with their understanding of Rogue conditions. The knowledge and experience of TAC members also allowed confirmation that results from REST were largely consistent with areas that local experts knew to be in need of restoration (or preservation). The TAC met four times over a year (July, October, January, April) to help guide REST as it was calibrated to local Rogue Basin conditions. TFT was able to contribute project management, facilitation, GIS, and field expertise as match to the project.

Table 1: Technical Advisory Committee (TAC)

Name	Organization	Office	Expertise	Attendance
Craig Harper	Southern Oregon Land Conservancy	Ashland	Restoration, Conservation	1,3,4
Brian Barr	Rogue River Watershed Council	Central Point	Fish biology, barrier removal/modification, restoration.	1,2,3,4
Jonas Parker	Bureau of Land Management	Medford	Hydrology	1,2,3,4
AJ Donnell			Fish Biology	2,3,4
Eugene Wier	The Freshwater Trust	Ashland	Riparian Restoration, Fish biology, Water Quality	1,2,3,4
Max Bennett	Oregon State University Extension	Central Point	Riparian Forestry	1,3,4
Chris Park	US Forest Service	Medford	Water quality, shade, and riparian vegetation.	3
Craig Tuss	Rogue Valley Council of Governments	Central Point	Fish biology, Restoration	1,3, 4
Priscilla Woolverton	Oregon Department of Environmental Quality	Eugene	Water Quality, TMDLs	1,2,3,4
Jay Doino	Oregon Department of Fish and Wildlife	White City	Fish Biology, Barrier Removal/Modification, Restoration	2,3,4

Table 2: TFT Project Staff

Name	Expertise	Deliverables	Attendance
Denis Reich	Facilitation, Project Management	Project Coordination, TAC facilitation and meetings, Reporting	1,2,3,4
Gustavo Monteverde / Bob Chappell	GIS, Cloud based applications	REST tool and web viewer	1,3
Olivia Duren	Vegetation Surveys	Field Surveys	2,4

Status of Deliverables

A list of six deliverables emerged in the proposal development based on the status of prioritization tools at the time and what the RRAP committee(s) requested in terms of analysis (see Table 3). TFT's riparian tools evolved from modelling used to quantify riparian heat loads in the Rogue and Bear Creek TMDLs. Prioritizing sites by thermal load interception i.e. shade, is a limited view of basin-level disturbance and restoration.

The REST tool expands on this single-variable approach by including other factors such as percent vegetation cover, floodplain elevation, and built environment. It also overlays other RRAP layers that pinpoint in-stream anchor habitat, ensuring prioritization accounts for where restoration is needed and where it can provide the most benefit.

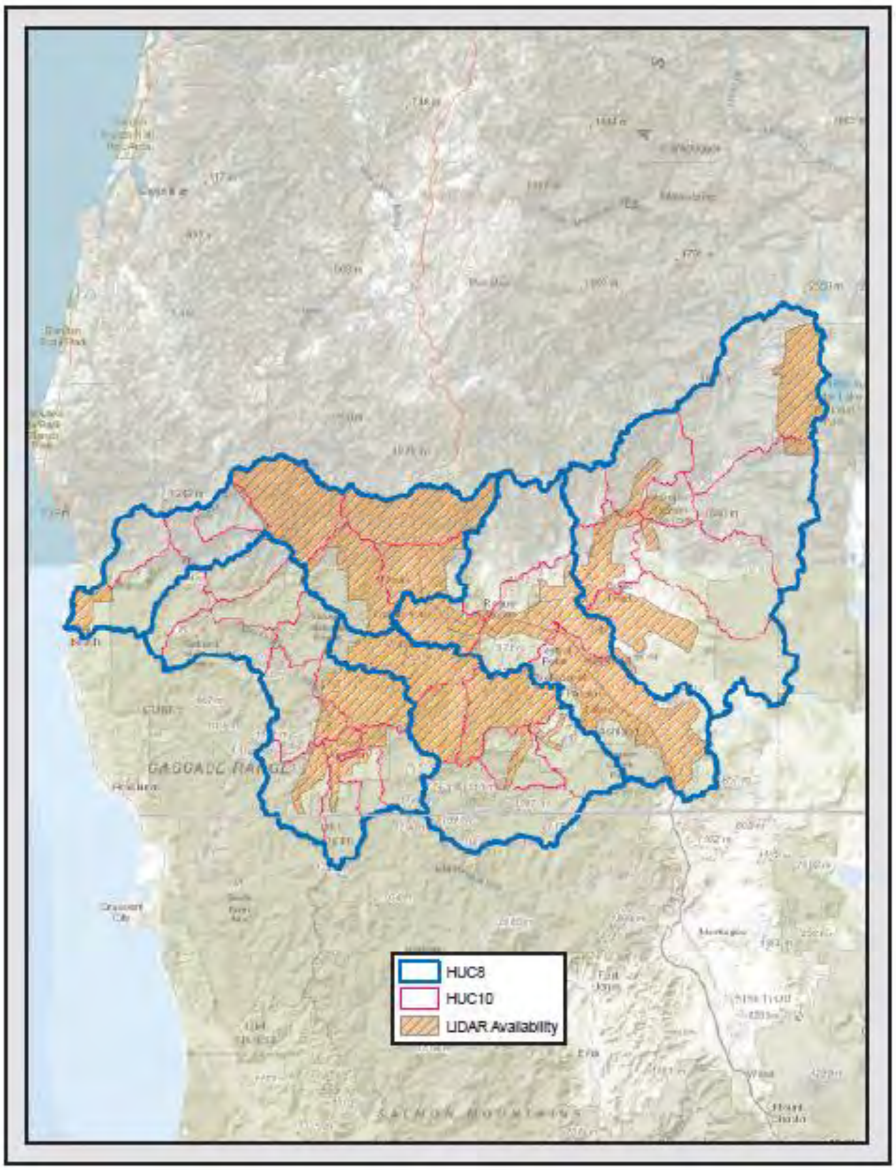
Table 3: Project Deliverables

Deliverable	Description	Status
1) A GIS-based assessment of riparian vegetation	Assessment of LIDaR covered Rogue and major tributaries. Within riparian ordinance boundaries, includes vegetated extent, tree heights and blackberry coverage at a basin scale.	*Complete* coverage analysis as percent cover of vegetation 16 feet or higher (NLCD, 2012) within 50 feet of ordinary high water mark (75 feet for mainstem). Blackberry coverage work *ongoing*.
2) A TAC-driven list of priority riparian projects	List of sites within project area of the Rogue River basin. The site list includes a preliminary scope and budget based on estimated site acreage, site preparation and land ownership.	*Complete*. List of top 25 taxlots assessed by REST for restoration using a combination scoring of disturbance and restorability. Additionally, the most degraded/restorable taxlots within or adjacent to Rogue Restoration Action Plan priority areas were identified.
3) GIS layers classifying disturbance of riparian areas	GIS comparison to reference conditions of current tree heights, vegetation extent. Blackberry coverage for LiDAR-covered stream reaches.	*Complete*. A layer for disturbance (based on coverage of vegetation above 16 feet) and a layer for restorability (based on bank elevation and geomorphic conditions) were part of the analysis.
4) GIS layers identifying priority projects	Projects were prioritized for riparian restoration within LiDAR-coverage.	*Complete*. Taxlot locations associated with deliverable #2 were included in the GIS layers.
5) A final report	A report with accompanying Webmaps and Google Earth files displaying the findings of the assessment.	*Complete.*
6) TAC-driven list of gaps	A description of data (LiDAR, etc.) still needed to employ REST basin-wide.	*Complete*. A list of the outstanding areas where LIDaR coverage would assist with riparian restoration efforts is included in this report.

