Post Fire Decision Support

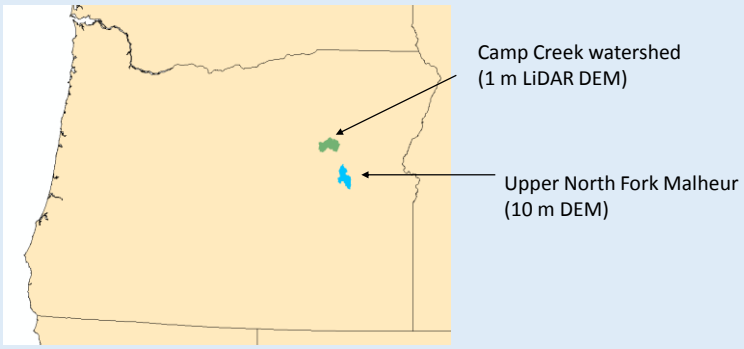
Identifying Aquatic/Riparian Habitats to Inform Post Fire Restoration

(Pilot Project, Canyon Creek Complex Wildfire, 2015, Malheur National Forest, Eastern Oregon)

TerrainWorks (NetMap), in Collaboration with US Forest Service, PNW Corvallis and Malheur National Forest
Summer, 2015

This Powerpoint presentation summarizes the use of NetMap for a Fire and Fish Decision Support System. Created on July 24, 2015 by Dr. Lee Benda and Kevin Andras (TerrainWorks).

For the Pre-fire analysis in two pilot areas in the Malheur National Forest, go to:
http://www.netmaptools.org/Pages/NetMap_Fire&Fish_Malheur1.pdf **and for video, go to:**
www.netmaptools.org/Pages/FireFish/NetMap_Fire&Fish2.pptx

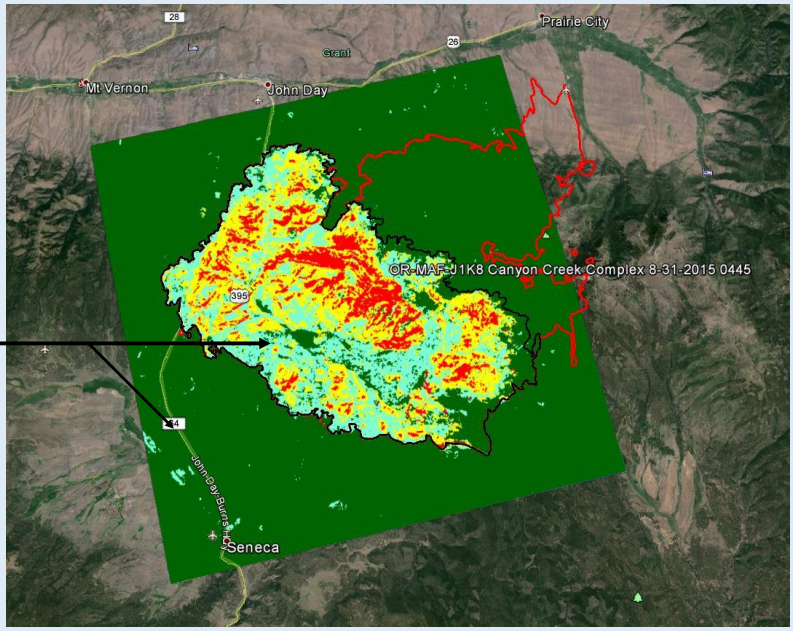


Continue with post fire (BAER) analysis, next slide…..

Post fire BAER Analysis

Canyon Creek Complex Wildfire, as of August 31, 2015

Canyon Creek BAER-NetMap analysis area (colored)



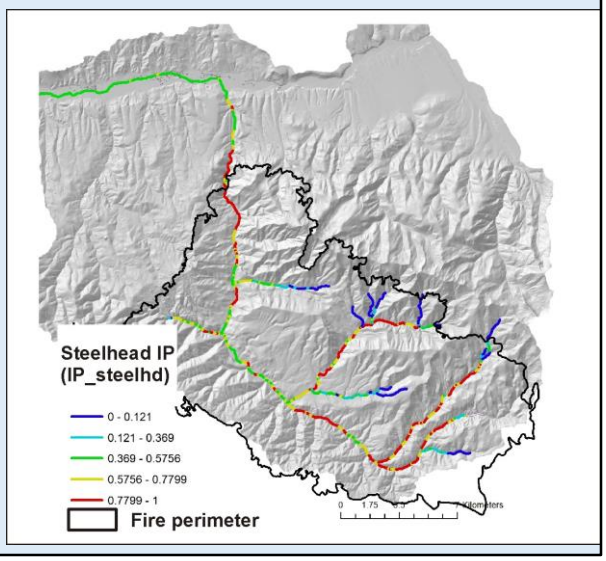
Models and Sources

(1) DEMs – 10 m
(2) Synthetic River Networks (stream layers) NetMap (www.terrainworks.com)
(3) Fire severity (BARC map, Canyon Creek Complex)
(4) Post fire surface erosion (WEPP – Disturbed)
(5) Post fire gully potential (Parker et al. 2010)
(6) Post fire landsliding/gullying (Miller and Burnett 2007, 2008, NetMap)
(7) Post fire road surface erosion and sediment delivery (GRAIP-Lite w/ modified sediment delivery)
(8) Flash Flood Index (Smith 2010, NOAA-NWS)
(9) Salmon habitat (FS habitat distribution/Intrinsic Potential Model, Burnett et al. 2007)
(10) Shade/thermal loading/thermal refugia (NetMap and Groom et al. 2011)
(11) Road – stability (NetMap)
(12) Cumulative habitat length above roads (NetMap)

Refer to NetMap's online technical help manuals for additional information

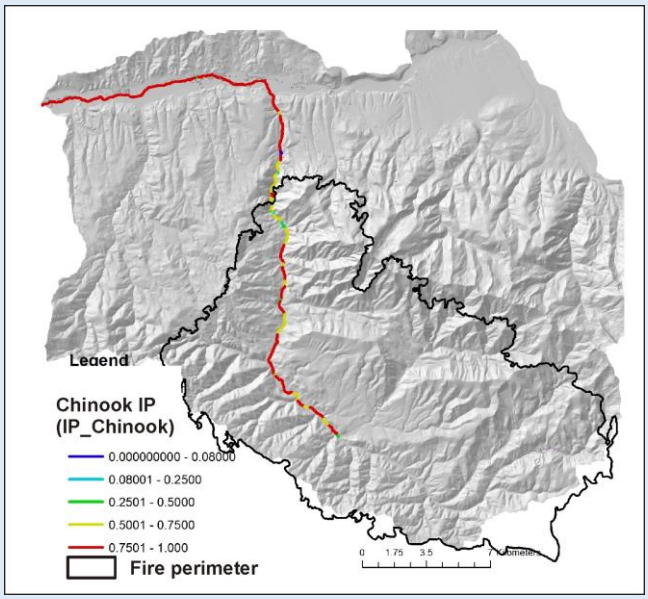
Here is a list of the various models and data sources there were used in the BAER analysis.

