

Synthesis Presentation
Using Overlay Analysis as a Tool to Identify Restoration Opportunities for Coho Salmon
TRFRP Campbell Creek Pilot Project
April 26 2018

SLIDE 2

Welcome everyone and thank you for attending this webinar. My name is Francesca Rohr, I am a Research Analyst with CALFIRE's Forest Practice GIS here in Santa Rosa and I am a member of the PPIIT for the Campbell Creek Pilot Project.

Today I'd like to present 3 items

1. A spatial analysis method I think could be useful as a means to synthesize the information produced from the 3-track analysis of Smith Creek sub-planning watershed.
2. A quick review of the data from the 3-track analysis in terms of Inputs to the spatial analysis.
3. Decision making needs from subject matter experts.

Hopefully this presentation will spark a discussion to help us move forward.

SLIDE 3

Overlay Analysis as a Method

Understanding Overlay Analysis

<http://desktop.arcgis.com/en/arcmap/10.3/tools/spatial-analyst-toolbox/understanding-overlay-analysis.htm>

What is a raster?

<http://desktop.arcgis.com/en/arcmap/10.3/manage-data/geodatabases/raster-basics.htm>

“Used for optimal site selection or suitability modeling. It is a technique for applying a common scale of values to diverse and dissimilar inputs to create an integrated analysis.”

Suitability models identify the best or most preferred locations for a specific phenomenon.

General steps outlined in Understanding Overlay Analysis

1. **Define the problem** = what is the objective?

We can define this directly from the Forest Planning Watershed Pilot Projects Concept Paper of May 2016:

Two of the ‘substantive areas to be addressed by the pilot projects’ are the ‘description of current forest conditions’ and the ‘identification of restoration opportunities in forested landscapes’.

The Campbell Creek Pilot Project has, so far, focused on coho salmon as a resource of concern. Thus, the objective would be to use information collected about the current condition of coho and coho habitat within the planning watershed to identify specific areas where restoration efforts might be of most value, or have the greatest potential impact.

It is important to note that the Concept Paper states the following:

‘To define “restoration” in the context of the pilot projects, we borrow from the Society for Ecological Restoration: “Ecological restoration is the process of assisting the recovery of an ecosystem that has been degraded, damaged, or destroyed.”’

SLIDE 4

2. Break the problem into submodels

Most overlay problems are complex, and this one is no different. Breaking it down into submodels helps us to organize the process and the data, which in turn helps us to more effectively answer our spatial question.

For this analysis, I see two submodels: ASSETS and THREATS

Specifically, using the data collected during the 3-track analysis,

Assets could be, in alphabetical order,

- Adequate riparian function
- Coho intrinsic potential
- Existing and restorable coho habitat
- Pool formation potential from large wood recruitment
- Watercourses and WLPZ

Threats could be

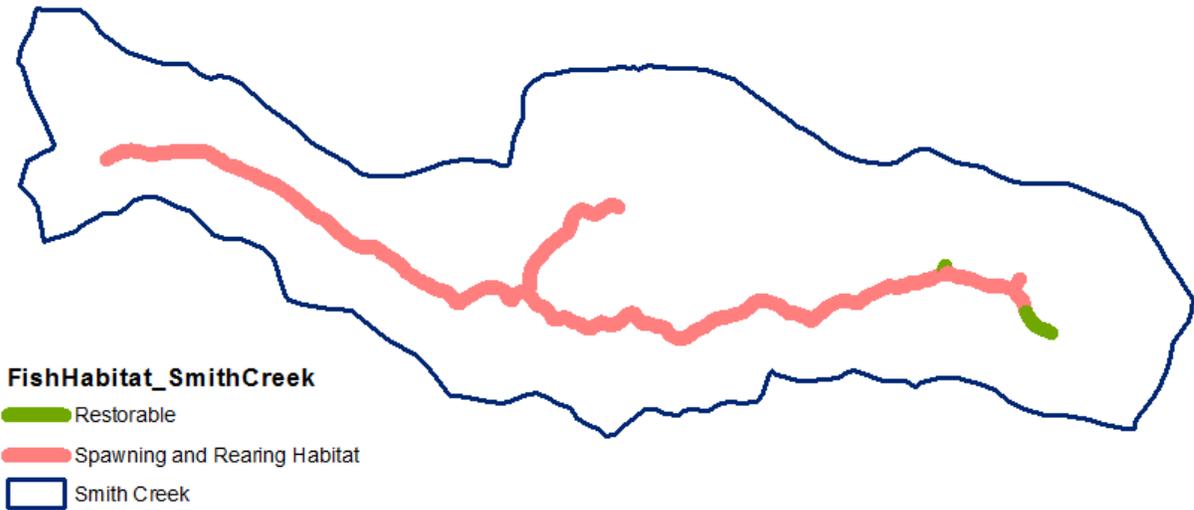
- Erosion hazard ratings
- Instream water temperature (not part of the analysis but deemed a missing piece)
- Landings
- Roads
- Timber harvesting
- Watercourse crossings

SLIDE 5

3. Determine significant layers

This step is where expert knowledge becomes critical in terms of choosing the inputs and deciding which attributes from those inputs are important.

Some inputs are simple – for example Coho habitat – which would belong to the Asset group. The data to be valued is straightforward - for the Class I watercourses in Smith Creek, either the habitat exists (spawning and rearing), or it is restorable.



Other inputs to the submodel might be more complex e.g. timber harvesting as an input to Threats. What attributes of timber harvesting contribute to Threats to coho? Should silviculture be included by type (e.g. clearcut, selection), by number of entries, proximity to a road, proximity to a watercourse, slope, or a combination of factors? These same questions can be asked about yarding. Should time decay be included? We can look to previous studies as a guide this process. Ultimately, subject matter experts need to make these decisions within the limits of the existing GIS data.