Project Area

The project area was originally intended to be a full assessment of the Rogue Basin from Crater Lake to the Rogue River estuary. After more research the sub-basins with the most complete LIDaR coverage were found to be upstream of the Rogue River Canyon in the inland Rogue (see Figure 1). Only piecemeal coverage existed downstream of this region, probably due to the amount of well-preserved wild and scenic riparian and upland forest that exist in these lower basin areas (Illinois, Middle and Lower Rogue sub-basins). Aerial assessments of healthy wild and scenic riparian areas are perhaps not as important to the primary land management agencies as other more impacted parts of the Rogue. Hence, this project focused on the inland Rogue (Upper and Middle Rogue 8-digit HUCs); total coverage by this completed version of REST is 196 miles or 2,692 acres of riparian area. The intent for the future is to build out REST to the lower Rogue sub-basins as LIDaR becomes available.

Figure 1: LIDaR coverage for the Rogue. The REST analysis for this project included the Upper and Middle Rogue 8-digit HUCs.



METHODOLOGY: TOOL DEVELOPMENT

Since 2012, TFT has implemented riparian restoration programs in the Rogue that prompted the development of internal site prioritization protocols. REST is a modification of these subroutines for a broader, basin-wide approach to riparian restoration prioritization.

The REST program utilizes an ArcGIS-based platform to host multiple, adjacent small riparian assessment units (RAUs) of equivalent area. RAUs are built using 25-meter nodes evenly spaced along the ordinary high water mark of perennial rivers and streams. Each RAU is approximately 0.10 acres (0.15 acre for 75 foot setback on mainstem). Together RAUs from a ribbon of adjoining polygons along the riparian edge of streams. LIDaR is superimposed on this ribbon allowing RAUs to be scored for disturbance and restorability.

Once RAUs are complete with disturbance and restorability scores they are combined to highlight areas that demonstrate both the *need* and *potential* for restoration. To help locate clusters or neighborhoods of sites scoring high with both need and potential additional z-statistics (normalization) on scores was performed to create hot spots for restoration (*see* Figure 5 on page 13).

This was then overlapped with known HUC_{12} sub-watersheds already prioritized by the accompanying RRAP and known taxlot boundaries to develop a list of priority sites. Using basic cost information the cost of restoration was included with these lists based on acreage and 4 additional years of maintenance – see Appendix A.

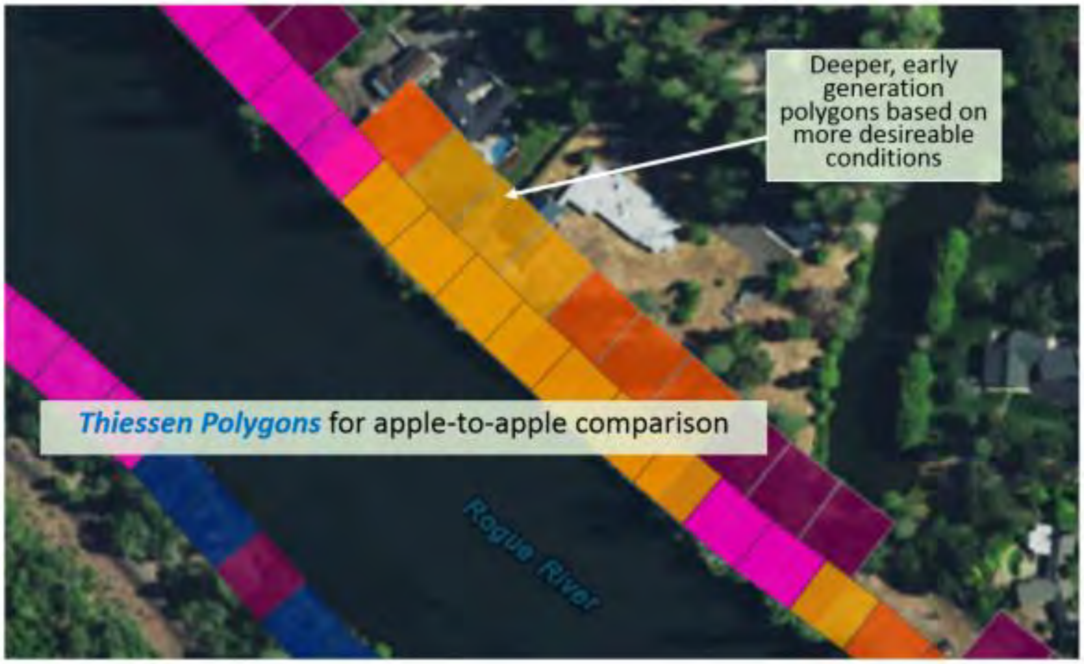
Riparian Assessment Units (RAUs)

To ensure REST would be a meaningful analysis, a repeatable building block for assessment was needed. This would allow the various parts of the Rogue's riparian area to be accurately compared on equal footing, to allow prioritization for restoration. The "RAU" or Riparian Assessment Unit was developed as the REST building block and continually refined as part of this project.

A RAU is a spatial unit created in GIS, of equal riparian frontage and approximately equal area based on a Thiessen polygon[1]. When grouped together, RAUs form a "ribbon" along both banks of the Rogue and its major tributaries (Figure 2).

[1] Thiessen polygons are polygons whose boundaries define the area that is closest to each point relative to all other points. They are mathematically defined by the perpendicular bisectors of the lines between all points.

Figure 2: Figure showing the "ribbon" depth of Riparian Assessment Units (RAUs).



Originally, each RAU covered 82 feet (25 meters) of riverfront and 164 feet (50 meters) of setback for an average area of 0.31 acres each. While the project TAC agreed this was good coverage of the floodplain and was representative of the ecological extent of a riparian area, there was consensus that the setback was probably not a practical size given limitations with private land access and ordinances. Jackson County has ordinances protecting riparian areas within 75 feet of the Rogue River mainstem from disturbance, and protecting areas within 50 feet of non-mainstem streams[1]. Josephine county riparian ordinances aren't as well established and so for consistency the Jackson County ordinance metrics were used for all RAUs in this version of REST. For consistency with local policy and other constraints, the RAU setback was reduced to 75 feet on the Rogue mainstem (0.14-acre RAUs) and 50 feet (0.09-acre RAUs) on tributaries (see Figure 2).

Disturbance Layer

The REST analysis includes two layers, the first is the Disturbance (or Degradation) layer, which defines the primary interest for prioritizing future revegetation projects. Local conservation groups are well-versed in the restoration priorities for their own particular sub-basins but sorting these into a uniform assessment for the basin has remained elusive. For REST to do this it was important to find a scientifically supported metric for defining healthy riparian forest or evaluating its disturbance. This proved to be a challenge. Correlations between stem density and LIDaR return density within height classes were initially considered e.g. how many stems at 5 to 10 feet, 10 to 15 feet, and so on. The challenge for this approach was the lack of literature supporting it. Additionally, the bulk of returns are from the canopy layer and, while there are usually enough returns to determine the ground layer, the

[1] Jackson Soil and Water Conservation District summarizes the county riparian ordinances well in its outreach materials: http://www.rvcog.org/Jackson%20County%20Riparian%20Brochure(1).pdf

understory remains hard to characterize because commercial grade LIDaR provides only a low density of second and third (mid-level) LIDaR returns.

Table 4: Disturbance Layer Scoring

Characteristic	Class	Class Score	
Percent cover at or above 16ft.	≥ 40%	1	Increasing Disturbance →
	< 40%	2	
	< 30%	3	
	< 20%	4	
	< 10%	5	

Reasonably healthy forest was defined as areas within a RAU that supports at least 20 percent tree cover, where trees were defined as 16 feet or greater in height[1]. Defining forest in terms of relatively low canopy cover and height accounts for the complexity of structures and the diversity of tree species that comprise native forest within the Rogue (e.g., open, short-statured oak woodland). Relatively low height also accounts for the diversity of stand ages that normally comprise dynamic floodplain environments.

In an early version of the tool, RAUs with less than 20% cover of plants at least 16 feet tall were assumed to be degraded from a forested condition. However, the TAC felt that this low tree canopy cover threshold resulted in some areas being defined as healthy that were known to be in need of restoration. The threshold for healthy riparian forest was therefore raised to 40 percent tree cover (tree height definition retained as at or above 16 feet height). A stratified scoring system was developed where RAUs in which tree canopy cover was 40 percent or greater were assigned the full score, while areas with lower cover were assigned progressively lower health scores (see Table 4).