Fish Habitat: steelhead Trout (*Oncorhynchus mykiss)*



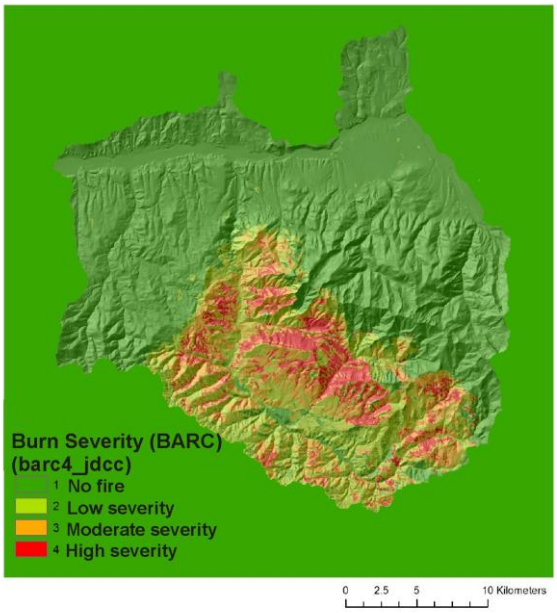
Based on intrinsic potential habitat modeling (Burnett et al. 2007).

Fish Habitat: Chinook salmon (*Oncorhynchus tshawytscha)*



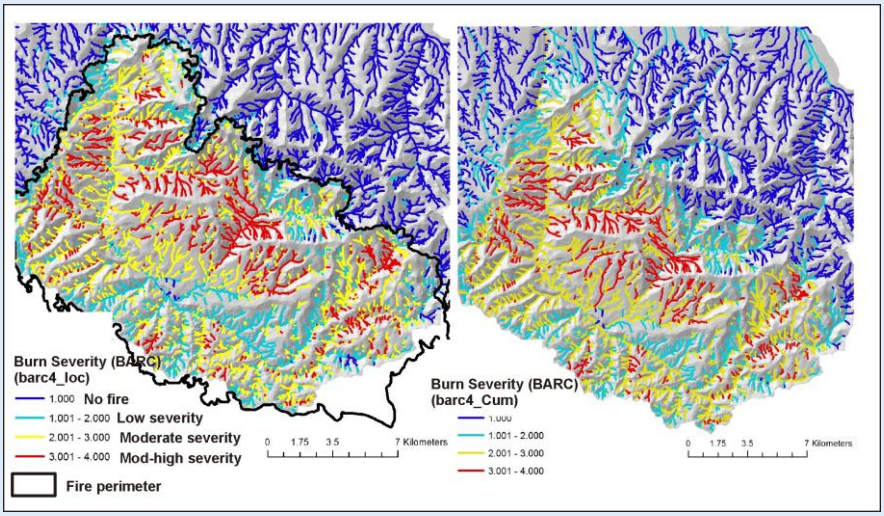
Based on intrinsic potential habitat modeling (Burnett et al. 2007).

Fire Severity (hillside, Burned Area Reflectance Classification [BARC] Map)



Fire severity as reported in the Burned Area Reflectance Classification [BARC] map.

Fire severity mapped to channels



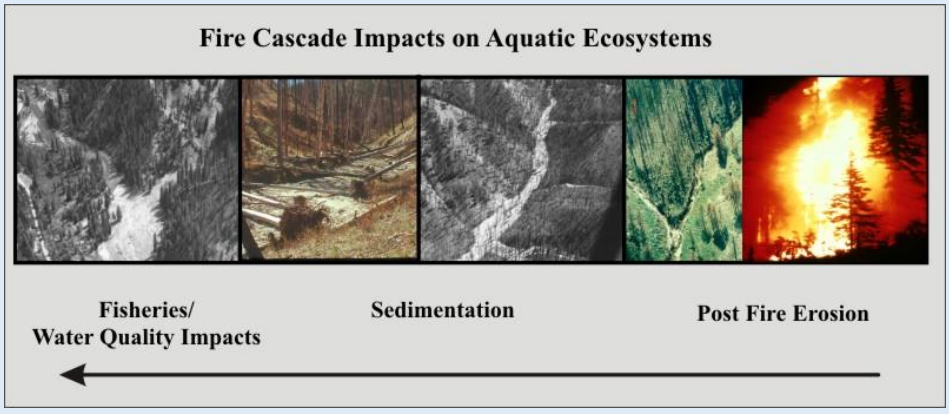
Why are hillslope attributes reported to channels, via drainage wings?

This facilitates comparing hillslope related stressors (fire severity, erosion, roads etc.) to fish habitats, a channel attribute.