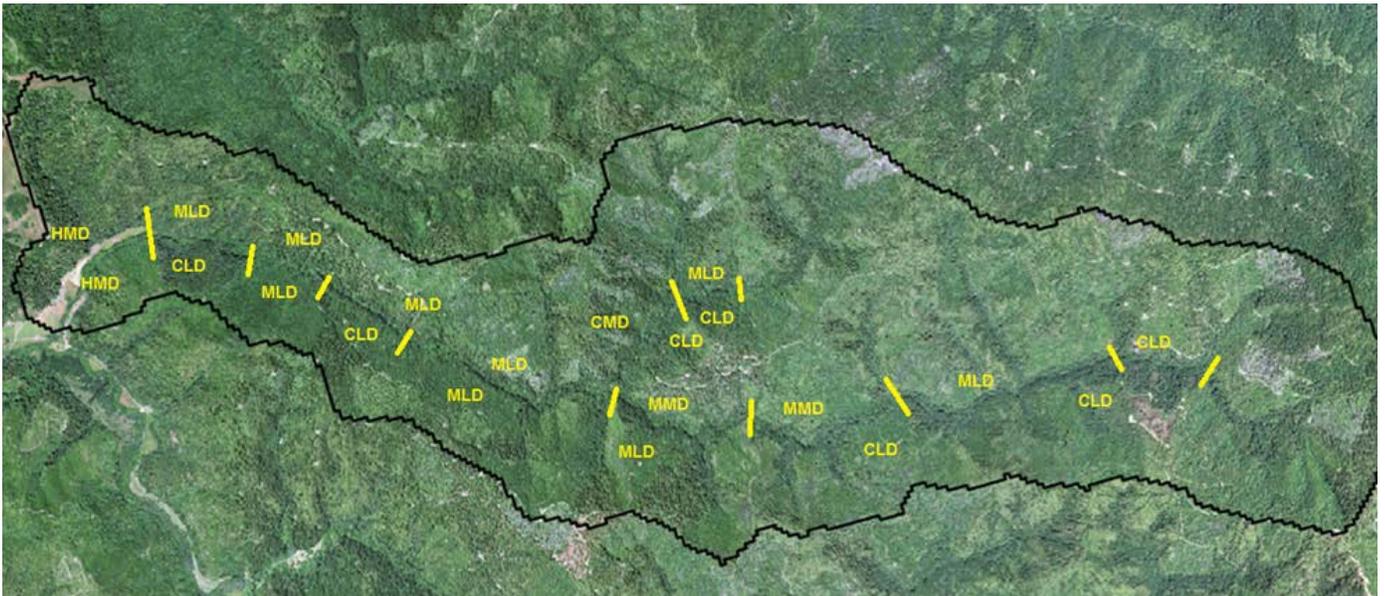
We will definitely be discussing this after my presentation. For now, I'd like to keep moving through the analysis method.

SLIDE 6

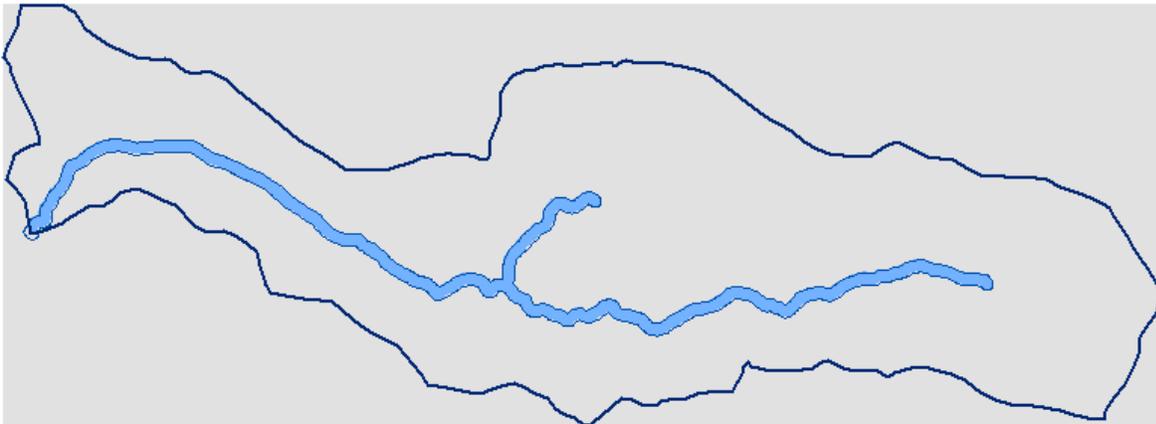
4. Reclassification/transformation

Once all the attributes of the Assets and Threats have been identified they may need to be converted to raster ([what is a raster?](#)), and then reclassified and valued. This is all 'geoprocessed' in the GIS. Interval or ordinal value scales are, in this case, probably the best fit (see page 3 [Understanding Overlay Analysis](#)).

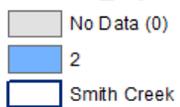
Using the example of the Riparian Function Assessment by Pete Cafferata, the data from his assessment is shown below, as he presented it at October PPWG meeting. It was then captured in the GIS as a polygon of the WLPZ or riparian area, using the maximum 150' protection from the Forest Practice Rules. The entire area was given a 'moderate' rating, per the assessment.



SLIDE 7



Reclass_RiparianFunction_SmithCrRaster



This polygon was then converted to a raster creating a rectangular grid. This raster or grid, can be reclassified so that grid 'cells' are given the following values:

No Data	0
Low	1
Moderate	2
High	3

This process is repeated for each Input item in both the Assets and the Threats submodel.

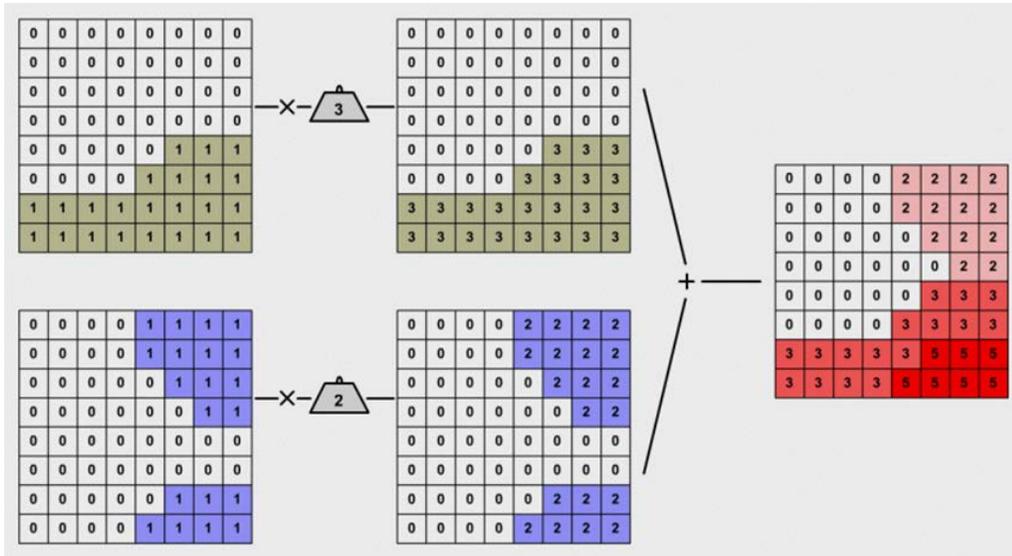
SLIDE 8

5. Weight

Once all the inputs for the Assets and Threats have been established, with their respective attributes and reclassified values, it is time to consider weighting the factors based on importance.

For example, if Input 1 is considered to be twice as important as Input 2, then Input 1 values would be multiplied by 2. The ratio between these two items would always be 2:1

The bottom grid illustrates exactly this. The top grid is showing a ratio of 3:1



It's important to remember that weighting is not a requirement, all inputs in a submodel may be considered of equal impact. Expert knowledge is needed to answer the questions:

Should the inputs be weighted? and if so,
How should they be weighted?