It should be noted that degradation was considered by the REST tool only in terms of gross absence of riparian forest. Other kinds of degradation certainly may have occurred within forested RAUs but cannot be detected by the tool (e.g., declines in tree density consequent to timber harvest or increases consequent to fire suppression, loss of large trees, decline in predominant canopy height, invasion of non-native species, loss of biodiversity, etc.). Nonetheless, this coarse assessment of riparian forest health is a useful first pass applicable at the large scales of interest.

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[1] Criteria for canopy cover and vegetation height were chosen to follow standard federal definitions of tree-dominated vegetation. (Tree canopy cover: Federal Geographic Data Committee (FGDC). 1997. Vegetation classification standard. USDI Geological Survey Report FGDC-STD-005. Vegetation Subcommittee, Reston, VA. Accessed at: http://www.fgdc.gov/standards/projects/FGDC-standards-projects/vegetation/vegclass.pdf. Tree height: US Department of Agriculture (USDA). N. d. USDA Plants Database. USDA Natural Resources Conservation Service. Accessed April 23, 2014 at: http://plants.usda.gov/growth_habits_def.html and National Land Cover Database. 2011. NCLD 2011 land cover classification legend. Multi-Resolution Land Characteristics Consortium. Earth Resources Observation and Science Center. US Geological Survey. Sioux Falls, SD. Accessed August 5, 2014, at: http://www.mrlc.gov/nlcd11_leg.php.
Note 5 meters = 16 feet.)

Restorability Layer

Early in the project's life the TAC was concerned with the achievability of restoration when identifying and prioritizing critically degraded sites for revegetation work. Three characteristics were included in the restorability layer to measure how practical restoration at a disturbed site would be: sharp, rocky descents (synonymous with higher longitudinal stream gradients), steep or incised banks (suggested by floodplain elevation), and urban encroachment (indicated by percent built environment). Lower stream gradients tend to support broader floodplains, which in turn have greater potential to retain large wood and to support off-channel fish habitats such as side channels that are important for juvenile stages of some salmonid species' life cycles. Lower floodplain elevation may reflect floodplain connectivity to the waterway, and as an indicator of water table elevations for support of tree and shrub growth. Similar to the Disturbance Layer, scoring was stratified between 1 and 5 to reflect the level of compatibility that each of these three characteristic has with restoration (see Table 5). For example, low stream gradient, low floodplain elevation, and minimal built cover would contribute to a maximum restorability score.

*Table 5: Restoration Layer Scoring. Determined **as an average of** gradient, elevation, and built environment scores.*

Characteristic	Class or Range	Restorability Sub-Score	
Stream gradient (%) “Rosgen” classes	≥10.0%	1	Increasing Restorability →
	4.0% to <10.0%	2	
	2.0% to <4.0%	3	
	0.5% to <2.0%	4	
	< 0.5%	5	
Floodplain elevation (m)	> 4m	1	Increasing Restorability →
	> 3m to 4m	2	
	> 2m to 3m	3	
	> 1m to 2m	4	
	≤ 1m	5	
Built Environment (%)	> 80% to 100%	1	Increasing Restorability →
	> 60% to 80%	2	
	> 40% to 60%	3	
	> 20% to 40%	4	
	≤ 20%	5	

Other factors the restorability scoring wasn't able to account for are soils[1] and obstacles to site access, whether it be the high labor and travel costs commuting to site (e.g., lower reaches of Wolf Creek, or islands). To partially account for the practicalities of site access, watersheds like Wolf Creek were left off the analysis because the distance to site from where most conservation groups and practitioners are

[1] NRCS SSURGO layers too coarse in resolution. Don't account for high variability and fluctuation in the flood plain.

based, and the small size of most riparian taxlots, diminishes the returns on restoration investments in the area.

Scoring Summary

The final outcome for each RAU: a *composite* score between 2 and 10, based on scores of 1 to 5 for *disturbance* and *restorability* is a function of four primary variables:

- percent forest cover – by area – of vegetation 16 feet or higher (disturbance : range 1 to 5)
- longitudinal gradient – by percent – of stream channel (restorability : ⅓ x range 1 to 5)
- floodplain elevation – by meters (restorability : ⅓ x range 1 to 5)
- built environment – by percent encroachment (restorability : ⅓ x range 1 to 5)

Field Surveys: Validation of Disturbance and Restorability Scores

During the proposal phase of the project, there was concern that a combination of GIS analysis and meeting room consensus would lack the integrity of ground truthing in the field. REST outcomes were validated by an on the ground assessment of forest degradation and restorability independent of methods used to analyze remotely sensed data. The purpose of field surveys was two-fold: 1) to validate the outcomes produced by REST to ensure that the REST tool is anchored in real-world conditions and is able to accurately describe them; and 2) to expand on REST's assessment capabilities by describing forest understory and other conditions, for which remote data are lacking. This provided a more complete picture of riparian health than tree cover alone.

Field surveys did not attempt to verify the accuracy of remotely sensed tree cover and height, stream gradient, and bank elevation as the precision of data sources is greater than the precision of tools that can be used to measure these same values in the field.

Field surveys were completed on 78 RAU sites along the Rogue mainstem, Bear Creek, and the Applegate River in October, 2015. Surveyed RAUs represented a range of tree covers, stream gradients, and floodplain elevations. Field surveys were implemented by trained surveyors familiar with Rogue basin ecology and riparian areas, who were experienced in qualitative and quantitative vegetation survey methods. Surveys compared onsite observations to REST outputs to ensure REST wasn't prone to generating false positives or false negatives. Additionally, surveyors assessed whether forest revegetation was an appropriate objective, or whether a different vegetation type was more suitable.

To summarize, the field validation surveys determined:

- Site conditions indicated that forest was an appropriate vegetation type within nearly all RAUs, and forest revegetation was therefore likely to be an appropriate objective at most disturbed sites.
- A small number of sites were not restorable due to exposed bedrock not being plantable. *This was not resolved by the project's completion (see Next Steps).*
- REST was sometimes slightly conservative (scoring lower) in assessing restorability. In some cases, the tool underestimated the practicability of forest revegetation compared to surveyor assessment of on the ground restorability metrics.

  REST is likely to slightly underestimate the level of disturbance when compared to field surveys, most often because field surveyors were able to assess understory conditions as well as tree canopy, and the presence of high invasive species cover within many RAUs indicated disturbance. Understory health *was not being captured by the REST analysis of canopy LIDaR (also see Next Steps)*.

Overall, results from field surveys suggest that the expectation was reasonable that forest was an appropriate vegetation type for most riparian areas within the stream setback (but that the tool will not screen out all sites that could be inappropriate – mostly missing unplantable surfaces like bedrock); that the tool's assessment of restorability was reasonable though somewhat conservative; and that the tool was overestimating forest health, as expected given the lack of understory data available for a remote sensing approach.

RESULTS

Results of the REST project are available online in a publicly accessible webmap. Google Earth files and this report are also available for download from the Rogue Basin Partnership's planning web page:

http://www.roguepartners.org/rogue-restoration-action-plan

Deliverables were driven by TAC consensus and the constraints of time and supported information availability. The key deliverables contained as part of the REST tool are: instructions for public use of the webmap; a preservation layer to identify areas worth of protection; priority taxlot scoping; and identification of areas where future LIDaR would be most beneficial to future Rogue Basin restoration site prioritization efforts.

TAC Outcomes

The TAC provided guidance on a number of major points and help set the agenda for next (see Table 6).