Fire Severity (channel, fish eye)

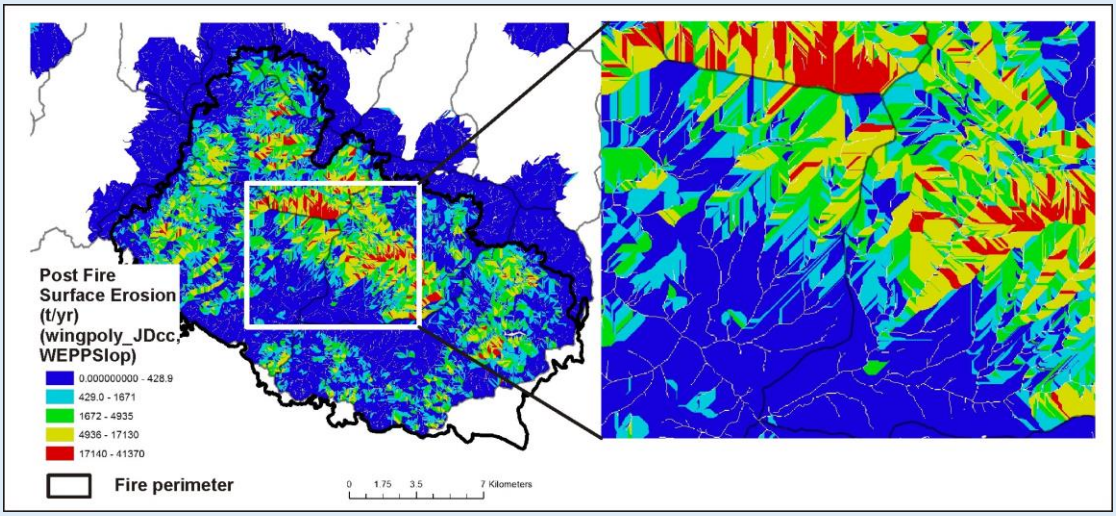
Fire Severity, Aggregated Downstream (tributary scale patterns)

Fire severity is reported to individual channel segments (left), via drainage wings, and aggregated downstream.



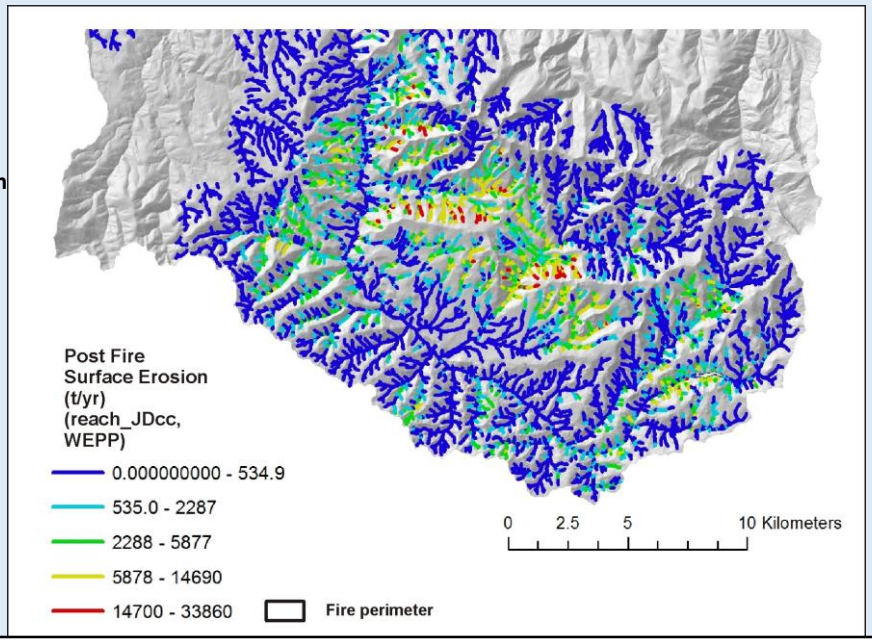
Post fire erosion and channel sedimentation are predicted for surface erosion, gullying and shallow landsliding.

Post Fire Surface Erosion (USFS WEPP model)



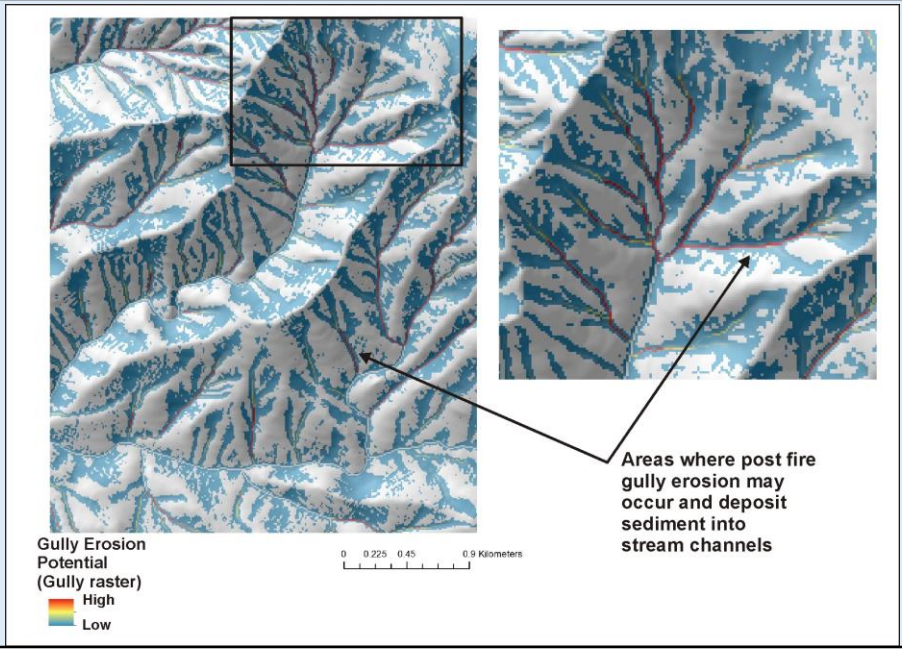
Post fire surface erosion was predicted using the WEPP-disturbed model. The color patterns indicating variable surface erosion illustrate the variable sizes and shapes of local contributing areas or drainage wings. See NetMap's online technical help materials for additional information: http://www.netmaptools.org/Pages/NetMapHelp/5_5_surface_erosion_veg_fire.htm

Post Fire Surface Erosion (WEPP, disturbed, e.g., function of fire severity) reported to stream channels (aggregated downstream also available)