SLIDE 9

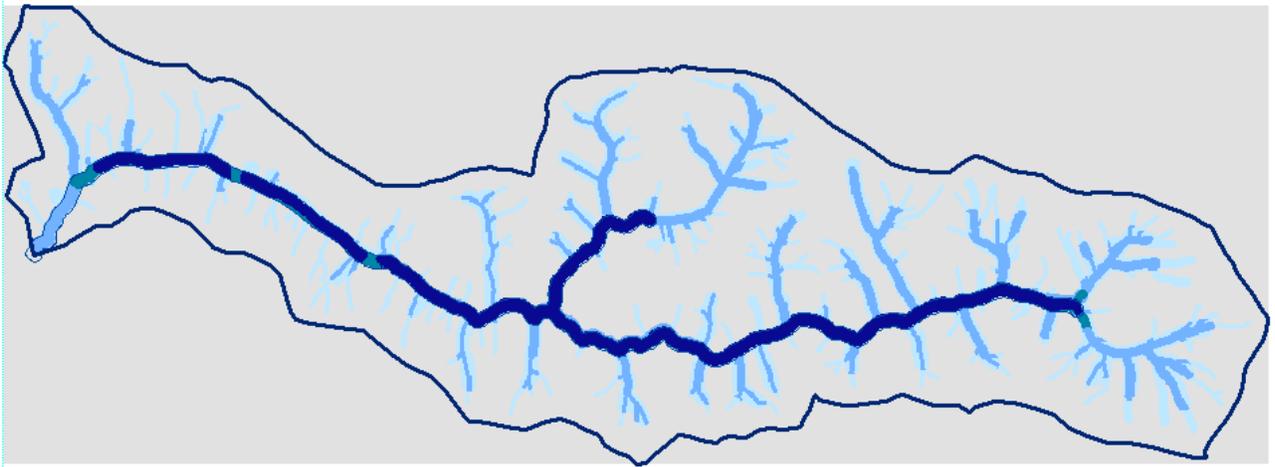
6. Add/Combine

Here is an example of combined values for each submodel.

The data is now in a more uniform format which means that

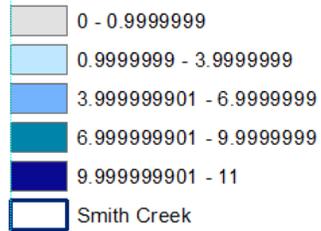
- All data layers are rasters with each grid cell of the individual Assets and Threats exactly overlapping the cells of the other inputs – imagine them stacked perfectly on top of each other.
- Each cell also has a value based on the attribute of interest, and the values have potentially been weighted by relative importance.
- A simple math calculation can sum the Assets and the Threats for each cell.

The results of this step can show us the spatial distribution of low to high Assets and low to high Threats.