Table 6: REST development guidance from TAC by meeting

Item	Meeting #1	Meeting #2	Meeting #3	Meeting #4	Next Steps
Separate RAUs into disturbance and restorability layers so one doesn't cancel out the other.	✓	✓			
Need for ecological context – use of Rogue Restoration Action Plan (RRAP) layers to help prioritize reaches and sub-watersheds of interest.	✓	✓	✓		✓
Include understory analysis in field surveys.	✓	✓	✓		
Develop a plan for evaluating understory degradation when overstory is mature.			✓	✓	✓
Improve "healthy riparian forest" metrics beyond NLCD definitions.			✓	✓	✓
Refine RAU depth to be more representative of restoration.	✓		✓	✓	
Include a preservation layer – areas worthy of preservation rather than needing restoration.		✓	✓	✓	
Include fish distribution layers.			✓	✓	

The advantage to using a TAC was threefold:

- Firstly, local experts are familiar with prioritization processes and what factors keep them relevant and applicable to local programming. As a group they were integral to achieving a balance between something simple enough to make sense for the whole basin, but also nuanced enough to be useful at the project and reach level. A good example of their collective wisdom providing important guidance was breaking the RAU ribbon into a disturbance and restorability layer.

- In striking this balance of scale, there are going to be areas that a tool like REST accurately assesses but also other smaller sections that REST scoring didn't initially capture well. For example, the need for a preservation layer that identified areas that were already reasonably healthy and perhaps good targets for protection or conservation easements was thanks to TAC input.

- Lastly, the TAC lent credibility to the process. Without the input of local expertise, an analysis of this type, no matter how comprehensive, will remain vulnerable to skepticism from both in and outside the basin. Having this team involved validates the work that TFT and other basin partners have done as well as the investment OWEB has made.

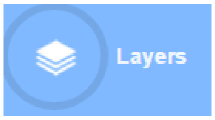
REST Implementation and Access: User Instructions

REST is a web-based platform that is publicly accessible. To reach REST online, enter the following web address into your browser (Chrome, Explorer, Mozilla, supported):

http://freshwatertrust.maps.arcgis.com/apps/webappviewer/index.html?id=8fe03d5fa9964a12a2aa52e6352cd753

A splash screen will introduce the user to REST basics. Upon clearing this screen an overview of the (inland) Rogue will appear similar to the view below (see Figure 4 on next page).

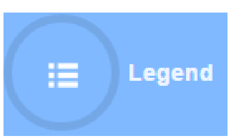
Streams that have been scored for REST are highlighted in blue: Rogue mainstem, Applegate including Williams, Thompson, and Little Applegate, Bear, Elk, Big Butte, Little Butte, including South Fork, Salt, and Antelope. The top left has a link to the home view a standard zoom in (+) / zoom out (-) feature. In the top right is a legend for currently selected layers and the layers menu:



b) The "Layers" icon allows the user to pick the layers that have been loaded into the REST tool. Included along with the REST "ribbons" (in grey) are the Action plan priority sub-watersheds, and fish distribution layers (see Table 7).

Table 7: Layers included in the first release of REST (August 2016).

Layer	Description	Source
Disturbance Scores	Disturbance layer or "ribbon" of RAUs	REST tool
Restorability Scores	Restorability layer or "ribbon" of RAUs	REST tool
Composite Scores	Combined Disturbance and Restorability layer or "ribbon" of RAUs	REST tool
Preservation Scores	Areas of healthy riparian forest – preservation targets.	REST tool
Hot Spot Analysis	z-statistics analysis on *composite scores* and graphically enhanced to identify priority "neighborhoods" for restoration[1].	REST tool
Action Plan Layers: Taxlots, confluences, corridors, watersheds	Anchor habitat areas for Salmonids and Lamprey	From Rogue Restoration Action Plan of the Rogue Basin Partnership
Coho Distribution (Intrinsic Potential)	Using geomorphic factors Coho IP describes channel size, gradient and flow most suitable to Coho spawning, rearing and migration.	From the NMFS recovery plan for Southern Oregon, Northern California, Coastal Coho or SONCCC Salmon.
Summer Steelhead	Population distribution.	Oregon Department of Fish and Wildlife
Geography: Streams, Places, Boundaries.	Generic map layers.	



c) The "Legend" icon displays the key for how selected layers that accompany REST layers appear on the web map.

Figure 5 provides an example view including the REST hot spot analysis and the RRAP (Rogue River Action Plan) priority sub-watershed layers selected. This image shows RRAP priority areas (green, blue, brown and aqua colored sub-watersheds) and priority spawning areas (red streams) overlapped with the REST hotspot analysis. Confluence areas in particular are clearly worthy of more serious consideration (Rogue/Bear/Little Butte; Elk/Rogue; Williams/Applegate; Applegate/Rogue).

[1] In layman's terms the hots spot layer can be explained as: the more composite RAUs score the same as their neighbors the darker the surrounding cloud or spot. The range of colors represents low scores or 2s (blue) up to high scores or 10s (red). So dark red spots are the areas of highest priority.

Figure 4: Initial view of REST on ArcGIS Web Viewer™ (after clearing the splash screen).

