# CORRIDORS OF FIRE MOVEMENT:

## Delineating Riparian Zones In Pre-Fire and Post-Fire Contexts Of The Bootleg Fire Extent

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**Final Project**

## INTRODUCTION

Riparian zones are important interfaces between terrestial and aquatic ecosystems. When terrestial fires occur in forested ecosystems, animals flee to riparian zones, where fire refuges – or areas unscathed by fire – form. Thus riparian zones are essential to understanding post-fire regeneration of connected terrestial and aquatic landscapes. Furthermore, when flooding occurs, followed by drought, the floods can kill trees and deposit coarse woody debris downstream, which then dries out in a subsequent drought year, providing high fuel loads for a lightning ignited fire to send fire paths upstream. In such situations, riparian zones function as "corridors of fire movement".

## STUDY SITE

I chose as my study area the spatial extent of the 2021 Bootleg Fire. Ignited by a lightning strike, the Bootleg fire blazed across Oregon starting on July 6, 2021. It blazed until containment in October of 2021. The spatial extent of the fire encompassed an area of 413,717 acres, affecting Klamath and Lake Counties. Given the high severity and extent of this fire and the extent of the stream network captured within it, I sought to see if I could tease out the effects of fire effects in riparian zones in this post-fire area.

## DATA SOURCES

I combined hydrological datasets, vegetation index-related NAIP imagery, and fire-related data sets for my project on fire effects in riparian zones. First, I used NAIP NDVI Imagery,

which is accurate to 1 m, to display the vegetation on the landscape prior to the Bootleg fire. The NAIP NDVI imagery is from 2019. Second, I used WFIGS Wildland Fire Locations data, which consists of point locations of fire incidents from 2014 until the present. It is a continuously updated dataset. Third, I used the USDA Forest Service Geospatial Technology and Applications Center's (GTAC), Rapid Assessment of Vegetation Condition after Wildfire (RAVG) dNBR (raster) imagery, for post-fire analysis of burn severity. Fourth, I used NHD Plus Flowlines to delineate the stream network. Fifth, I used the USDA Geospatial Data Gateway's Watershed Boundary Dataset (WBD) for Lake County, which encompasses the Bootleg fire context, as well a provides spatial extent to sample the historical fire incident data to generate optimized hotspots within the Bootleg fire context.

## **PROJECT OBJECTIVES & GOALS:**

I aimed to use the 2021 Bootleg Fire context as the study area, using the GTAC RAVG shapefile and dNBR raster. NDVI NAIP imagery would be used to visualize the pre-fire context, inparticular to note if the burn severity maps visually correspond to patches of burn severity (i.e., fire corresponds to vegetation loss). I would add in NHD Plus Flowlines and overlay them on the fire extent, to display the stream network through the study area.

Next, I would create two delineations of riparian zones: 40 m and 100 m. A 40 m buffer is one of the less complex methoods of delineating a riparian zone that is as accurate as more complex methods (*See* Collins, J. N., Sutula, M., Stein, E., Odaya, M., Zhang, E., & Larned, K. (2006). Comparison of methods to map California riparian areas. Final report prepared for the California Riparian Habitat Joint Venture). A 100 m buffer is the maximal buffer used in semi-

arid montane riparian zones (*See* Salo, J. A., Theobald, D. M., & Brown, T. C. (2016). Evaluation of methods for delineating riparian zones in a semi-arid montane watershed. JAWRA Journal of the American Water Resources Association, 52(3), 632-647).

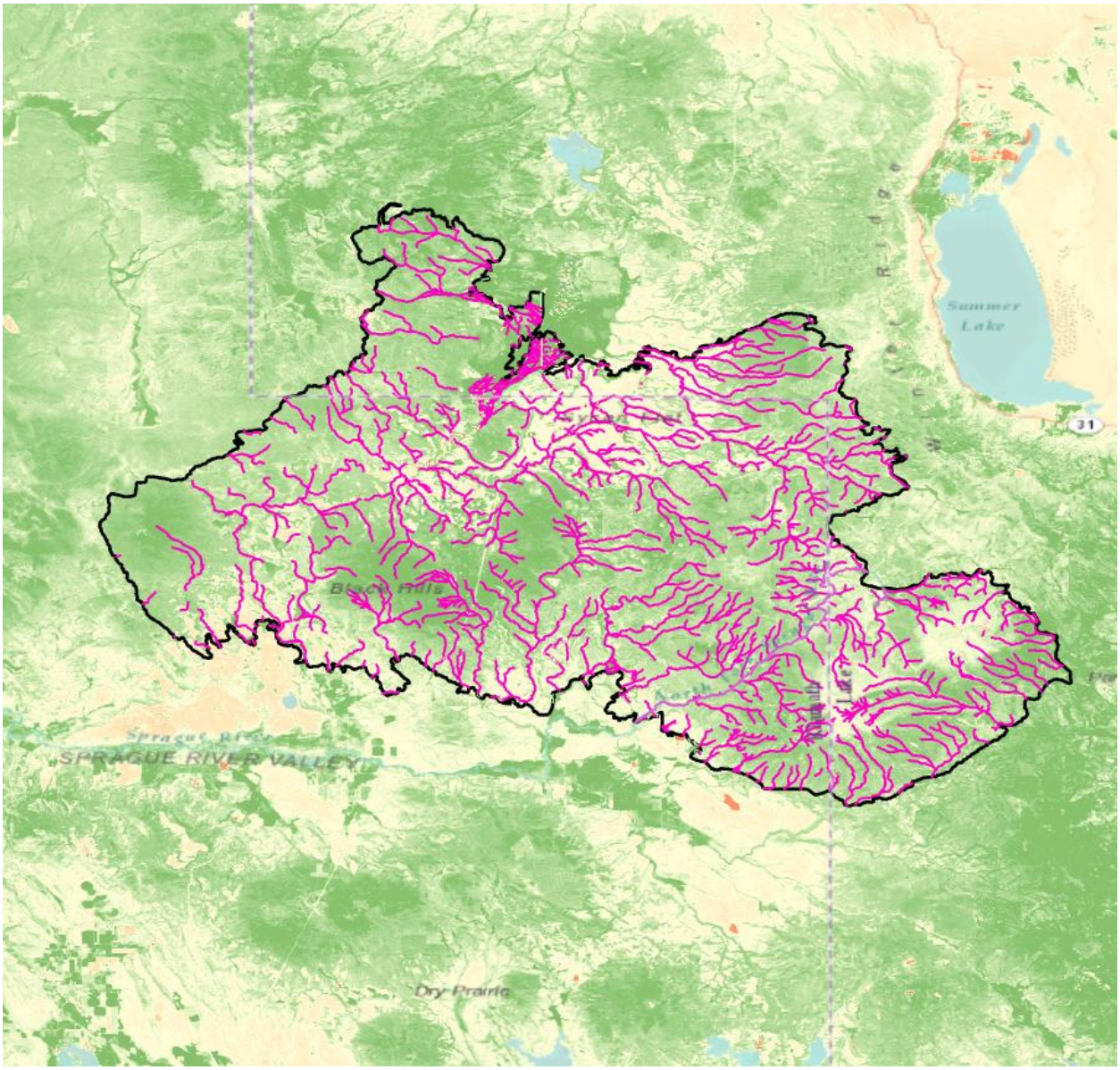
Once I have created the riparian zone buffer, I would be able to see, due to the WFIGS layer, the wildland fires that are inside and outside of that buffer. I would then use Optimized Hot Spot Analysis over the entirety of Lake County, mapped to the river network, to see where the wildland fires are most likely to arise within the Bootleg Fire Context.