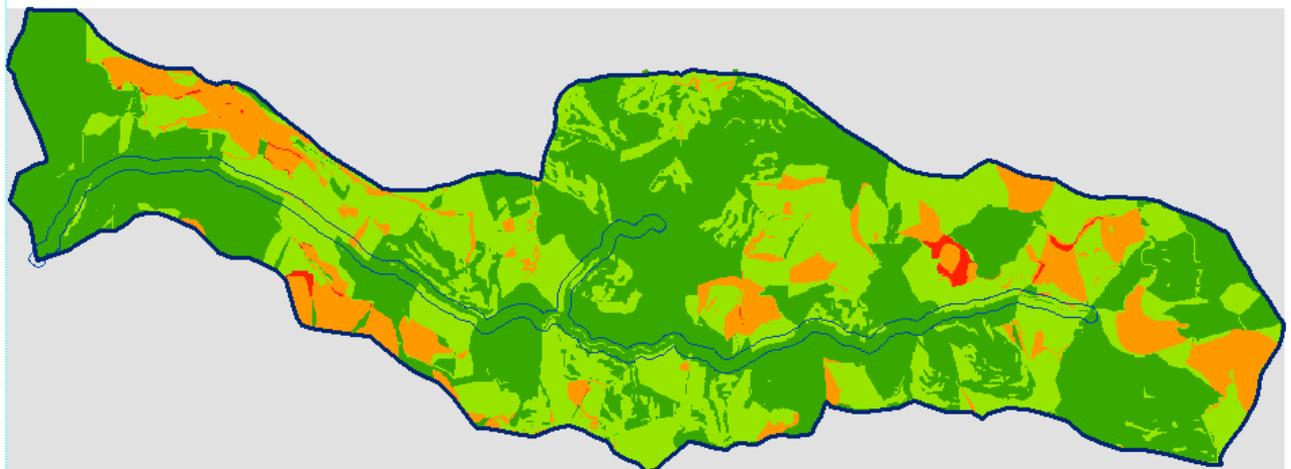


Assets

Value

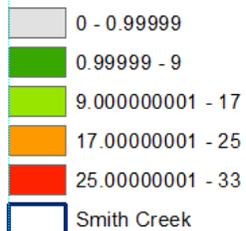


Combined Threats



Threats

Value

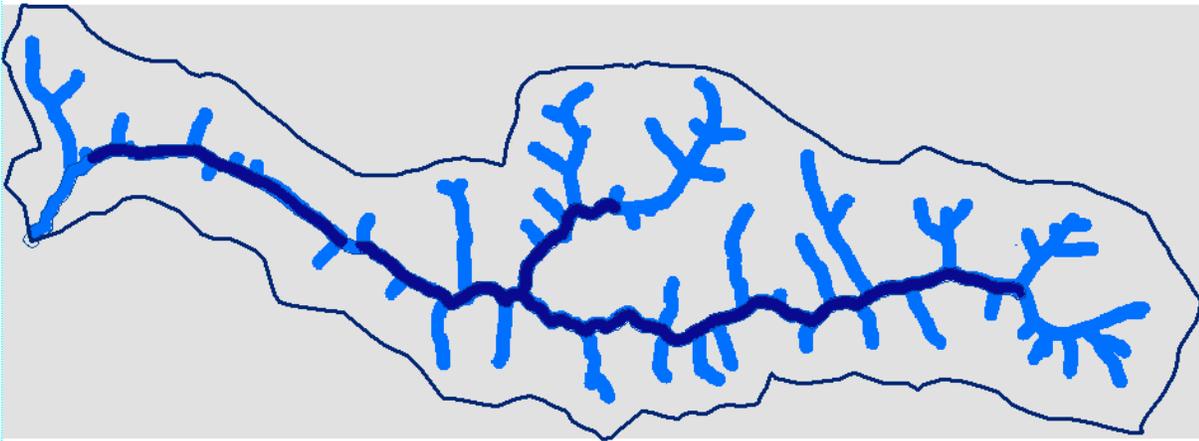


SLIDE 10

7. Analyze

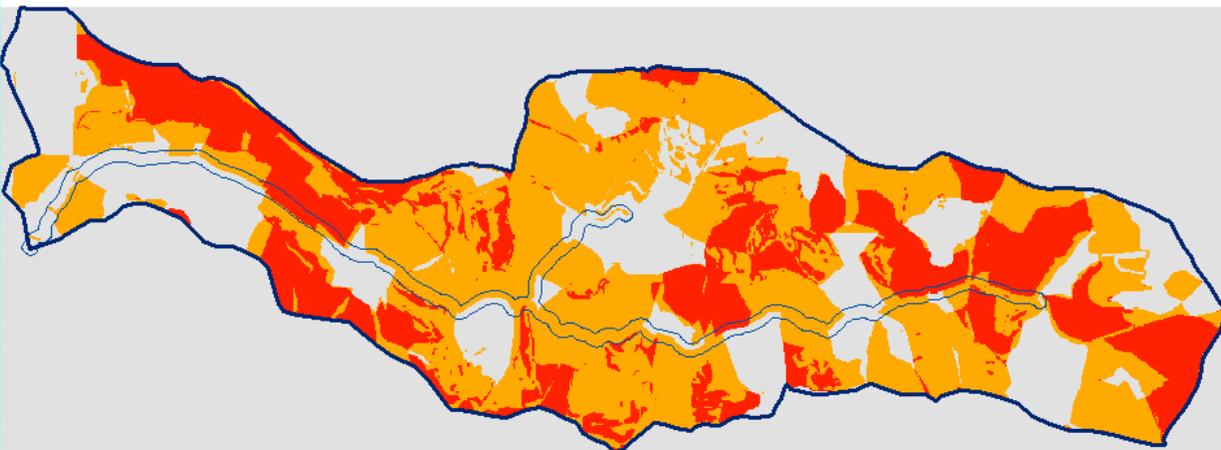
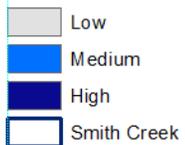
So how do we identify potential areas for restoration from these results?

Let's regroup the values into High, Medium, and Low to make the Assets and Threats values more digestible.



Assets

Value



Threats

Value

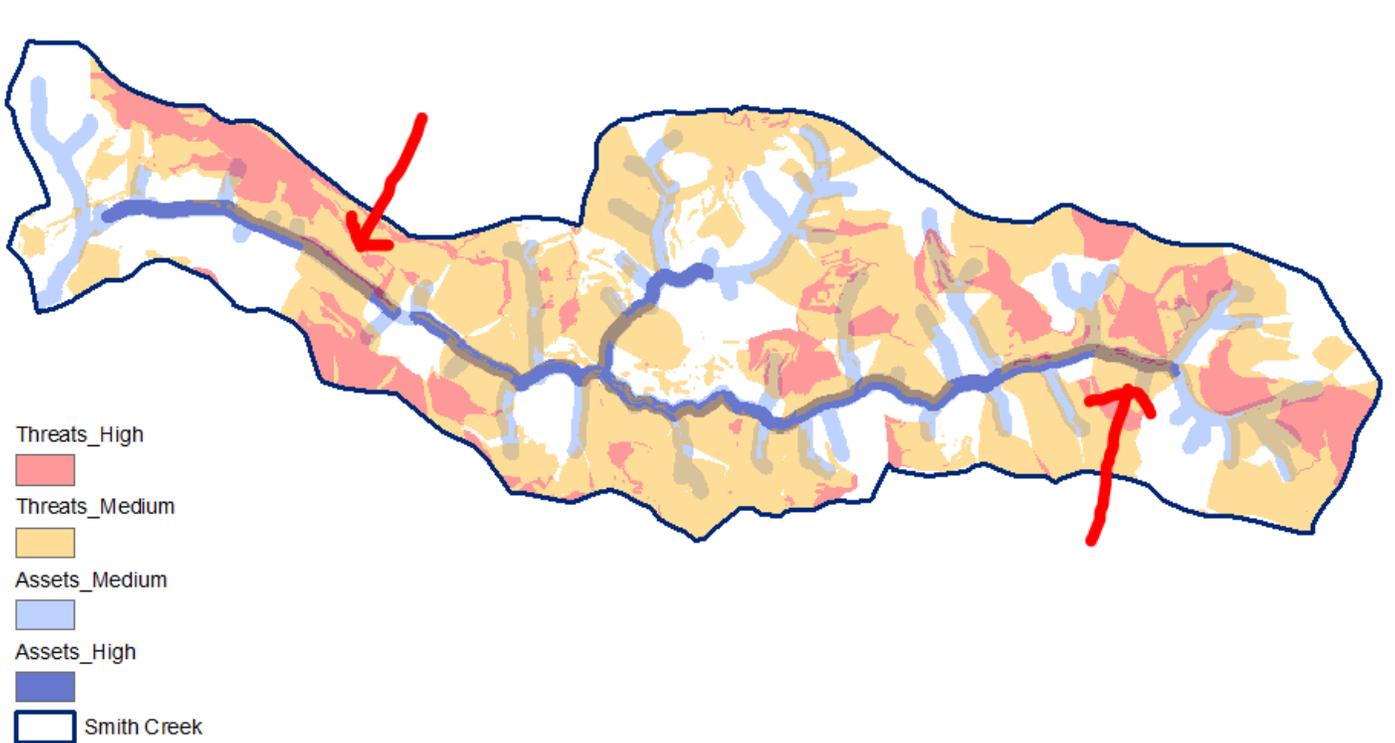


SLIDE 11

If we now think in terms of RISK, we can ask the following question

Where are the Assets at greatest risk? In other words,

Where are high Assets overlapped by medium or high Threats?



The red arrows point to two areas where high and medium Threats overlap high Assets. That is, where high value areas for the resource of concern are potentially at greater risk from impacts. These locations are where potential restoration activities could have the greatest effect.

Once potential restoration sites have been identified, these locations MUST be visited to validate the analysis.

So that's the Overlay Analysis method. There will be time for questions and comments in just a few minutes. If you will bear with me, I'd like to present the areas where subject matter expertise is needed for this analysis to have potential.

SLIDE 12

Refinement of Inputs

Before this analysis can be run, a final list of Inputs to the Assets and Threats submodel needs to be agreed on.

This includes determining which attributes should be valued and whether the inputs should be weighted.

SLIDE 13

Here is a quick reminder of the data that was collected during the 3-track analysis on the Smith Creek subwatershed:

Assets could include

- Adequate riparian function
- Coho intrinsic potential
- Existing and restorable coho habitat
- Pool formation potential from large wood recruitment
- Watercourses and WLPZ

Threats could include

- Erosion hazard ratings
- Instream water temperature (not part of the analysis but deemed a missing piece)
- Landings
- Roads
- Timber harvesting
- Watercourse crossings

We did collect Map Points and they are not included here. It was difficult to determine how they could be valued or useful in this analysis.