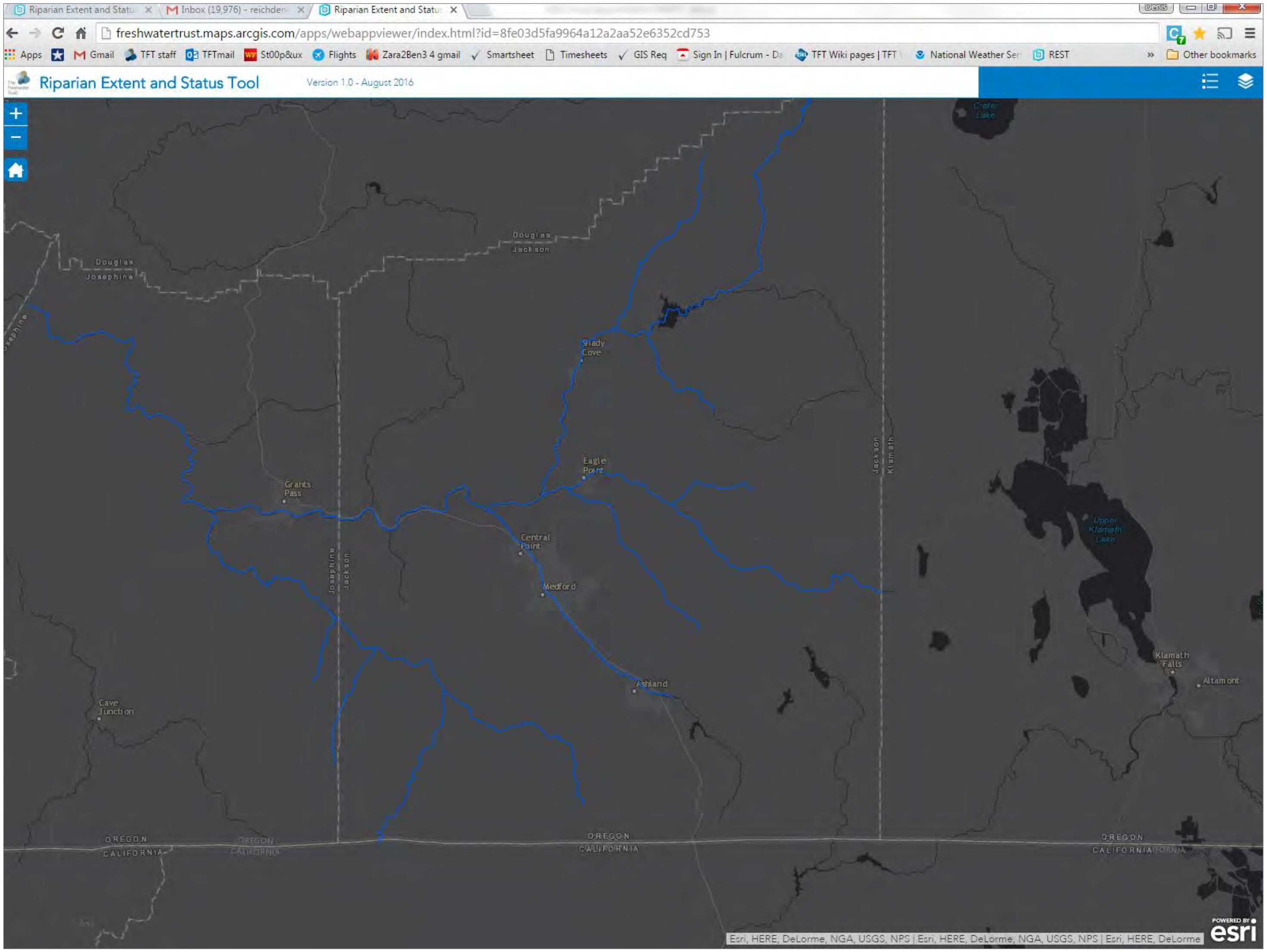
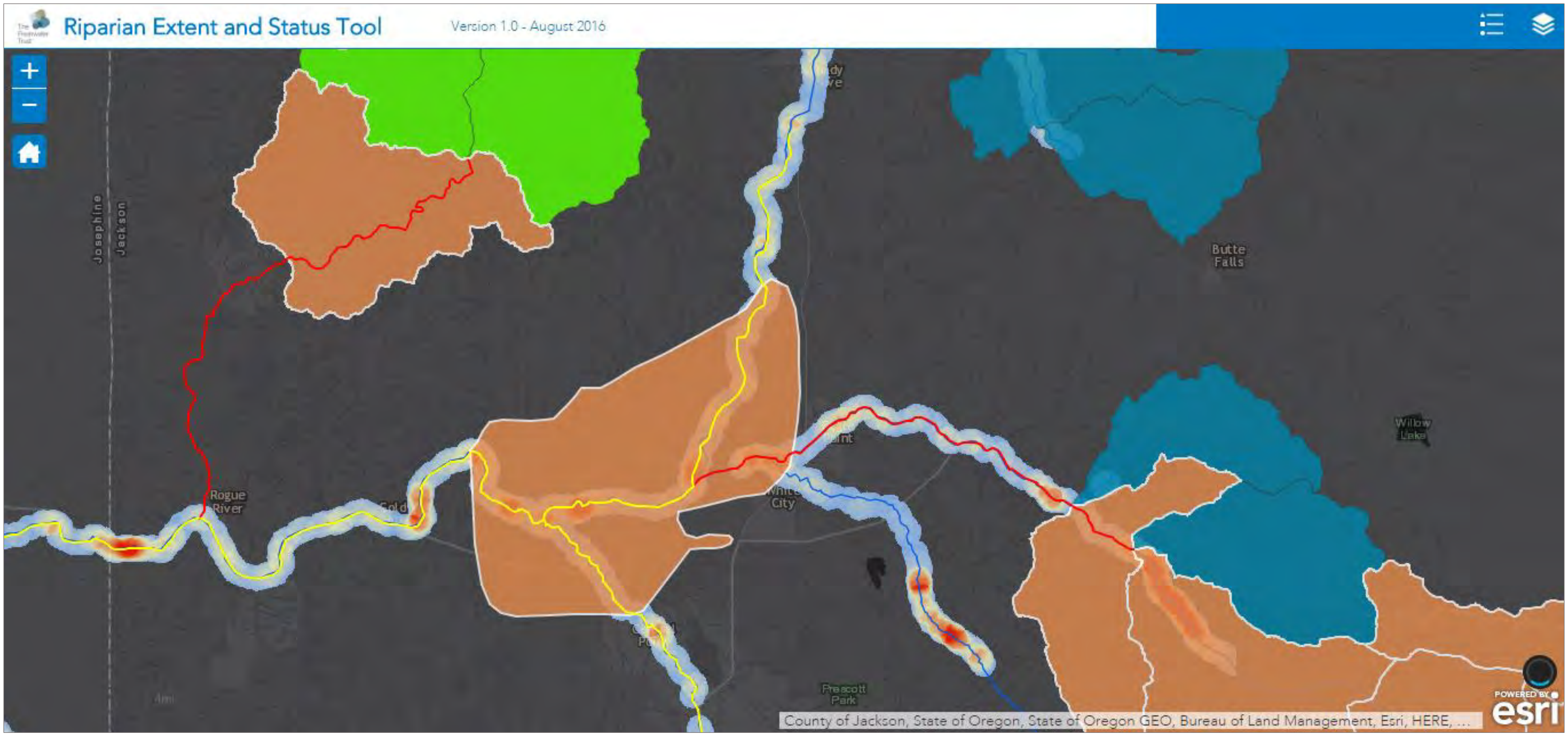
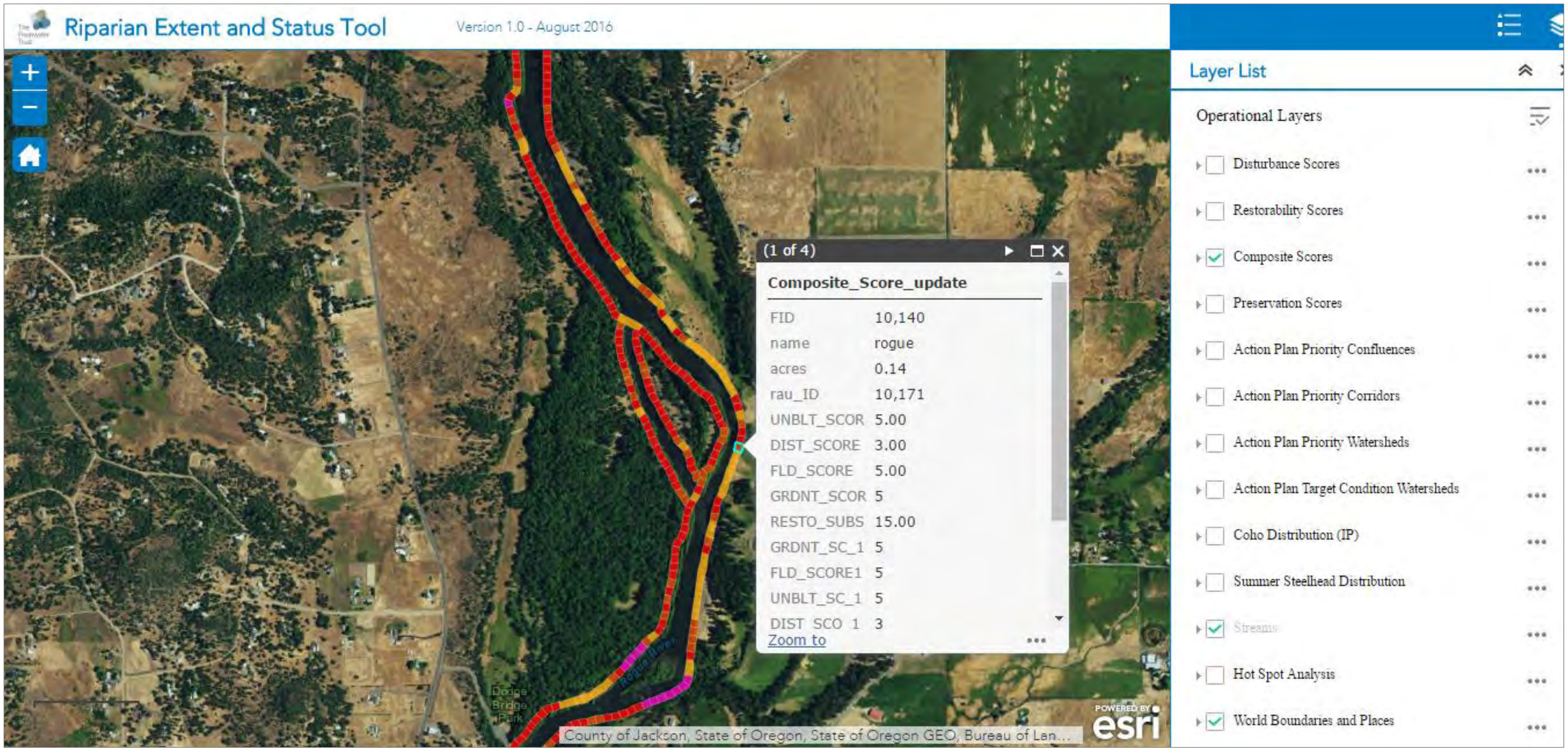


Figure 5: An example view from the REST web tool showing the z-statistics based "hot spot" analysis overlapping with action plan priorities.