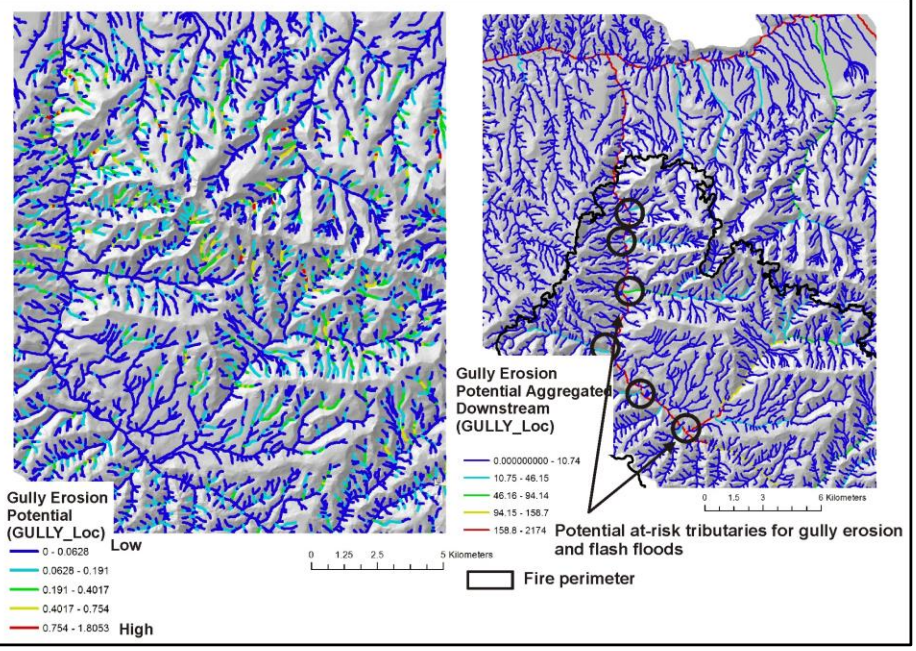


Predicted surface erosion is transferred to individual stream segments (left) and aggregated downstream (right), the latter revealing erosion patterns at the tributary and subbasin scale.

Post Fire Gully Potential

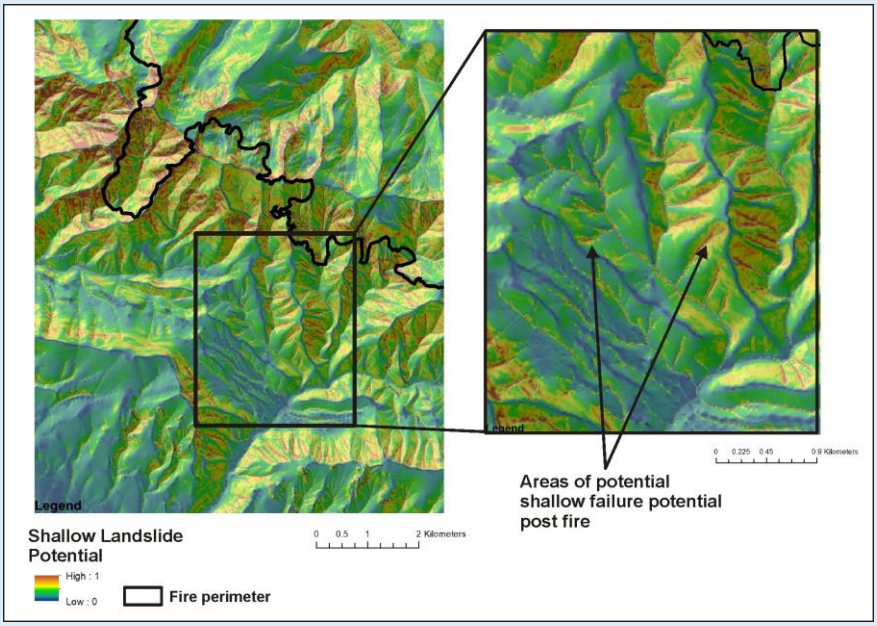


An gully erosion model was used in the analysis (Parker et al. 2010). See NetMap's online technical help materials for additional information. http://www.netmaptools.org/Pages/NetMapHelp/gullying.htm

Post Fire Gully Potential (fish eye view)	

Gully erosion results reported to stream channels, via drainage wings or local contributing areas.

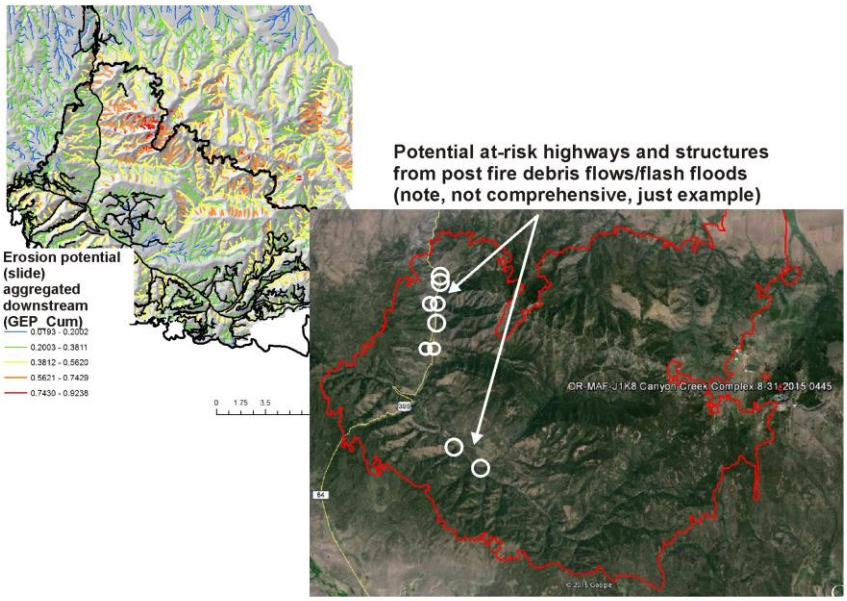
Shallow Landslide Potential, Debris Flow Source Areas



A shallow landslide model (Miller and Burnett 2007) based on hillslope gradient and curvature was used in the analysis. See NetMap's online technical help materials for additional information:
http://www.netmaptools.org/Pages/NetMapHelp/hillside_1.htm