Under Threats I have included Instream water temperature in the Threats because that was deemed a missing piece some time ago and we were able to obtain a 3-year dataset of instream temps.

Also under Threats, landings are in red because the idea of not including this data has been floated more than once. The Forest Practice Rules do not require landings to be mapped if they are outside of a WLPLZ. Or, perhaps just those within a WLPZ could be included.

Are there additional inputs that we want to include that we have the data for? For example

Slope?

Sediment?

SLIDE 14

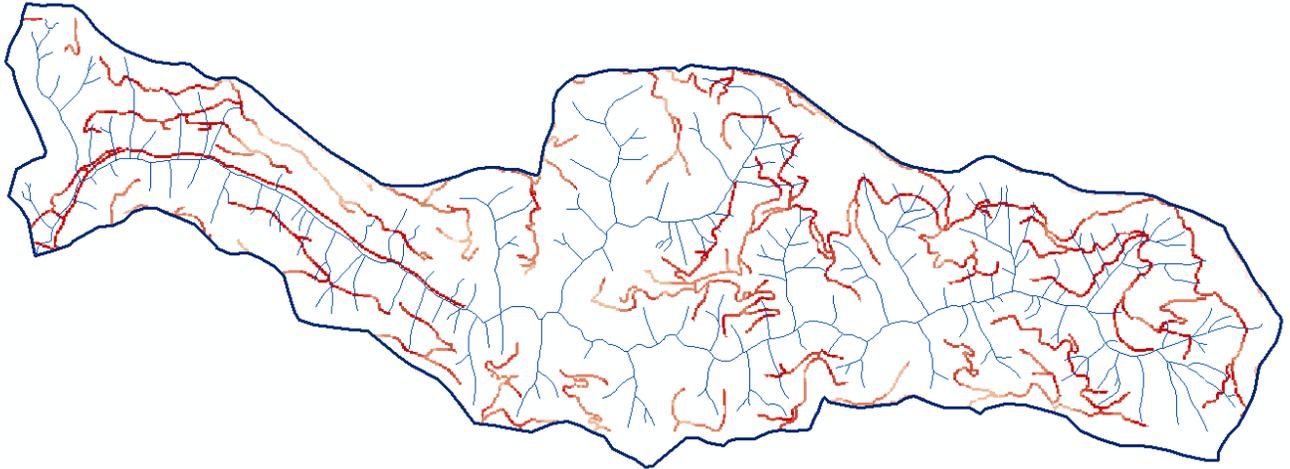
As I mentioned during the method presentation, when talking about determining the significant layers and the attributes to be valued, some inputs are complex and expert knowledge becomes critical.

Roads and timber harvesting fall into this category. I'd like to illustrate some potential options regarding these two datasets. These options are based on feedback I received from within CALFIRE's Forest Practice and Watershed Protection programs.

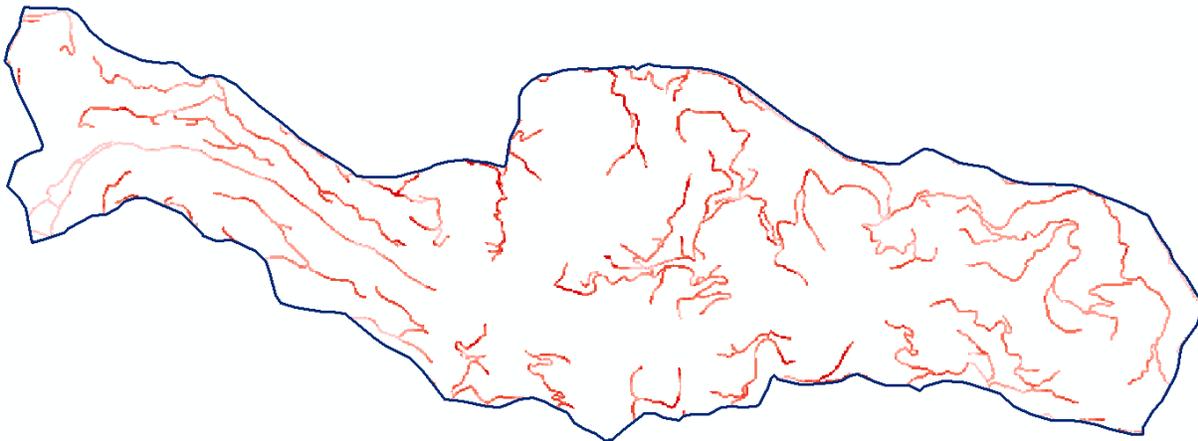
SLIDE 15

If we look at **roads** first,

Roads could be valued by distance from watercourse shown immediately below - the darker the color the closer the road is to the watercourse.



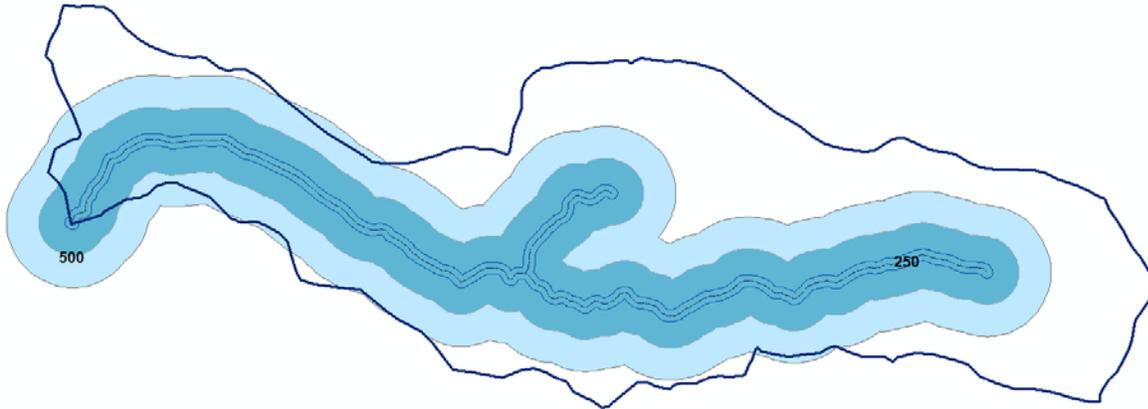
Roads could also be valued by slope, shown below – the darker the color the steeper the hillslope that the road is on.