When operating the REST tool, it's important to remember that RAUs are small relative to the extent of the map. To see the ribbon and examine individual RAUs and their scores, users will need to zoom in (see Figure 6 on next page).

Figure 6: Zoomed in on the Rogue mainstem (just above Dodge Bridge at the Rogue River Preserve) showing a RAU selected to examine underlying REST scores

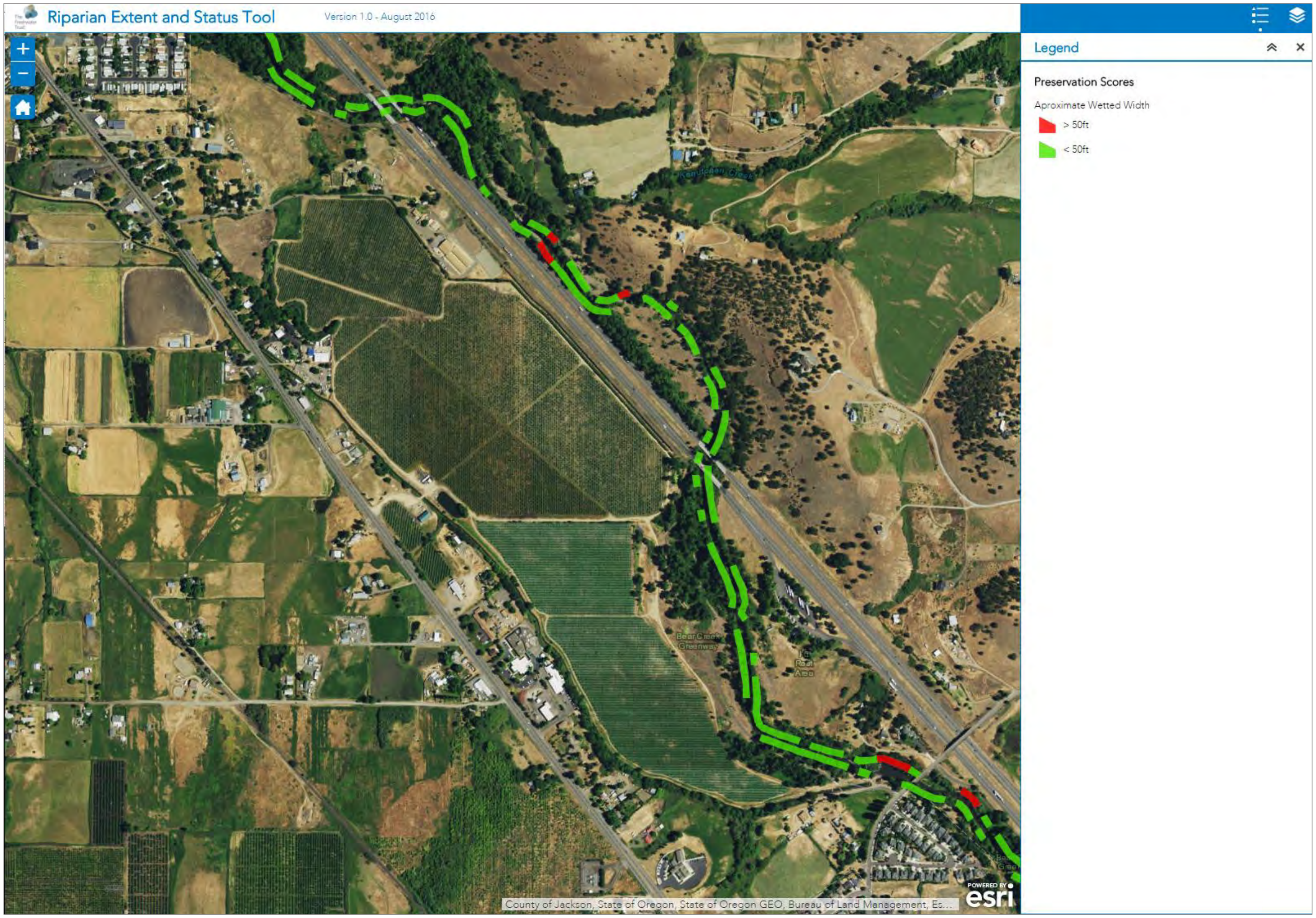


Note: color coding for selected layers is always available in the Legend layer.

Preservation Layer

Craig Harper (at the time) with Southern Oregon Land Conservancy and TAC member was interested in areas that were healthy and worthy of preservation. An additional layer was established with a 65 percent tree cover threshold. Chris Park who was involved with establishing temperature TMDLs for the Rogue also explained that 65 percent cover was the point at which maximum shading was established, this was particularly significant on streams of 50 feet or less since with well establish riparian vegetation canopy closure is possible on these smaller streams – *see Figure 7*.

Figure 7: The preservation layer on the Bear Creek greenway. RAUs with at least 65 percent cover are shown. Red indicates channel width greater than 50ft, green less than 50 ft.



Priority Taxlots

A taxlot layer was also developed that accounted for priority areas identified by the Rogue Restoration Action Plan (RRAP). This was broken into four categories: confluence (C), priority watershed (sW), confluence and priority watershed (C&sW), and other (O). All taxlots that overlapped with these priority areas and also had a mean *and* median[1] combination REST score of 7 or above were included. Other taxlots (taxlots of importance not overlapping with priority confluences or watersheds) were included if they had a mean *and* median combination score of 8 or above. These thresholds are arbitrary and could be adjusted to increase or decrease the size of the priority taxlot list. The current list (Appendix A) is a healthy target pool of sites to recruit from that also provides an initial understanding of the cost for a larger basin-wide riparian restoration effort.

TFT has installed and maintained a number of riparian projects in the Rogue since establishing a presence in 2012. The contractors they use are also utilized by many local conservation partners. By analyzing trends and patterns in the costs of these projects TFT was able to offer rough budget estimates of 5 year projects for all priority taxlots (5 Year Projection). These are included in the priority taxlot layer along with a breakdown of site preparation and planting (PnP), and annual maintenance (Maintenance per Year).

LIDaR Gaps

The LIDaR layers for the Rogue Basin lack complete coverage needed to implement REST basin-wide. The major gaps in the inland Rogue are Evans Creek, the mainstem Rogue between Grants Pass and the confluence with the Applegate, the upper reaches of Little Butte Creek (North and South Forks), and upper Big Butte Creek. In the Lower Rogue, the Illinois and upper estuary are the major omissions. The Lower Illinois is largely pristine and is on public land and is probably not in urgent need of restoration assessment. Sucker Creek in the Upper Illinois and Lobster Creek in the lower Rogue are probably the reaches that would benefit most from LIDaR coverage in the bottom half of the basin.

Additionally, the age of LIDaR is a potential problem. Some layers were captured as much as five summers ago and with the addition of new Evans Creek and the Grants Pass coverage in 2016 that represents a significant time spread, especially with the dynamic nature of the Rogue and how much vegetation grows in five years. As LIDaR gets cheaper to collect and other technologies (like Structure from Motion) are able to plug gaps this should resolve itself – but this is still a number of years out.

CONCLUSIONS

The objective of designing a tool that could use available LIDaR in the Rogue Basin for the purposes of riparian revegetation site prioritization has been successful. A webtool is now publicly available along with accompanying Google Earth and ArcGIS layers. A prioritized taxlot layer with accompanying restoration budgets has also been successfully completed as a result of this project.

The REST tool will allow not only individual conservation partners to scope riparian projects and programs, but will also enable umbrella organizations like the Rogue Basin Partnership to begin budgeting for more substantial, long-term restoration objectives.

[1] Mean and median scores were derived from all RAUs completely within the taxlot boundary.

Next Steps

With the REST analysis complete, the first step is to distribute it among partners. To do this, the Rogue Basin Partnership and TFT will host a link to the webtool along with download links for this report and zip files of kmz's for Google Earth and for GIS.

There is a possibility that sites inappropriate for forest, e.g., those with exposed bedrock, could be screened out using data from the National Agricultural Imagery Program (NAIP)[1].