I would then overlay the RAVG layer of the Bootleg Fire, which shows where the severe burns actually occurred, as well as the delineated riparian zones, onto the optimized hot spots. The theory here is that if a riparian zone intersects a high severity burn patch from a recent fire and that is within a hot spot derived from historical fire incident data that is mapped to the river network, then that riparian zone might be a "corridor for fire movement" (*See* Pettit, N. E., & Naiman, R. J. (2007). Fire in the riparian zone: characteristics and ecological consequences. Ecosystems, 10(5), 673-687).

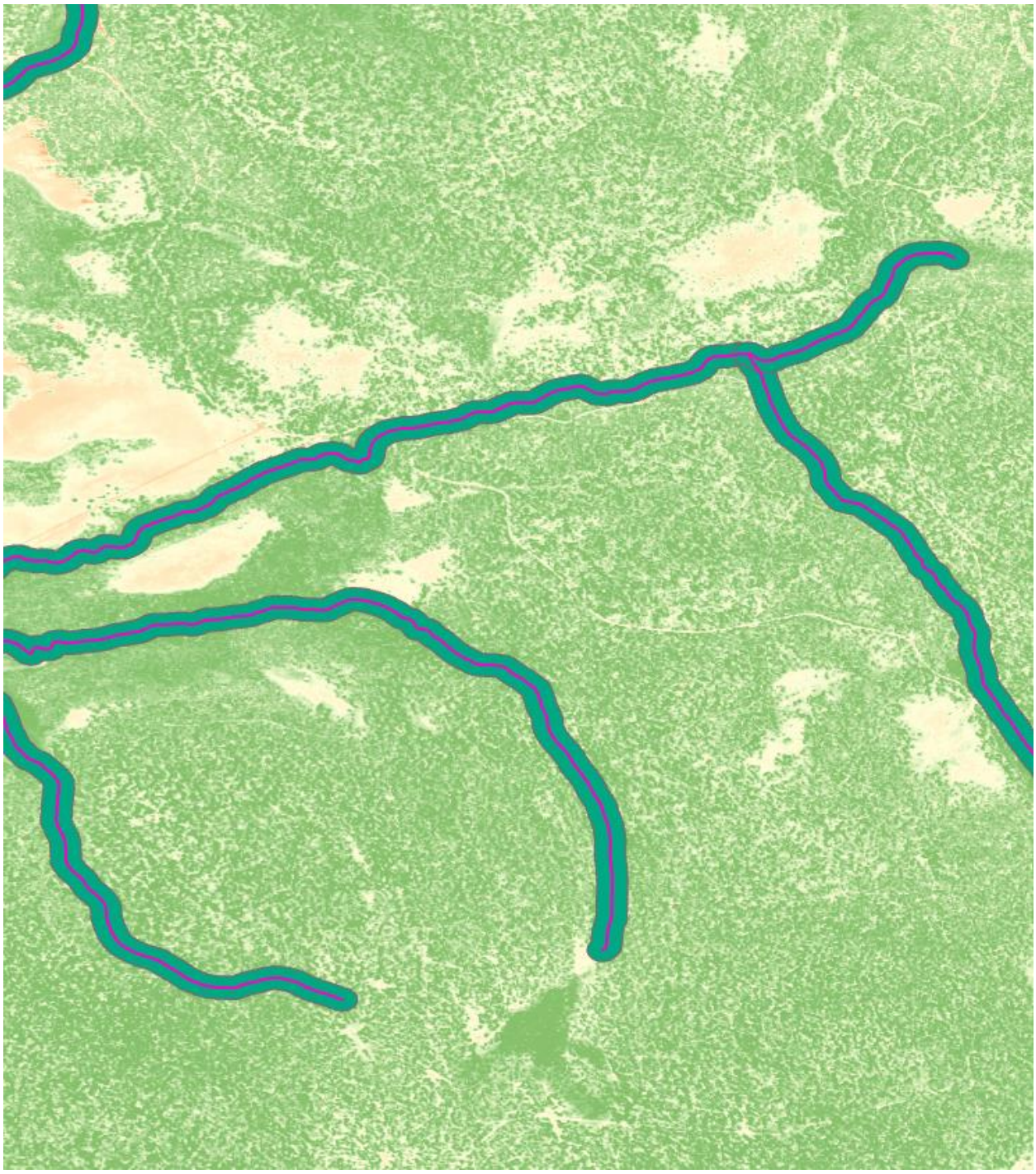
## **METHODOLOGY**

To discuss the methodology, I will proceed by demonstrating the visual results of my process:

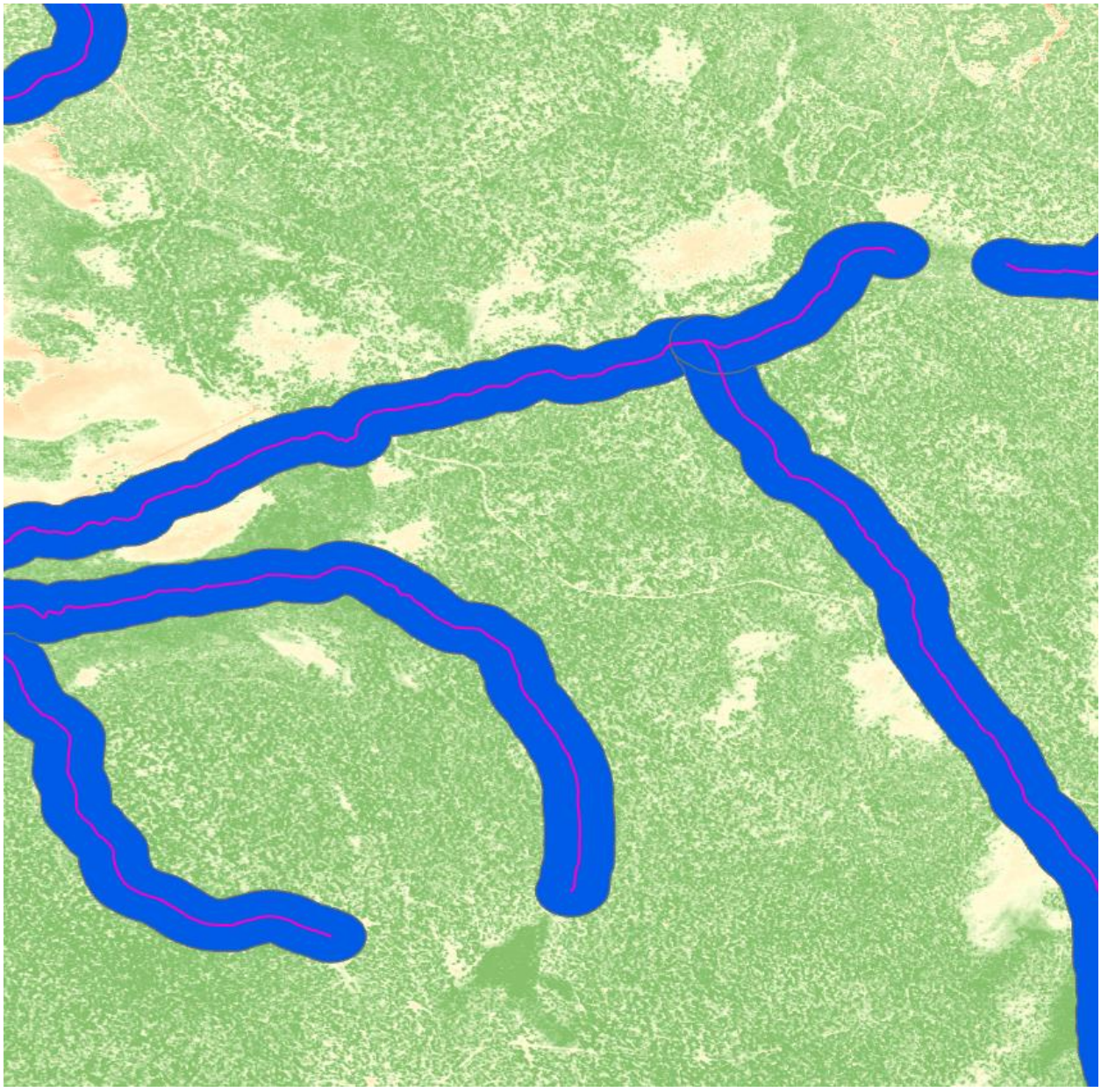
1. First, I overlaid the Bootleg Fire Shapefile and the NHD Flowlines Plus stream network over the 2019 NDVI NAIP Imagery:


Summer Lake
31
Beach Hills
SPRAGUE RIVER VALLEY
Dry Prairie

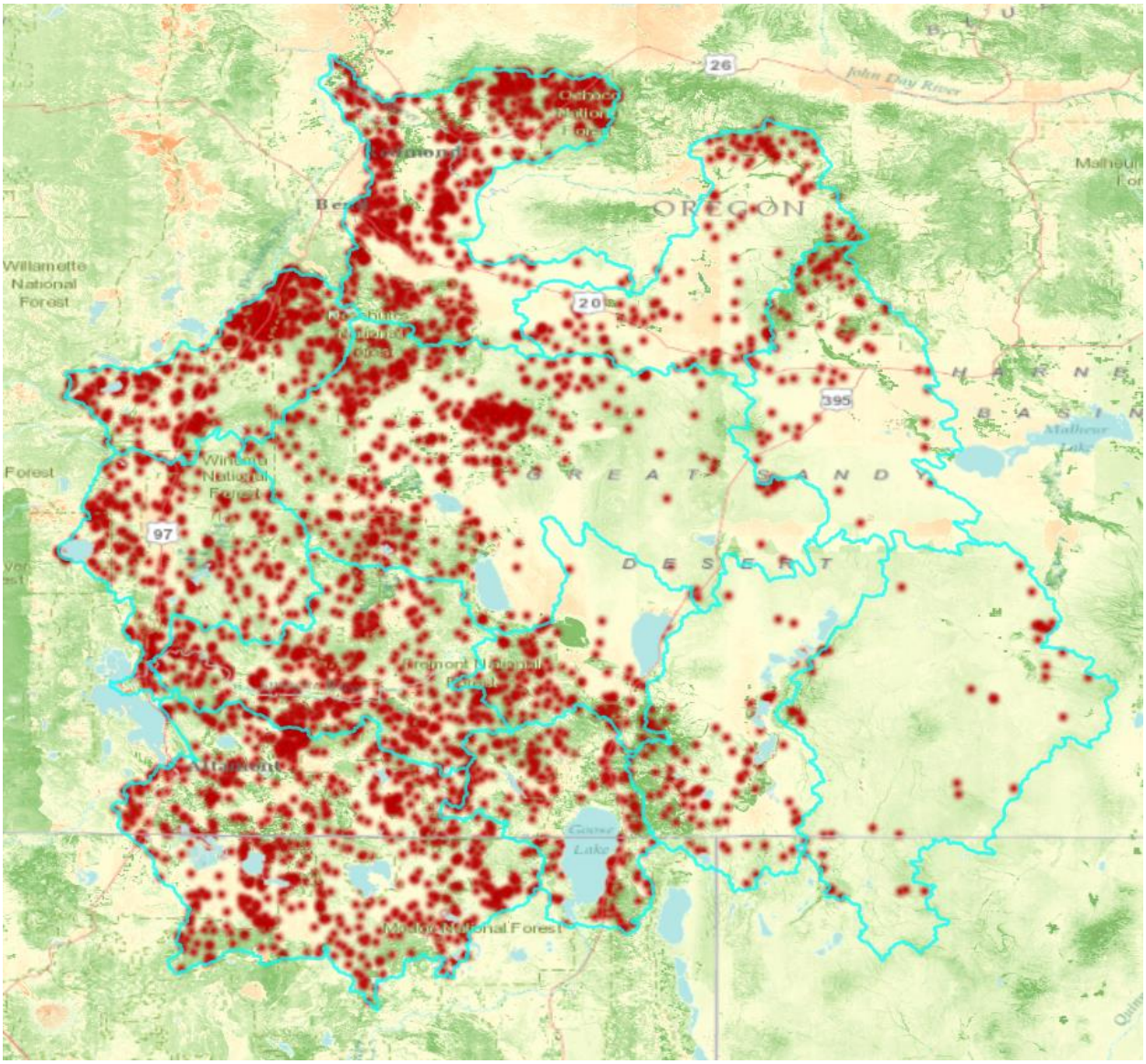
2. Next, I delineated the 40 meter buffer:

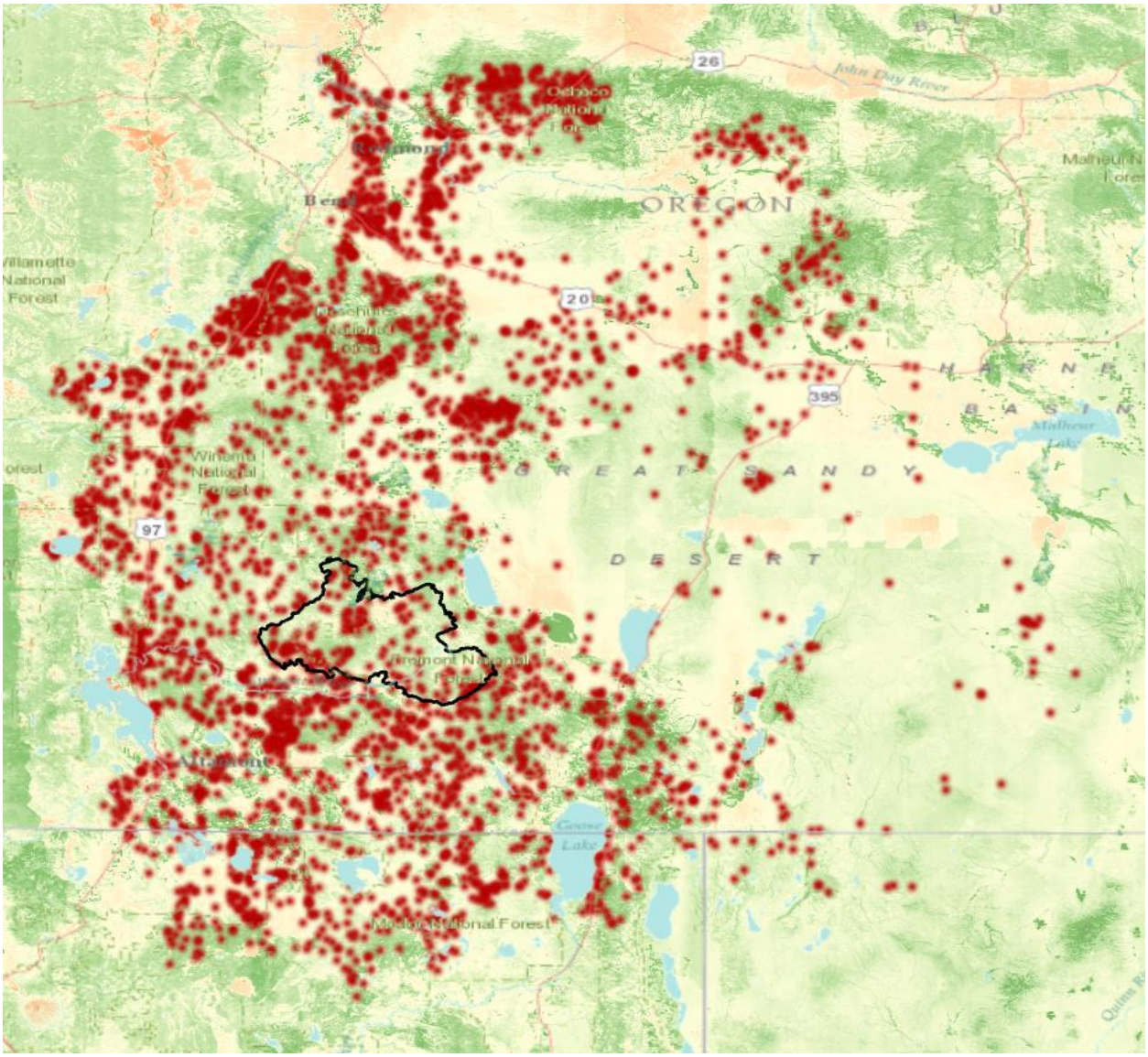


3. I then delineated the 100 meter buffer:

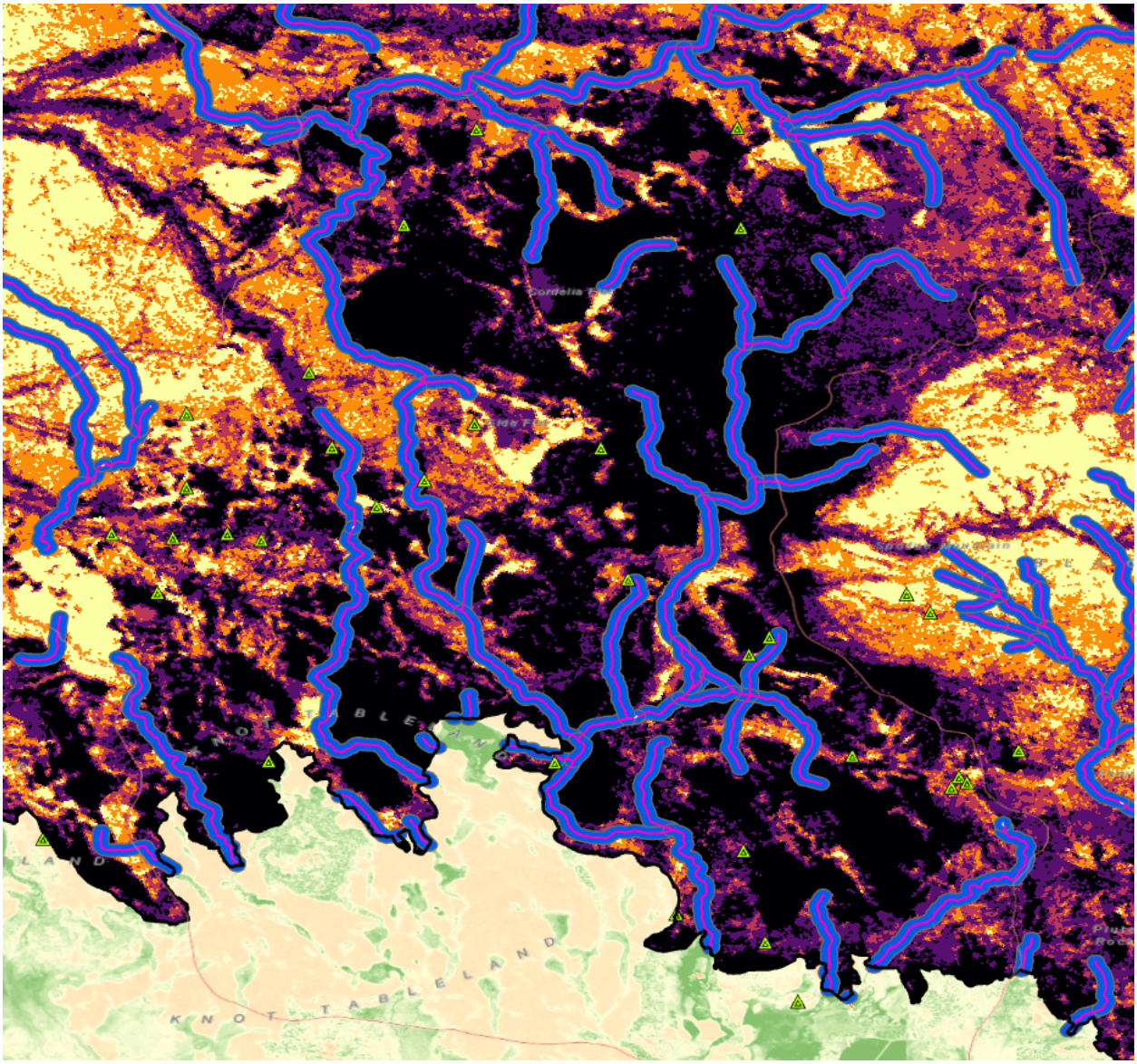


4. I further used the select by location feature to create an ad hoc mask extraction of the historical fire incident data to the Lake County watershed extent, and