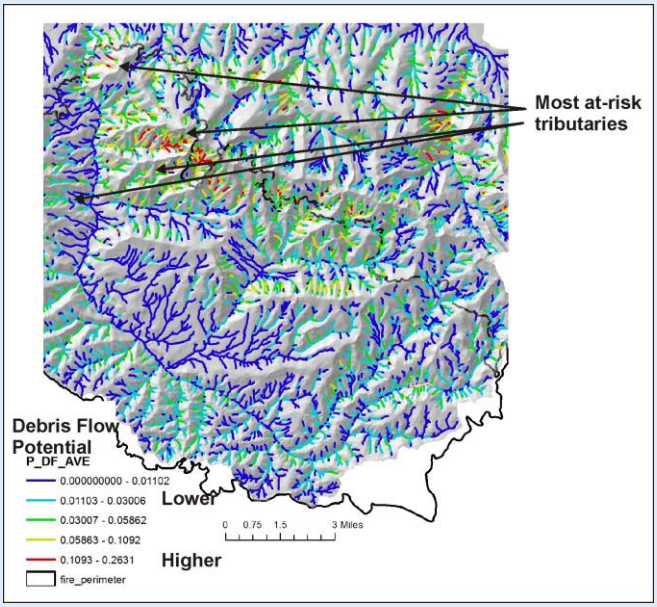
Example of a risk assessment

you can combine post fire surface erosion with gullying and shallow failure



Here is an example of a risk assessment that overlays predicted erosion potential (aggregated downstream, and thus tributary scale) and the locations of vulnerable highways and residences.

Consider tributary debris flow risk



Although the model employed (Miller and Burnett 2007) is based on data from another mountainous landscape, it provides an approximation of at-risk tributaries using universal attributes related to debris flows including number of source areas, tributary channel gradients, valley confinement and tributary junctions. Also predicted is gully erosion, shallow failure potential and flash flood potential.

FLASH FLOOD Potential

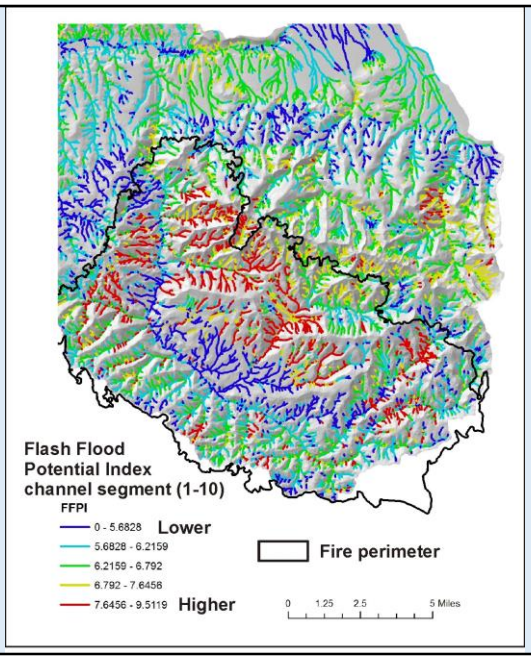
A dimensionless index developed by the National Weather Service. The Flash Flood Potential Index (FFPI) consists of four factors:

1) **hillslope gradient**
2) **soils (percent silt, clay and sand)**
3) **vegetation density (forest, shrubs, grasses)**
4) **fire impacts on soils and vegetation.**

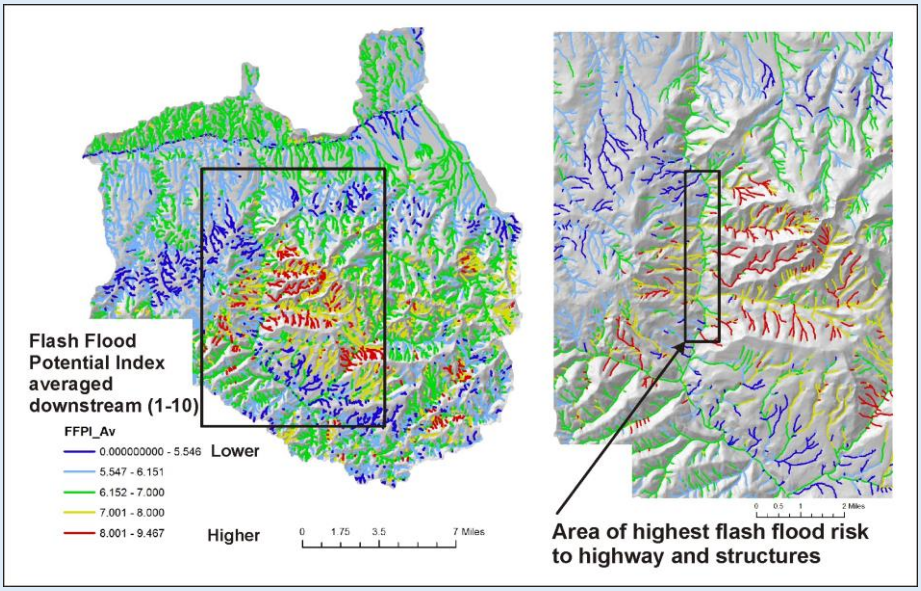
See NetMap's online technical help manual for additional details.

A flash flood potential index will be applied to the study area (second week of Sept).

Flash Flood Potential Index
(individual channel segment scale)

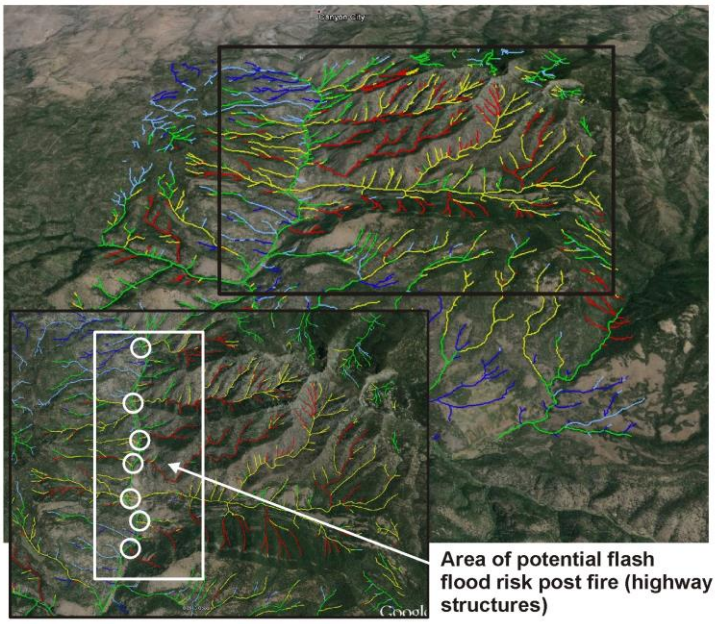


Flash Flood Potential Index (tributary scale, most relevant from risk assessment)