The understory characterization for a Himalayan blackberry/weed layer was not completed. It proved to be more complex than time and resources allowed for. Solving this would address one of the most prevalent ecological challenges to the Rogue. Aging overstory is increasingly and repeatedly inundated with invasive species propagules that allow weed domination and reduce species diversity and structural complexity. Being able to identify these areas would allow local conservation groups to gain a better understanding of the extent of this expanding problem and developing a more formal strategy to address it. TFT continues to dedicate resources to unlocking this important problem.

Finally, the revegetation project budget information will become part of larger planning and funding requests in an effort to increase the pace and scale of stream corridor restoration in the Rogue.

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[1] https://www.fsa.usda.gov/programs-and-services/aerial-photography/imagery-programs/naip-imagery/

Appendix A : Priority Taxlots

Please also refer to Results > Priority Taxlots on page 18 and also the Taxlot layer on the REST webmap.

Table A.1: Taxlot category key and budget totals. Categories are where high REST scoring taxlots align with RRAP priority areas

Code	Description	Threshold	5-year project budget Totals
C&sW	*Priority confluence and priority sub-watershed*	≥7 in both Avg and Med	$653,837
sW	*Priority sub-watershed*	≥7 in both Avg and Med	$1,544,126
C	*Priority confluence*	≥7 in both Avg and Med	$1,023,322
O	*Other i.e. higher priority not captured in above categories*	≥8 in both Avg and Med	$1,808,009
TOTAL	Total Acreage = 485		**$5,029,294**

Table A.2: Priority taxlot acreage, REST score, and restoration cost data

ID	Acres	Avg	Med	Cat	Prep&Plant	Maint/yr	5 year project
362W16500	0.77	10	10	C&sW	$14,610	$2,922	$29,221
362W16400	7.01	9	10	C&sW	$13,863	$1,141	$19,568
362W16400	7.01	9	10	C&sW	$13,863	$1,141	$19,568
362W18103	0.85	9	9	C&sW	$14,600	$2,897	$29,087
362W18202	0.85	9	9	C&sW	$14,600	$2,897	$29,083
362W17300	1.28	9	9	C&sW	$14,549	$2,776	$28,427
362W18300	2.41	9	9	C&sW	$14,414	$2,453	$26,679
331E331300	4.11	9	9	C&sW	$14,210	$1,968	$24,050
331E331300	4.11	9	9	C&sW	$14,210	$1,968	$24,050
331E331300	4.11	9	9	C&sW	$14,210	$1,968	$24,050
331E31200	1.14	8	9	C&sW	$14,566	$2,816	$28,645
362W20200	5.95	8	9	C&sW	$13,990	$1,443	$21,207
362W12100	9.77	8	9	C&sW	$13,533	$1,000	$18,533
331E301400	1.13	8	8	C&sW	$14,566	$2,817	$28,650
341W021700	1.14	8	8	C&sW	$14,566	$2,816	$28,646
362W191601	1.42	8	8	C&sW	$14,532	$2,735	$28,208
362W17102	1.42	8	8	C&sW	$14,532	$2,735	$28,207
362W18102	1.71	8	8	C&sW	$14,498	$2,654	$27,765
362W17301	3.84	8	8	C&sW	$14,243	$2,046	$24,473
331E700	66.36	8	7	C&sW	$6,761	$1,000	$11,761
362W14100	1.28	7	7	C&sW	$14,549	$2,776	$28,431
362W18201	1.28	7	7	C&sW	$14,549	$2,776	$28,427
362W211300	1.41	7	7	C&sW	$14,534	$2,739	$28,228
362W13301	2.84	7	7	C&sW	$14,362	$2,330	$26,012
331E331400	5.11	7	7	C&sW	$14,091	$1,683	$22,503
362W17105	6.50	7	7	C&sW	$13,924	$1,286	$20,356

362E331003	0.75	10	10	sW	$14,612	$2,926	$29,241
372E04300	0.84	10	10	sW	$14,601	$2,900	$29,100
351W091600	0.85	10	10	sW	$14,600	$2,897	$29,087
362E33401	1.13	10	10	sW	$14,567	$2,819	$28,663
351W29304	1.14	10	10	sW	$14,566	$2,816	$28,647
362E331001	1.40	10	10	sW	$14,534	$2,740	$28,237
362W16100	1.42	10	10	sW	$14,532	$2,736	$28,212
362E33400	0.56	9	10	sW	$14,635	$2,980	$29,533
351W201000	0.56	9	10	sW	$14,634	$2,979	$29,531
361W06701	0.57	9	10	sW	$14,634	$2,979	$29,529
362W18205	0.57	9	10	sW	$14,634	$2,978	$29,524
361W08500	0.66	9	10	sW	$14,623	$2,952	$29,385
361W06705	0.71	9	10	sW	$14,617	$2,938	$29,308
351W29504	0.99	9	10	sW	$14,583	$2,857	$28,869
362E7100	3.65	9	10	sW	$14,265	$2,099	$24,759
362W16600	4.25	9	10	sW	$14,193	$1,927	$23,829
372E900	4.88	9	10	sW	$14,118	$1,749	$22,862
362E33900	7.05	9	10	sW	$13,858	$1,129	$19,503
361W06400	0.99	9	9	sW	$14,583	$2,857	$28,866
372E04500	1.04	9	9	sW	$14,578	$2,844	$28,799
362W281800	1.32	9	9	sW	$14,544	$2,764	$28,364
351W29700	1.71	9	9	sW	$14,498	$2,654	$27,768
372E700	2.35	9	9	sW	$14,420	$2,469	$26,764
363W12101	2.41	9	9	sW	$14,413	$2,452	$26,676
361E10200	2.51	9	9	sW	$14,402	$2,425	$26,526
361W08100	4.47	9	9	sW	$14,167	$1,864	$23,489
362E5300	5.44	9	9	sW	$14,051	$1,588	$21,994
362E5500	10.54	9	9	sW	$13,441	$1,000	$18,441
351W16500	0.71	8	9	sW	$14,617	$2,938	$29,308
363W12103	0.71	8	9	sW	$14,617	$2,938	$29,306
372E701	0.92	8	9	sW	$14,592	$2,877	$28,979
362E33100	3.29	8	9	sW	$14,308	$2,202	$25,317
351W31600	0.57	8	8	sW	$14,634	$2,979	$29,529
363W01800	0.57	8	8	sW	$14,634	$2,979	$29,528
372E4202	0.65	8	8	sW	$14,624	$2,954	$29,395
331E321300	0.71	8	8	sW	$14,617	$2,938	$29,306
351W201700	0.71	8	8	sW	$14,617	$2,938	$29,306
362W281101	0.75	8	8	sW	$14,612	$2,927	$29,245
331W351502	0.99	8	8	sW	$14,583	$2,857	$28,870
372E10400	1.03	8	8	sW	$14,578	$2,845	$28,804
372E1001	1.32	8	8	sW	$14,544	$2,765	$28,368