then removed the Lake County perimeter, while adding in the Bootleg Fire boundary:



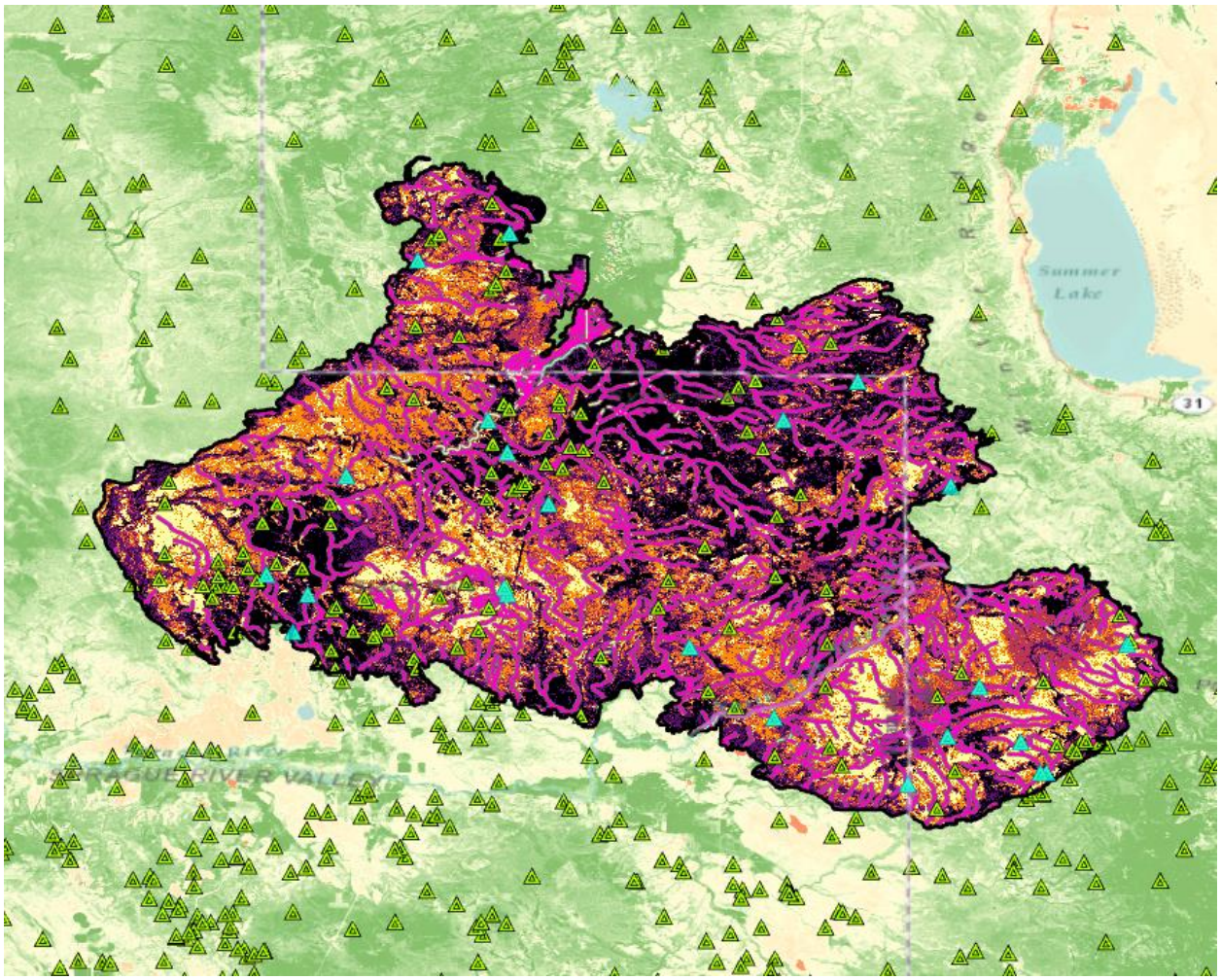

26
20
395
97
OREGON
GREAT SANDY
DESERT
HARNEY
BASIN
Deschutes National Forest
Willamette National Forest
Fremont National Forest
Malheur Lake
John Day River