Flash Flood Potential Index **(tributary scale, most relevant from risk assessment)**

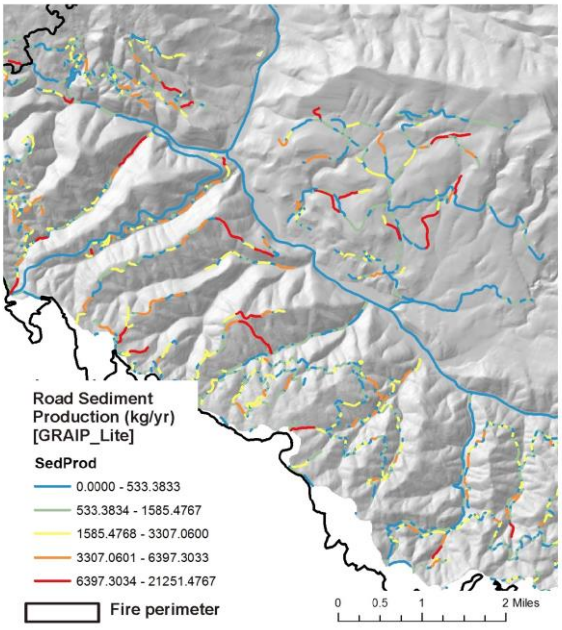
mapped to Google Earth



Road Surface Erosion and Sediment Delivery to Streams, Post Fire

Roads can be significant sources of flooding, erosion and sediment delivery to streams, post fire.

First, start with road sediment production

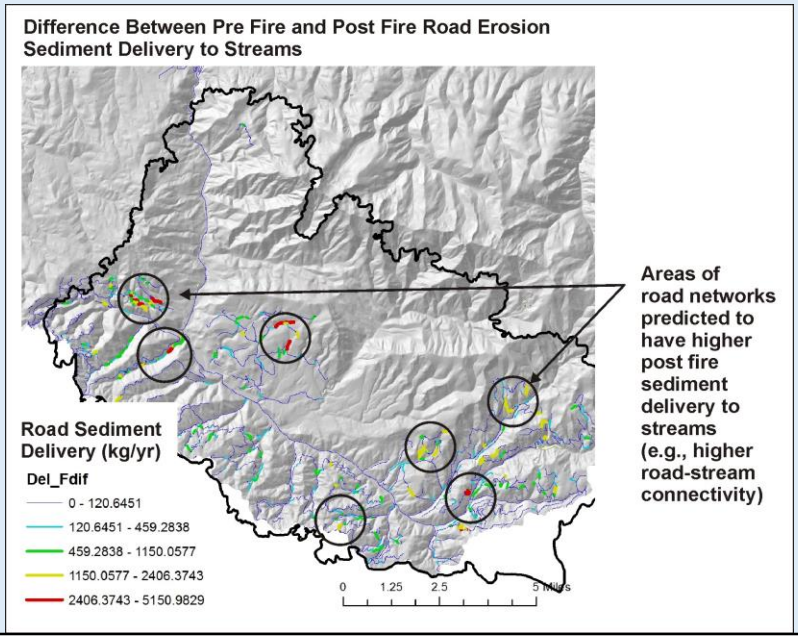


Sediment production as predicted by GRAIP-Lite; a base erosion rate of 1.5 kg/yr was used.

Next, calculate sediment delivery pre fire and compare that to sediment delivery post fire, and identify areas of predicted increases

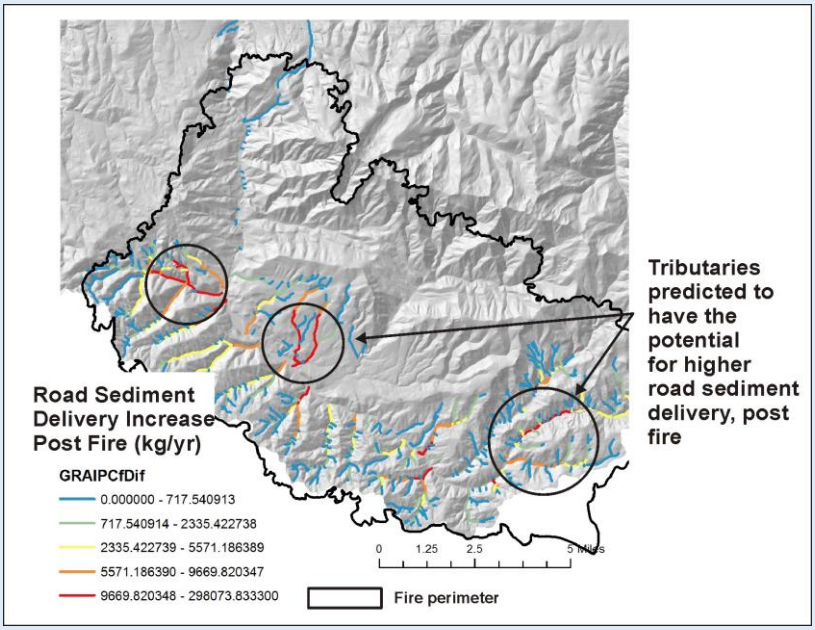
higher connectivity can occur because high to moderate severity fires can reduce soil infiltration rates, leading to longer road runoff sediment plumes