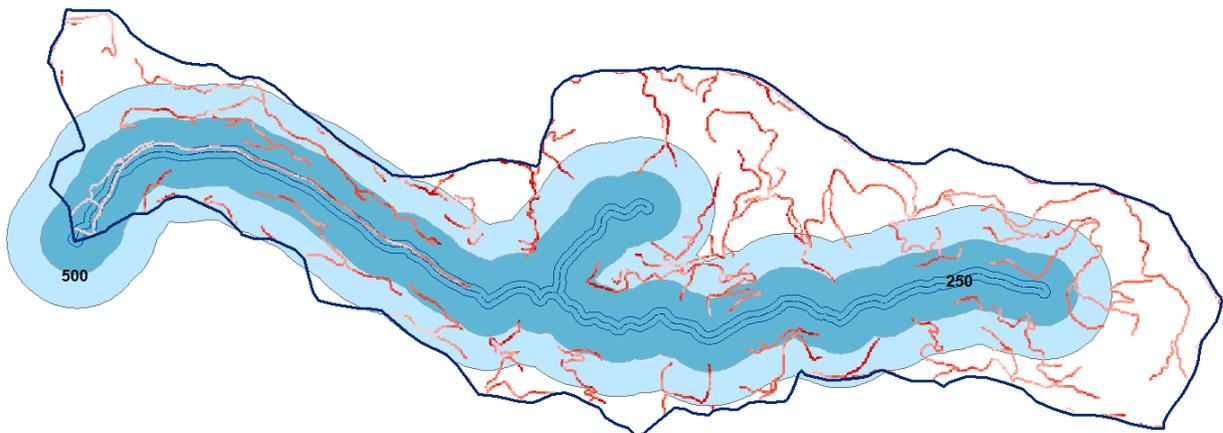
We could combine these two attributes simply by adding their cell values together. Or, we can look at roads and their relationship to watercourses slightly differently.

SLIDE 16

The top figure shows the watercourse as the thin blue line, the WLPZ as the line around the watercourse, a 250m buffer, and a 500m buffer. These can be used as Zones of Influence for Class I watercourses.



If we add road slope to this we can view roads in terms of their hillslope and the watercourse zone they are in.



Roads could also simply be valued by being in a WLPZ, or not in a WLPZ.