372E800	1.41	8	8	sW	$14,533	$2,739	$28,227
363W12500	1.42	8	8	sW	$14,532	$2,735	$28,206
362E5303	1.78	8	8	sW	$14,489	$2,632	$27,650
351W17101	2.13	8	8	sW	$14,447	$2,533	$27,110
361W06500	2.27	8	8	sW	$14,431	$2,493	$26,897
361W09B900	2.36	8	8	sW	$14,420	$2,467	$26,756
362W282604	2.43	8	8	sW	$14,411	$2,446	$26,642
351W31900	2.70	8	8	sW	$14,379	$2,371	$26,232
361W06401	2.96	8	8	sW	$14,348	$2,297	$25,834
351W08600	2.99	8	8	sW	$14,345	$2,288	$25,787
362W16711	7.53	8	8	sW	$13,801	$1,000	$18,801
351W29200	1.42	8	7	sW	$14,532	$2,735	$28,209
361W091600	6.37	8	7	sW	$13,940	$1,323	$20,556
361W08300	8.94	8	7	sW	$13,633	$1,000	$18,633
363W01403	1.28	8	6	sW	$14,549	$2,776	$28,429
361W09D500	0.65	7	8	sW	$14,624	$2,954	$29,395
341W10907	0.57	10	10	C	$14,634	$2,978	$29,524
331E34C900	0.66	9	9	C	$14,623	$2,952	$29,385
364W21B800	0.71	9	9	C	$14,617	$2,938	$29,307
393W032000	0.75	9	9	C	$14,612	$2,926	$29,243
384W23C1100	0.57	9	8	C	$14,634	$2,979	$29,529
384W222900	0.66	8	9	C	$14,623	$2,953	$29,387
393W111000	0.75	8	8	C	$14,612	$2,925	$29,239
384W223800	0.66	8	7	C	$14,623	$2,953	$29,388
384W21801	0.83	9	9	C	$14,602	$2,903	$29,117
341W03D300	1.56	9	9	C	$14,515	$2,695	$27,992
391E11300	1.98	8	9	C	$14,465	$2,576	$27,346
384W223900	1.13	8	8	C	$14,567	$2,819	$28,661
384W28100	1.77	8	8	C	$14,490	$2,636	$27,671
341W10100	2.13	8	8	C	$14,447	$2,532	$27,108
364W22B2500	2.98	8	8	C	$14,346	$2,291	$25,801
364W22C4600	4.83	8	8	C	$14,124	$1,763	$22,937
38050100002600	0.75	8	8	C	$14,612	$2,926	$29,240
360620C0001200	1.20	8	8	C	$14,558	$2,797	$28,546
38050100001501	1.22	7	6	C	$14,556	$2,791	$28,513
38050100000300	1.23	9	10	C	$14,555	$2,791	$28,508
38051200000900	1.31	8	7	C	$14,545	$2,766	$28,377
37053500001304	1.32	8	9	C	$14,544	$2,765	$28,368
360620C0001101	1.40	8	8	C	$14,535	$2,741	$28,241
38050100001100	1.60	8	7	C	$14,511	$2,684	$27,933

36062000000500	1.60	8	8	C	$14,510	$2,684	$27,929
360620C0001300	1.69	9	10	C	$14,499	$2,657	$27,785
38050100000400	1.79	9	10	C	$14,488	$2,630	$27,636
38050100000800	1.79	7	6	C	$14,488	$2,630	$27,636
38051200001300	3.29	8	9	C	$14,308	$2,201	$25,315
36061900000200	3.43	8	8	C	$14,291	$2,161	$25,098
37053600001500	3.76	8	9	C	$14,252	$2,068	$24,594
38050100001400	4.14	8	8	C	$14,207	$1,960	$24,007
38050100001400	4.14	8	8	C	$14,207	$1,960	$24,007
38050100001400	4.14	8	8	C	$14,207	$1,960	$24,007
36063000000400	4.43	7	6	C	$14,172	$1,877	$23,560
38051200001000	5.75	7	6	C	$14,014	$1,500	$21,516
38050100001000	5.83	8	9	C	$14,004	$1,477	$21,391
36063000000100	7.07	9	10	C	$13,856	$1,124	$19,479
361E11700	0.56	10	10	O	$14,634	$2,979	$29,532
351W361304	0.56	10	10	O	$14,634	$2,979	$29,531
361E302201	0.57	10	10	O	$14,634	$2,979	$29,528
361E302100	0.64	10	10	O	$14,626	$2,958	$29,418
361E302200	0.66	10	10	O	$14,623	$2,953	$29,390
361E302101	0.66	10	10	O	$14,623	$2,953	$29,387
363W11100	1.28	10	10	O	$14,549	$2,776	$28,429
364W25B1400	1.85	10	10	O	$14,481	$2,613	$27,545
363W19A400	0.57	9	10	O	$14,634	$2,978	$29,526
361W03AD100	0.66	9	10	O	$14,623	$2,953	$29,388
351W352700	0.84	9	10	O	$14,602	$2,902	$29,111
364W25B1500	1.14	9	10	O	$14,566	$2,816	$28,648
341W29201	1.99	9	10	O	$14,464	$2,574	$27,334
361E14100	2.17	9	10	O	$14,443	$2,522	$27,055
371E05216	4.10	9	10	O	$14,211	$1,970	$24,059
361E14500	4.61	9	10	O	$14,151	$1,826	$23,282
341W28600	5.11	9	10	O	$14,091	$1,683	$22,505
363W15600	5.97	9	10	O	$13,988	$1,438	$21,179
361E10500	0.57	9	9	O	$14,634	$2,979	$29,531
391E04B500	0.75	9	9	O	$14,612	$2,926	$29,240
341E11402	1.03	9	9	O	$14,578	$2,845	$28,805
361E04801	1.04	9	9	O	$14,578	$2,845	$28,801
364W24C103	1.28	9	9	O	$14,549	$2,776	$28,428
341E11400	1.32	9	9	O	$14,544	$2,765	$28,369
384W281100	1.40	9	9	O	$14,535	$2,742	$28,246
364W24C102	1.71	9	9	O	$14,498	$2,654	$27,767

384W281001	1.95	9	9	O	$14,469	$2,584	$27,391
363W11900	1.99	9	9	O	$14,464	$2,573	$27,326
371E05214	2.16	9	9	O	$14,444	$2,524	$27,065
372W02D400	2.70	9	9	O	$14,379	$2,371	$26,233
364W26D100	3.27	9	9	O	$14,311	$2,208	$25,353
364W27400	3.98	9	9	O	$14,226	$2,005	$24,251
371E05215	5.22	9	9	O	$14,077	$1,650	$22,327
371E09201	7.13	9	9	O	$13,849	$1,106	$19,376
372W02D2000	0.56	8	9	O	$14,634	$2,979	$29,531
351W352600	0.56	8	9	O	$14,634	$2,979	$29,531
341W15BD500	0.71	8	9	O	$14,617	$2,938	$29,309
361W141000	0.75	8	9	O	$14,612	$2,927	$29,248
361W101400	0.84	8	9	O	$14,602	$2,901	$29,109
361E04102	0.94	8	9	O	$14,589	$2,872	$28,948
372W13AA300	1.32	8	9	O	$14,544	$2,765	$28,367
372W13AA300	1.32	8	9	O	$14,544	$2,765	$28,367
361W15700	1.69	8	9	O	$14,500	$2,660	$27,799
371E05203	1.78	8	9	O	$14,489	$2,633	$27,655
351W361400	2.16	8	9	O	$14,444	$2,524	$27,065
351W04601	2.55	8	9	O	$14,397	$2,412	$26,458
361E11500	2.63	8	9	O	$14,387	$2,389	$26,332
381W15A500	2.76	8	9	O	$14,372	$2,354	$26,144
361E051900	3.10	8	9	O	$14,331	$2,255	$25,607
361E12900	6.66	8	9	O	$13,905	$1,240	$20,103
37052600000200	0.57	10	10	O	$14,634	$2,979	$29,530
37052600000300	0.75	10	10	O	$14,612	$2,926	$29,242
36063000001100	0.77	10	10	O	$14,609	$2,920	$29,209
37052600000202	0.85	9	10	O	$14,600	$2,898	$29,093
360524D0003300	0.85	10	10	O	$14,600	$2,898	$29,088
36052300000900	1.28	10	10	O	$14,549	$2,777	$28,433
37053500000300	3.25	10	10	O	$14,313	$2,213	$25,380
37053500000100	6.27	9	10	O	$13,952	$1,353	$20,715
37062400002403	0.75	9	9	O	$14,612	$2,926	$29,242
37060600002500	1.21	8	9	O	$14,557	$2,795	$28,533
37060800002501	1.22	9	9	O	$14,556	$2,792	$28,514
38052600000100	1.22	8	9	O	$14,556	$2,791	$28,512
36063100000700	1.28	8	9	O	$14,549	$2,776	$28,428
37052100003102	1.41	8	9	O	$14,533	$2,737	$28,220
36063000001000	2.16	9	9	O	$14,444	$2,525	$27,068
37052100002200	2.93	8	9	O	$14,352	$2,305	$25,878