Prioritize remediation

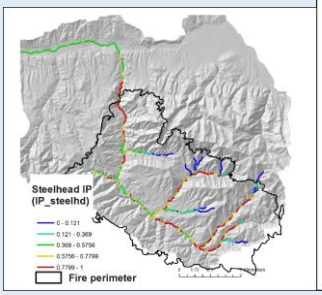


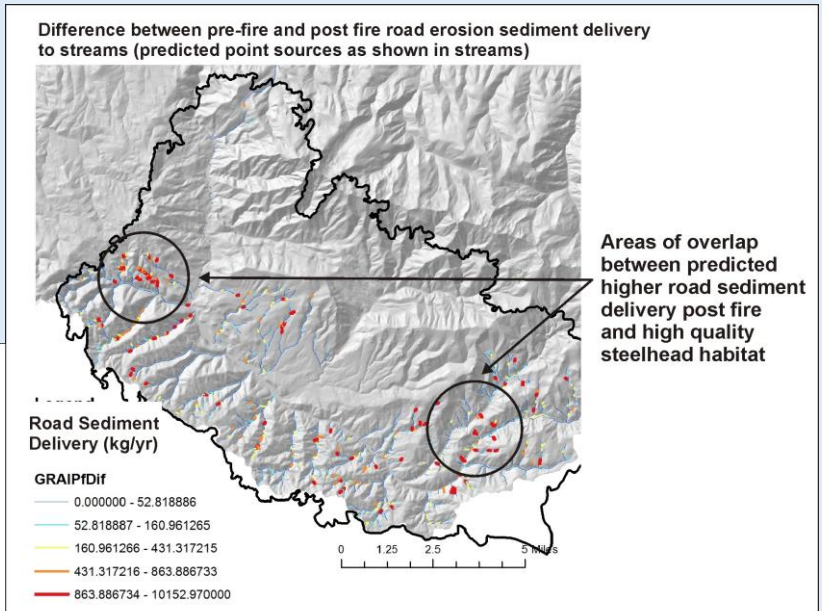
A difference map of road sediment delivery reveals that some road segments are more sensitive to fire reductions in infiltration capacity compared to others.

Identify tributary scale increases in delivery of road sediment



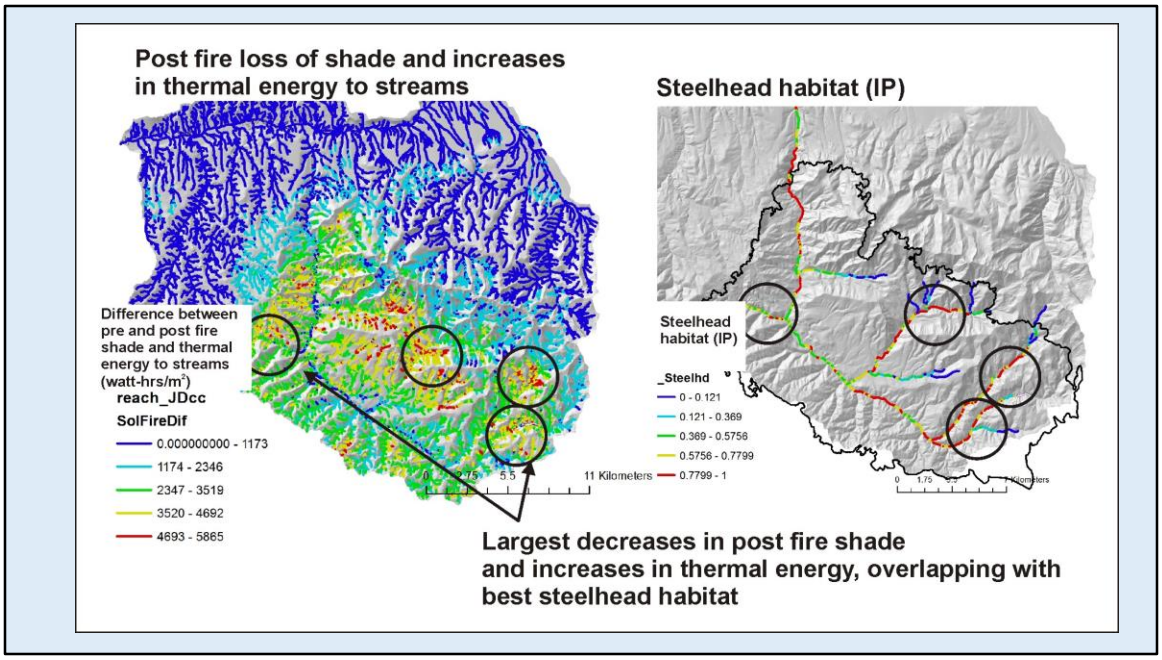
Then compare it to locations of high quality and sensitive aquatic habitats



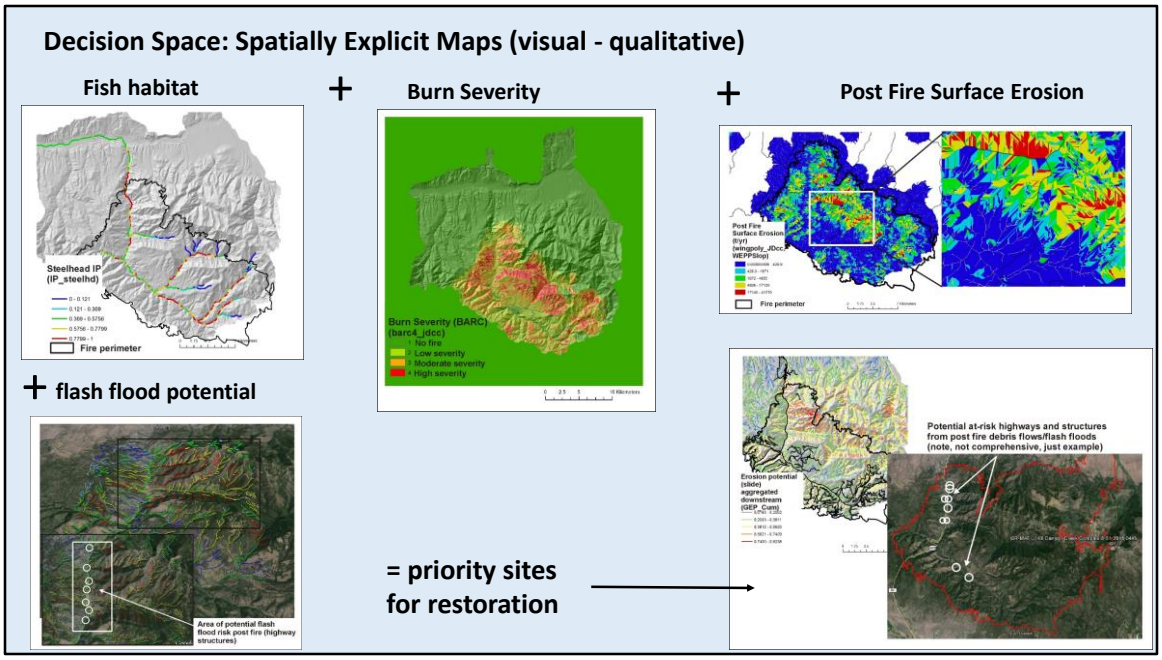


Stream reaches where post fire road sediment delivery is predicted to increase; some of these reaches overlap sensitive fish habitats.