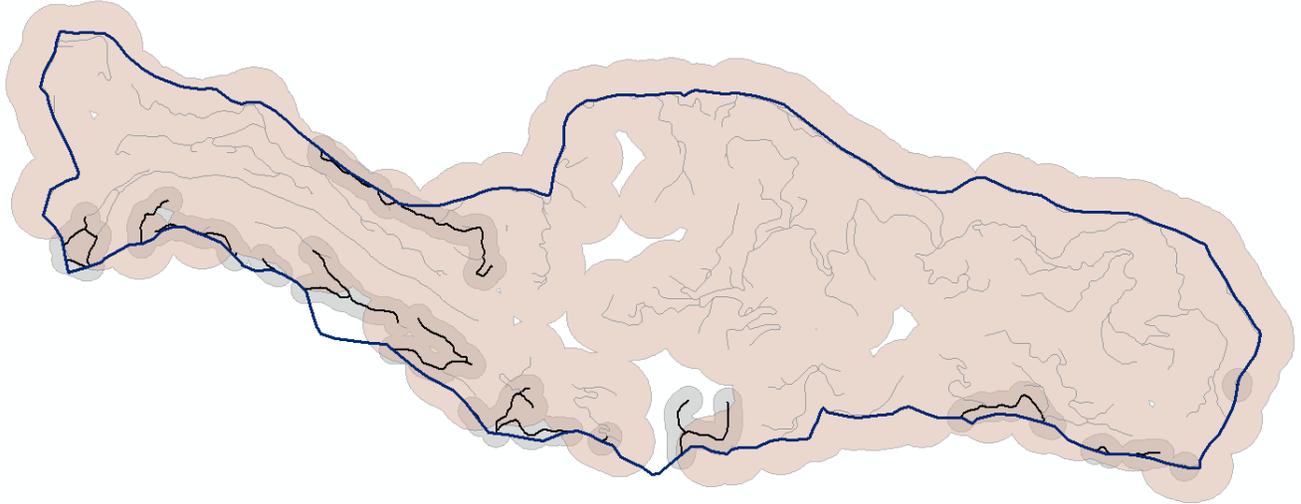
SLIDE 17

We can also create Zones of Influence for roads themselves

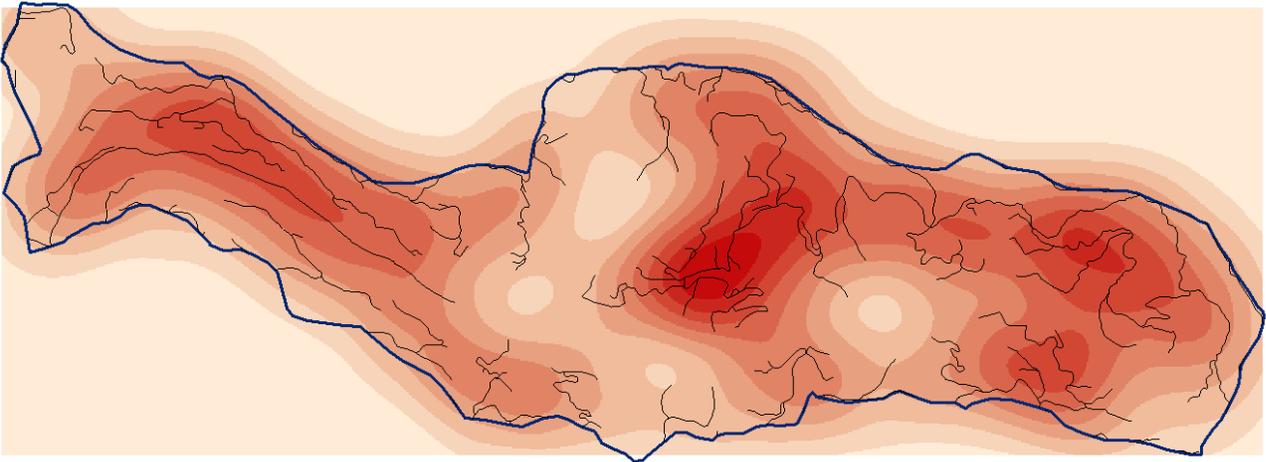
The top figure shows

permanent roads as black with a 100m zone of influence, and

seasonal or temporary roads as grey with a 250m zone of influence

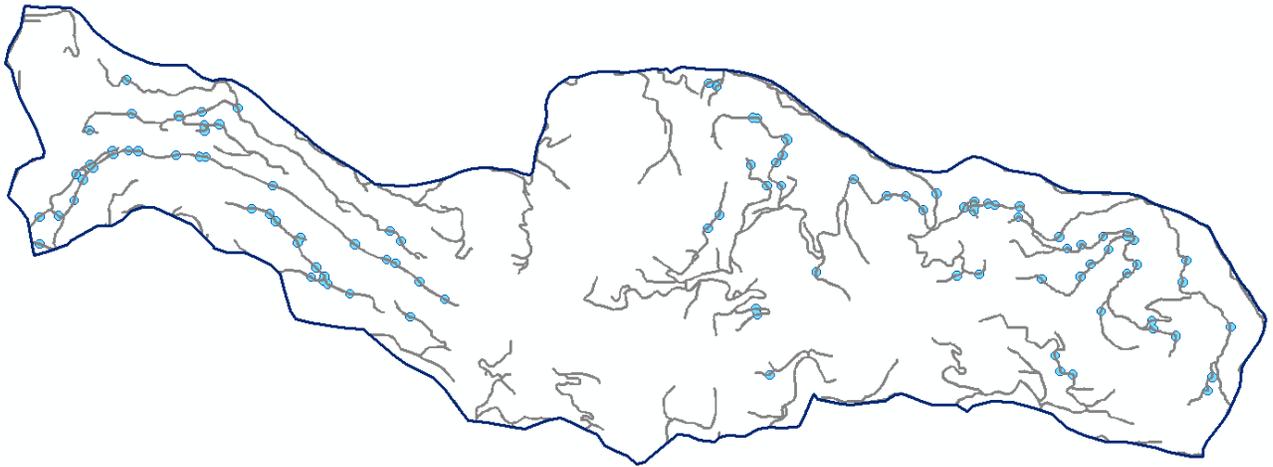


We may decide that road density is important to include. The bottom figure shows roads per acre with the darker color indicating a higher density.

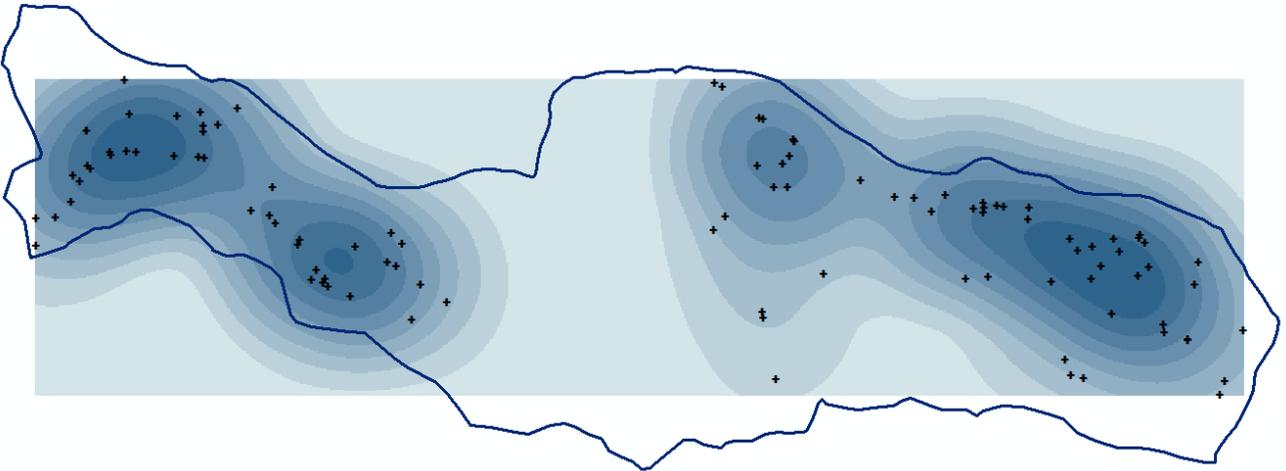


SLIDE 18

We can look at roads in terms of their proximity to watercourse crossings. The top figure shows 100ft buffers for generated watercourse crossings. Road grid cells could be valued by whether they are within the 100ft buffer or not.



We can look at this same data in a different way – as road-stream crossing density per acre.

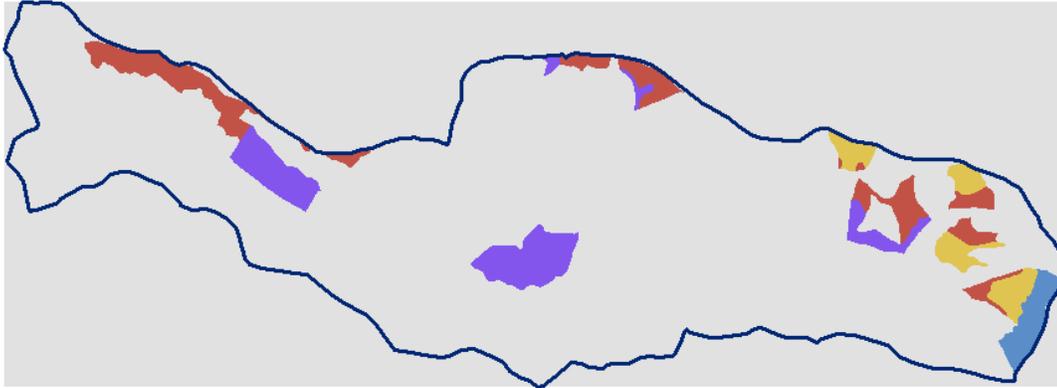


Multiple aspects of roads, or any feature, can be included in an overlay analysis. One way to do this is to put the individual road inputs into a submodel. They can be valued separately and then weighted by importance in relation to each other. Then the roads submodel can be combined with the other inputs in the Threats submodel.

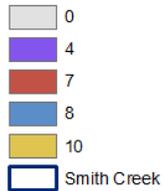
SLIDE 19

The other obviously complex Input is Timber Harvesting. For this example, the data has already been broken down into a Timber Harvesting submodel.

I used a very simple value system as an example. Values for silviculture and yarding were given, as shown, to harvest areas by year, based on the plan approval year, and then summed together.

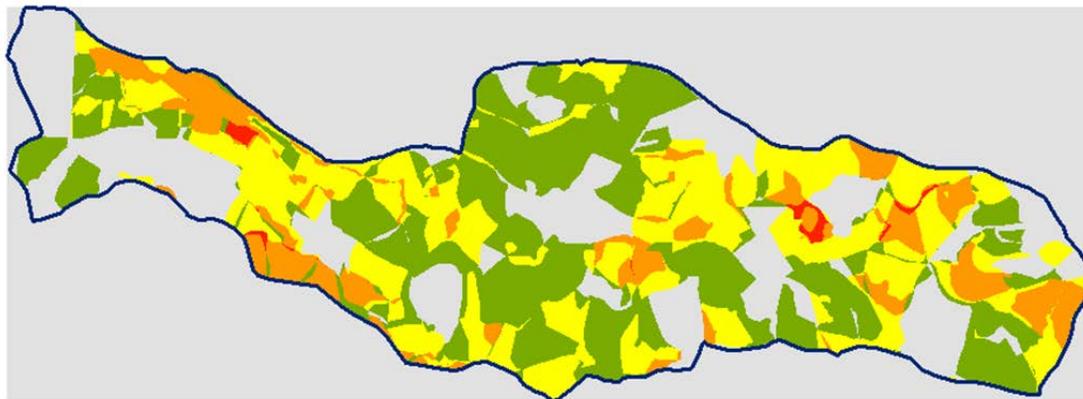


Reclass_THPS_2013_SmithCrRaster



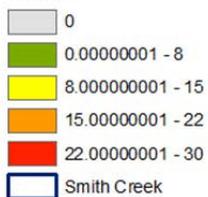
SLIDE 20

If we repeat this process for all the years of timber harvesting in Smith Creek we can produce a Total Harvest Impact raster by adding up all the values from the various years for each cell.