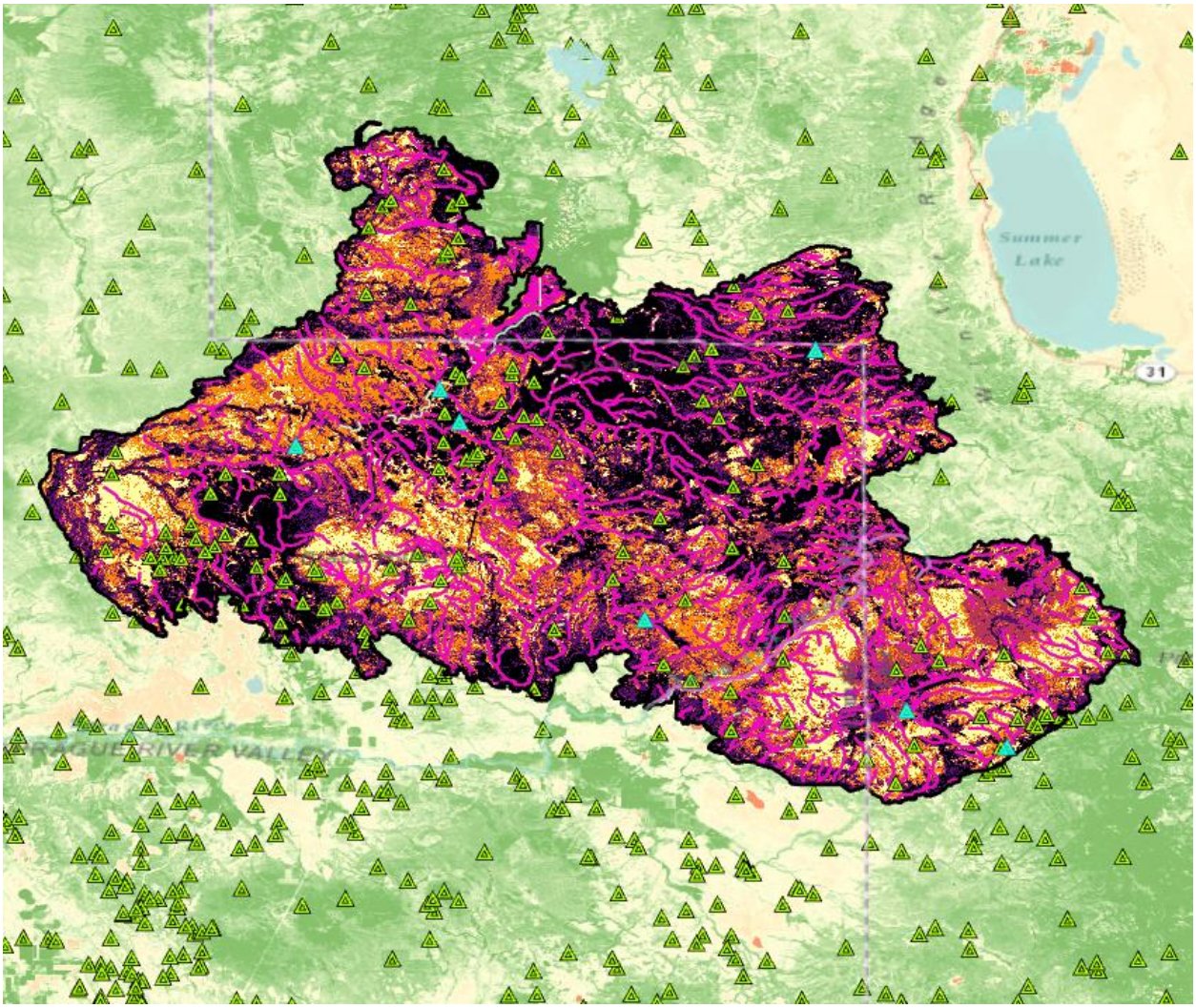
5. I next overlaid the dNBR burn severity map onto the Bootleg Fire boundary, along with the delineated riparian zones, to identify historical fires inside and outside of the riparian zones. Here is the zoom-in for illustrative, not analytical purposes:



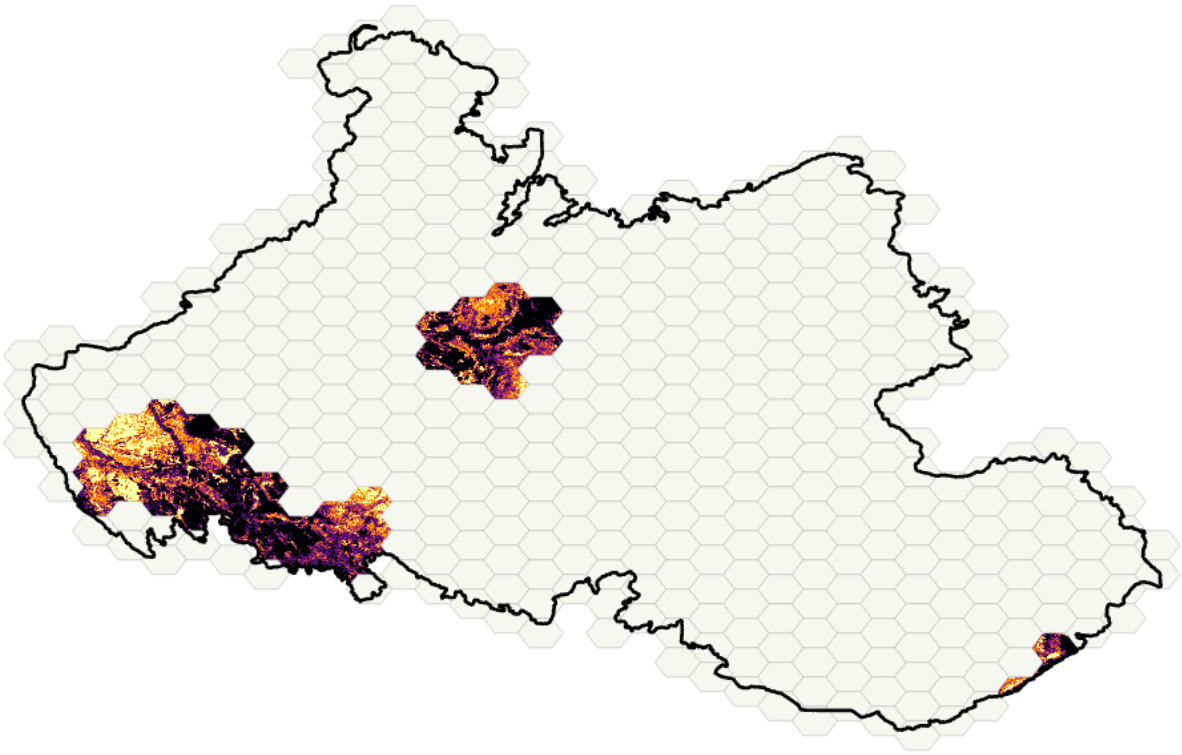

6. As a matter of analysis, I identifed the proportion of historical fire incidents within the 100 m buffer (19/140) in comparison to the proportion of historical fire incidents

within the 40 m buffer (7/140). In the following series of images, the 100 m buffer precedes the 40 m buffer:

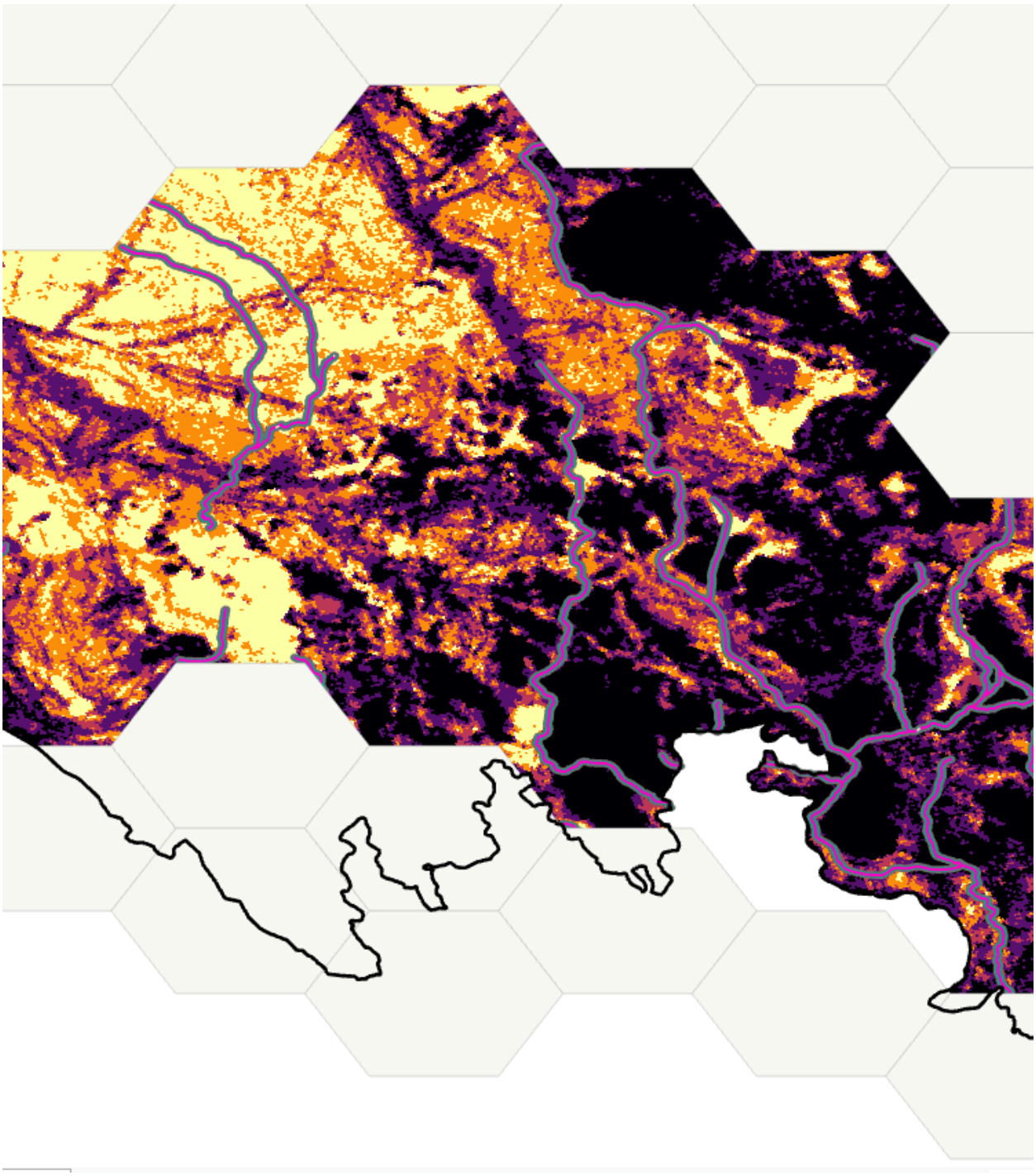





7. I next created Optimized Hot Spots, using the historical fire incidents from Lake County. I then created an inverse mask, so that within those hotspots, I had visualized the riparian zones and the (dNBR) burn severity map:

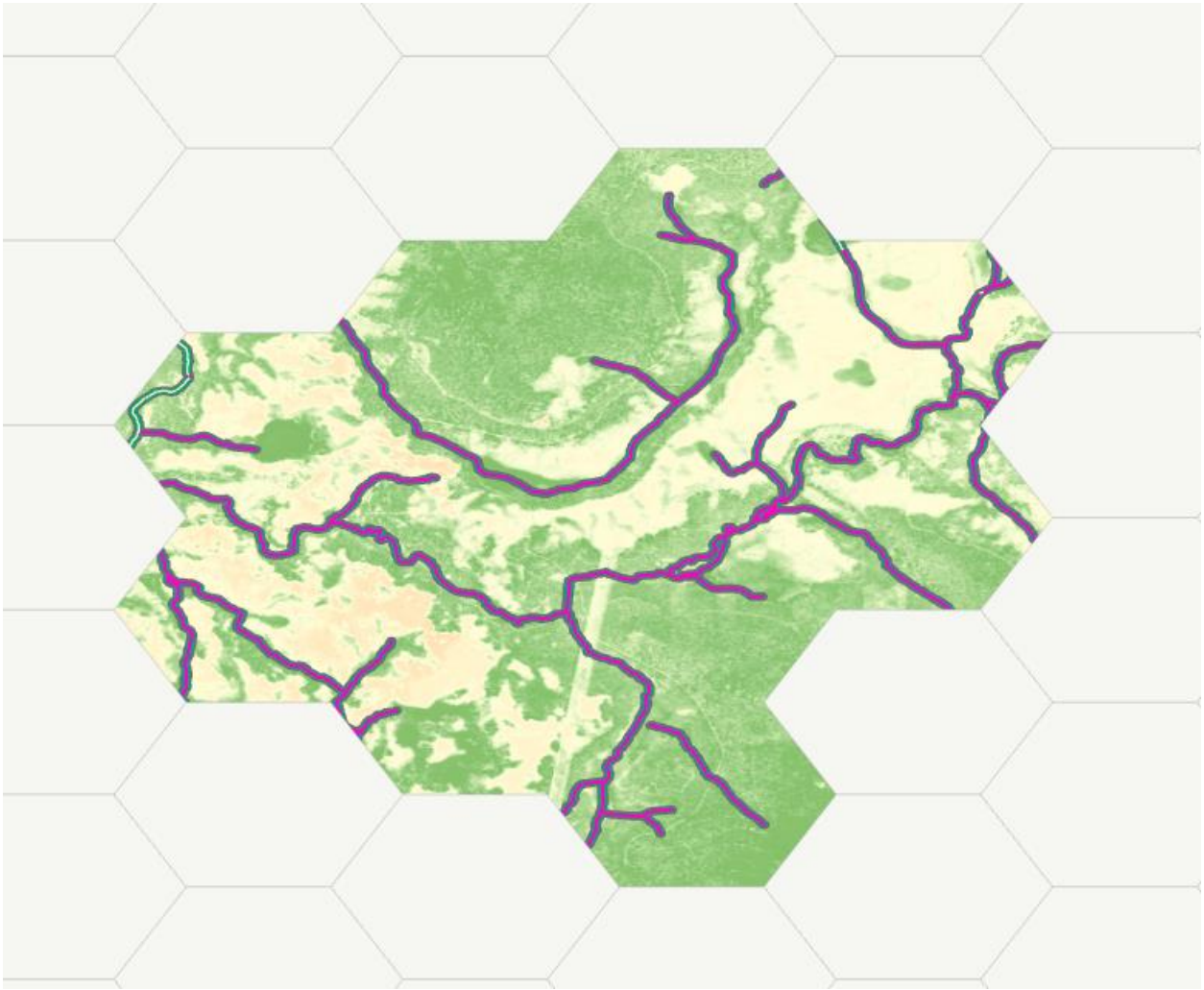


8. In the zoom-in, it is visible that the burn severity to some extent matches the course of the river network, as well as traverses high severity burn patches:



9. It is also clear that in some areas of the hot spots within the Bootleg Fire context, those high burn severity patches following the course of the river match the NDVI

NAIP imagery of pre-existing vegetation, including within the delineated riparian zones:



## CONCLUSION

As this would appear to be confirmation of my theory, I have concluded that some of the riparian zones in the hot spots I generated within the Bootleg Fire extent were corridors of fire

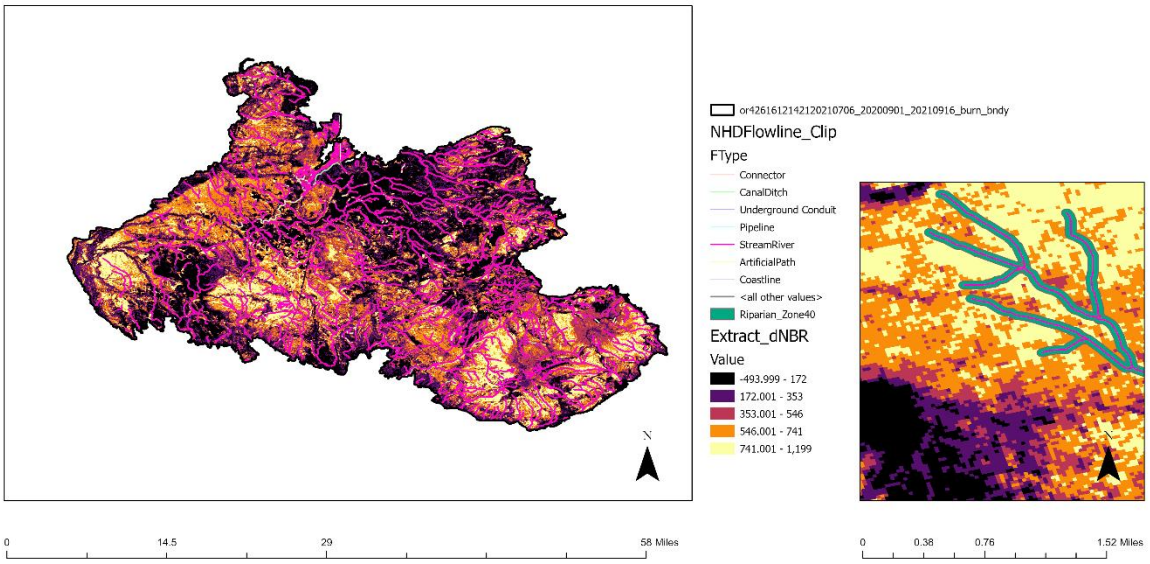
movement that featured pre-existing fuel accumulation and dry weather conditions sufficient to send fire paths upstream during the Bootleg Fire of 2021.

## CITATIONS


1. Pettit, N. E., & Naiman, R. J. (2007). Fire in the riparian zone: characteristics and ecological consequences. Ecosystems, 10(5), 673-687).
2. Salo, J. A., Theobald, D. M., & Brown, T. C. (2016). Evaluation of methods for delineating riparian zones in a semi-arid montane watershed. JAWRA Journal of the American Water Resources Association, 52(3), 632-647.
3. Collins, J. N., Sutula, M., Stein, E., Odaya, M., Zhang, E., & Larned, K. (2006). Comparison of methods to map California riparian areas. Final report prepared for the California Riparian Habitat Joint Venture.

# APPENDIX

## Bootleg Fire Extent With 40m Riparian Zone




This map is of the Bootleg Fire Extent. A 40 m riparian zone around an NHD Flowline stream network has been overlaid on a differenced Normalized Burn Ratio burn severity map.