Riparian Zones: Impacts from Fire, Loss of Shade, Increases in Thermal Loading and Loss of Cool Water Refugia

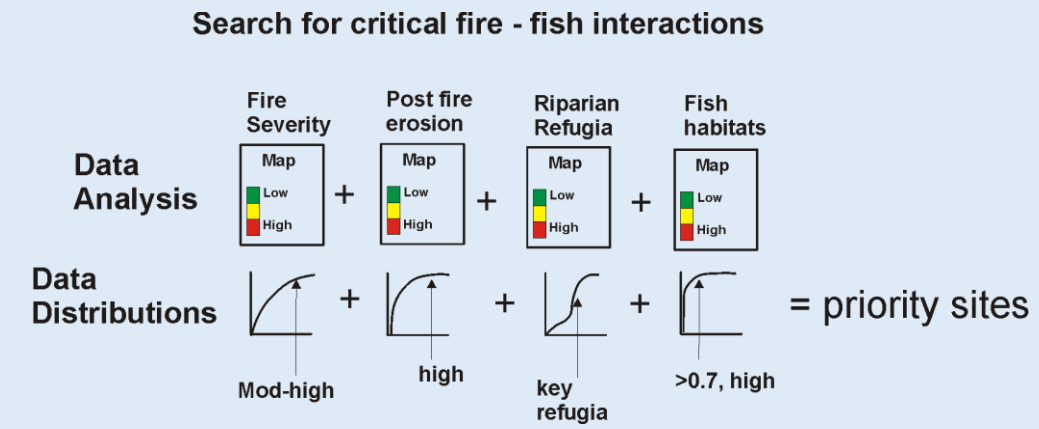


The difference between thermal energy to streams under no fire shade conditions (using LEMMA vegetation data (http://lemma.forestry.oregonstate.edu/) and fire-reduced shade. Many channel segments receive higher thermal loading, post fire.



Information provided in the BAER analysis (previous slides, among other data) can be used visually and qualitatively to search for intersections or overlaps between various fire related stressors (fire severity, post fire surface erosion, gully erosion) and sensitive aquatic habitats, as illustrated above. Or one of NetMap's tools (Resource – Fire Stressor Overlap Tool) can be used quantitatively to locate overlaps and intersections (see next slide).

Decision Space: Spatially Explicit Quantitative (use NetMap's Resource-Fire Stressor Overlap Tool [Quick Tool])

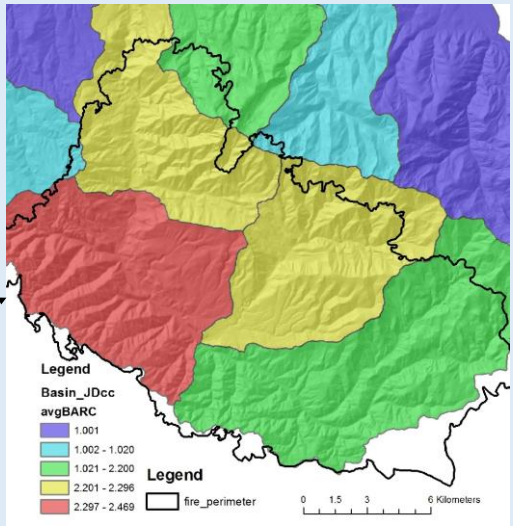


NetMap's Quick Tool that contains the Resource – Fire Stressor overlap capability can be used to locate intersections between fire related impacts and sensitive fish habitats. The tool calculates, on the fly, the full frequency distribution of values (shown as the cumulative distribution of values in this slide), and the analyst, using the tool, selects from the distributions to search for overlaps. For example, an analyst can quickly search for intersections among the highest 10% of fire severity, highest 5% of post fire surface erosion (or landsliding or gullying), highest 10% of fire related increases in thermal loading, and fish habitats (either presence of habitat or some numeric value of habitat quality [used in IP]).

For additional information, see NetMap's online technical help that describes the overlap tool:
http://www.netmaptools.org/Pages/NetMapHelp/overlap_tool___reaches.htm

And the Quick Tool, which is provided as part of this analysis:
http://www.netmaptools.org/Pages/NetMapHelp/netmap_quick_tool.htm

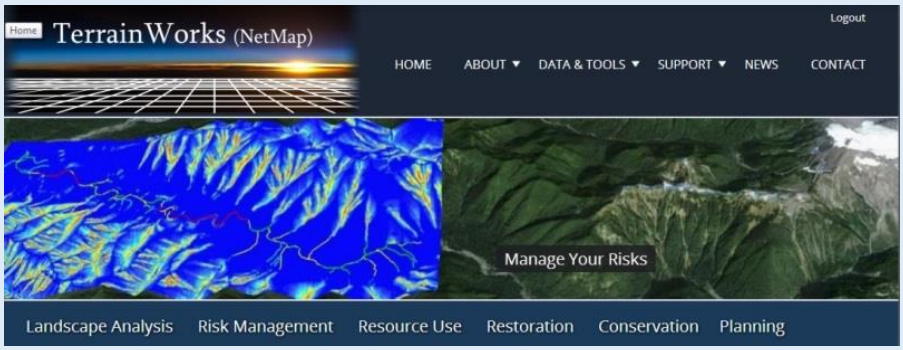
All analysis results are summarized at the scale of HUC 6th field



For example, burn severity (BARC) per 6th field subbasin

All analysis results are summarized to the HUC 6th subbasin scale. This can be used to examine subbasin scale patterns of fire related attributes and stressors and the locations of aquatic habitats. Subbasin scale data summaries may be most useful at the scale of larger watersheds or entire national forests.

Presentation Complete



TerrainWorks designs and builds the most advanced watershed and landscape analysis system in the world. Learn more about NetMap virtual watersheds, watershed analysis tools, online technical help and tools at: www.terrainworks.com. Contact us with questions, we are here to help.