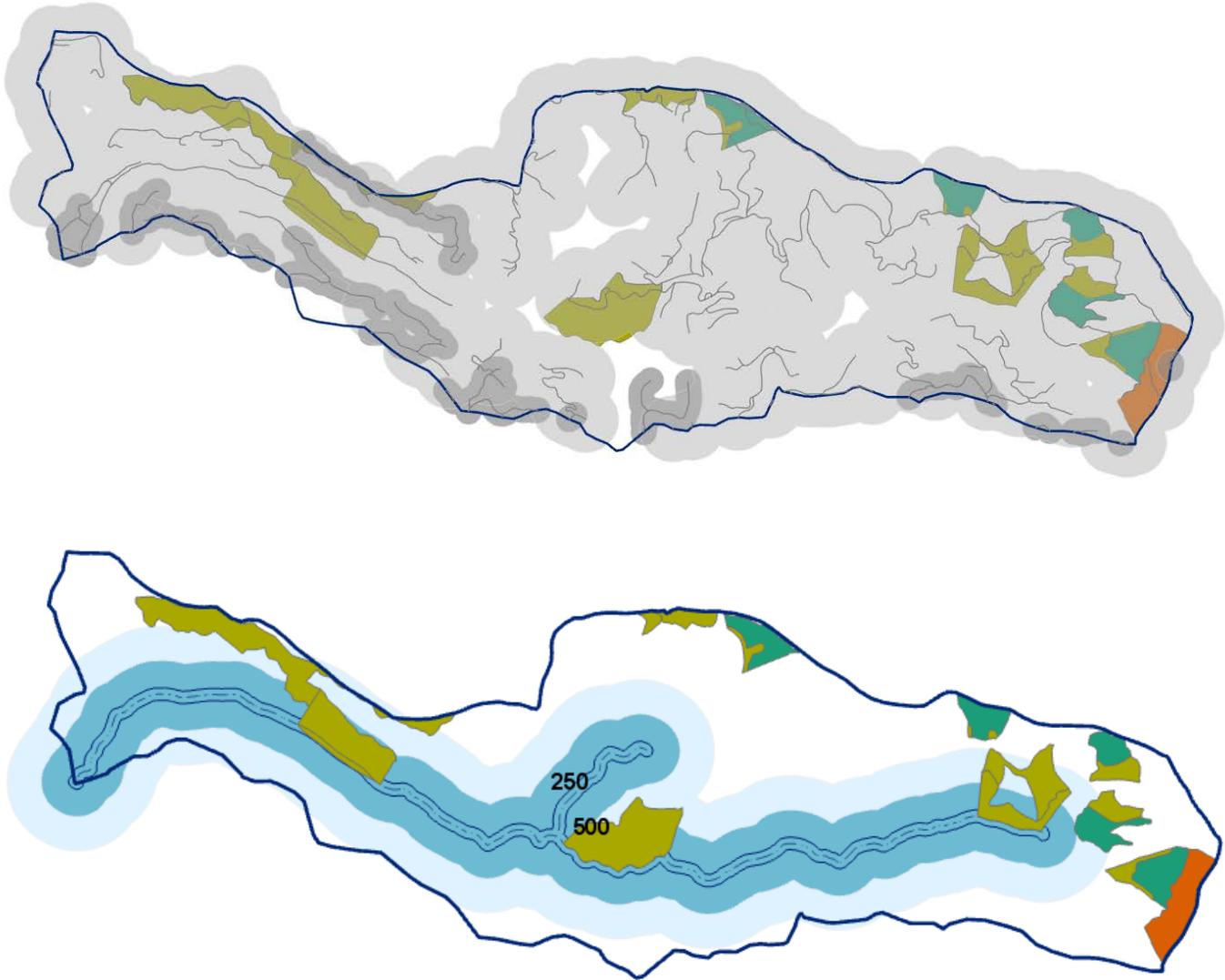
Total Harvest Impact

Value



SLIDE 21

There are, of course, other ways to look at and value timber harvesting:



The top figure shows timber harvesting from plans approved in 2013 on top of Zones of Influence of roads. The idea here is that we can value timber harvesting by proximity to roads.

And the bottom figure shows the same timber harvesting areas with the Zones of Influence for Class I watercourses. So, we can also value timber harvesting by proximity to watercourses.

SLIDE 22

One final slide on timber harvesting introduces the idea of including Time Decay. This is taken from the Sierra Nevada Ecosystem Project from 1996 where a time decay was used as part of an Equivalent Roaded Areas approach to cumulative watershed effects.

Table 1: ERA coefficients as originally developed for the Eldorado N. F.

Activity or Impact	Years since impact					
	1	2	5	10	20	50
I. Transportation system						
A. System & non-system roads and landings						
1. good drainage	1.0	1.0	1.0	1.0	1.0	1.0
2. poor drainage	1.5	Fixing road during problems associated with ditches, culverts, etc.: coefficients return to 1.0				
3. diversion potential	2.0	Same comment as above				
B. Abandoned roads and landings	1.0	0.9	0.9	0.8	0.8	0.8
C. Trails (recreational)	1.0	1.0	1.0	1.0	1.0	1.0
D. Ripped and obliterated roads and landings	0.4	0.3	0.3	0.2	0.1	0.1
II. Silvicultural system						
A. Tractor (includes impact due to skid trails)						
1. Clearcut and seed tree	0.25	0.24	0.20	0.15	0.10	0.08
2. Shelterwood	0.22	0.20	0.15	0.10	0.10	0.08
3. Overstory removal	0.20	0.16	0.12	0.10	0.10	0.08
4. Sanitation / Salvage	0.15	0.10	0.08	0.05	0.05	0.04
5. Selection / Thinning	0.15	0.12	0.10	0.08	0.08	0.08
B. Cable						
1. Clearcut	0.15	0.14	0.10	0.05	0	0
2. Overstory removal	0.10	0.06	0.02	0	0	0
C. Helicopter						
1. Clearcut & seed tree	0.10	0.09	0.05	0.02	0	0
2. Overstory removal	0.05	0.05	0.05	0	0	0
3. Sanitation / Salvage	0.02	0	0	0	0	0
4. Selection / Thinning	0.05	0.02	0.01	0	0	0

As you can see, time decay coefficients are given for timber harvesting dependent on yarding and silviculture combinations and numbers of years since impact. The older the harvest, the less its relative value.

Again, timber harvesting is definitely a complex input which needs expert opinion on how it should be included. There are certainly additional ways of using the data that have not been presented here.

SLIDE 23

The next steps in this synthesis modeling would be:

- Subject Matter Experts agree upon inputs, values, and weighting (PPWG, other professionals)
- Ground truth results
- Publish model(s)

