WILDFIRE BEHAVIOR MODELING FOR THE FERN ROAD ELECTRICAL SUBSTATION

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ABBREVIATIONS

AaD	Aiken series soil type
Ag	Agriculture
AMSL	Above Mean Sea Level
BLM	Bureau of Land Management
CAL FIRE	California Department of Forestry and Fire Protection
CC	Canopy Closure
CEQA	California Environmental Quality Act
CmD	Cohasset series soil type
Comm/Res	Commercial/Residential
CPUC	California Public Utilities Commission
FARSITE	Fire Area Simulator model
FEIS	Fire Effects Information System
FRA	Federal Responsibilty Area
FSA	Full Study Area
Gr	Grass
IFTDSS	Interagency Fuels Treatment Decision Support System
KID	Kilarc series soil type
LANDFIRE	Landscape and Fire Management Planning System
LRA	Local Responsibility Area
MHdW/C	Mixed hardwood and confer stands
MMA	Minimum Mapping Area
PcD	Parrish series soil type
PG&E	Pacific Gas and Electric Company
Pisa	Foothill Pine (*Pinus sabiniana*)
PPS	Proposed Project Site
Qudu	Blue oak (*Quercus douglasi*)
RAWS	Remote Automatic Weather Station
SCFD	Shasta County Fire Department
SRA	State Responsibility Area
SuD	Supan series soil type
TCC	Tree Canopy Closure
TeD	Toomes series soil type
Tr	Tree
TSS	TSS Consultants
USDA	United States Department of Agriculture
USDI	United States Department of the Interior
USFS	United States Forest Service
USGS	United States Geological Survey
VHFHSZ	Very High Fire Hazard Severity Zone
V/LU	Vegetation/Land Use
WHR	Wildfire Hazard Risk

TERMS USED IN THIS REPORT

Crown fire – In a situation where the vegetation formation is dominated by tree species, a fire that is burning at the level of the tree canopy which is characterized by fine fuels types (leaves/needles, twigs and small diameter branches).

Fuel column – A situation where there is a high degree of fuel continuity in a vertical direction, for example where surface fuels are connected to the tree canopy by fuels referred to as “ladder fuels”.

Fuel continuity – A description of the spacing between individual fuel elements, for example are tree crowns touching the crowns of all its neighbors or are they moderately, or even widely, spaced.

Gallery Formation – Stands of woody brush and tree species located on the banks of natural watercourses, wetlands, or artificial watercourses such as canals or flumes.

Image Resolution – The minimum surface area for which a reflectance value (as in LandSat imagery) or generated attribute result (as in the LANDFIRE behavior modeling process). For the purposes of the determination of wildfire risk for the Fern Road ESS the LandSat resolution for the panchromatic bands is on the order of 15 meters[1] and for the LANDFIRE modeling on the order of 90 meters.[2]

Intensity – A measure of the heating quotient typically described in either degrees Fahrenheit or Centigrade.

Ladder fuels – Vegetative fuels that provide a pathway for fire to move from the surface to the tree canopy.

Minmum Mapping Area – The area on the earth’s surface where individual conditions are represented by a single value or attribute. This situation, also often referred to as the resolution, establishes the threshold at which finer information breakdowns are not possible.

Nearest-Neighbor Analysis – A “smoothing” process typically used in a pixel-based type of interpretation analysis. The process averages the reflectance values of the central pixel and its eight surrounding pixels; giving greater weight to the central pixel. This process enables a greater appreciation of transition from one distinctly different reflectance type to another. Typically, this process is not applied beyond the eight surrounding pixels.

Phenotype - The set of observable characteristics of an individual species or a stand resulting from the interaction of its genotype with the environment.

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[1] USDI, USGS. August, 2021.

[2] LANDFIRE, August, 2021 [https://www.landfire.gov]

Pixel – A picture element that, in the case of satellite imagery use, provides an averaged presentation of reflectance over a specified size of the surface.

Prevailing winds – A wind from the direction that is predominant at a particular place or season.

Residence time – The length of time a wildfire burns at a single location. This behavior characteristic is typically defined by the fuel size categories that are present and dominant. Grass-based fuels models are fully dominated by the presence fine fuels with a resulting short residence time, whereas woodland models are dominated by larger diameter fuels and longer residence times.

Spotting or Spot Fires – Process where a fire front advances without immediate contact with adjacent fuels. The dominant mechanism in his process is windblown embers.

Spread rate – Average speed at which a fire front advances; typically reported as feet, meters, or chains (66'), per hour.

Stand – A group of individual plant species, with a dominance of tree species, with a defined surface coverage, distinctly definable physical form, and distinctly different species compositions.

Station roll-out – The moment when equipment physically leaves its assigned station.

Surface fire – A fire tht is confined to fuels located at ground level.

Torching – Involvement in fire of an entire single tree, often used in the situation where the tree is isolated, there is no direct contact with neighboring tree crown, and potential for fire spread.

Tree crown closure – The percentage of the ground's surface, as seen from a vertical vantage point, covered by the leafy canopy of tree species.

Vegetation formation – A grouping of vegetation that has 1) a homogeneous species composition, 2) physical appearance, and 3) ecological setting requirements, that occurs at several locations within a region.

Vegetation/Land Use type – The nature, as related to wildfire behavior, of the use that a definable land area is characterized by. These include occupation by various natural vegetation types, agricultural endeavors, residential uses, non-flammable transportation system surfaces, open water bodies, etc.

Wind Roses – Wind roses are graphical charts that characterize the speed and direction of winds measured at weather stations. Presented in a circular format, the length of each "spoke" around the circle indicates the amount of time that the wind blows from the indicated direction. The data typically available to the public is comprised of an annual summary and monthly reports.

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INTRODUCTION

TSS Consultants, was retained by Heritage Environmental Consultants to conduct an assessment of wildfire hazard risks (WHR) associated with the proposed siting of an electrical substation next to a Pacific Gas and Electric Company's (PG&E) transmission line in Shasta County. TSS convened a project team comprised of three credentialed and experienced discipline specialists (see Appendix A for biographical information) and conducted the assessment in the months of July and August, 2021.

Proposed Project Description

The Round Mountain 500 kilovolt (kV) Area Dynamic Reactive Support Project (Proposed Project) was approved by the California Independent System Operator Corporation (CAISO) to ensure the reliability of the CAISO controlled grid. This would be accomplished through the construction of a dynamic reactive device. The Proposed Project is being proposed by LSPGC, a Delaware limited liability company established to own transmission projects in California.

The main components of the Proposed Project are two Static Synchronous Compensators (STATCOM) and a 500kV Gas-Insulated Substation (GIS), referred to as the Fern Road Substation. The STATCOM units would be equally sized and would provide approximately +/- 529 million volt-amperes, reactive (MVAR) of dynamic reactive support. The STATCOM units would be connected to the 500kV GIS which would be independently connected (i.e., looped-in) to PG&E's regional electric transmission system via the Round Mountain – Table Mountain #1 and #2 500 kV transmission lines that are located adjacent to the Proposed Project Site (PPS).

LSPGC holds an option to purchase 40 acres or more within an approximately 426-acre parcel located directly adjacent to the Round Mountain – Table Mountain #1 and #2 500 kV transmission line corridor. The PPS is located east of Fern Road and east of the existing PG&E transmission right-of-way (ROW), approximately 1.6 miles northwest of the unincorporated community of Whitmore and approximately 9.3 miles north of State Highway 44 in unincorporated southern Shasta County. The PPS is primarily open space area with minimal development, and is currently used as grazing land.

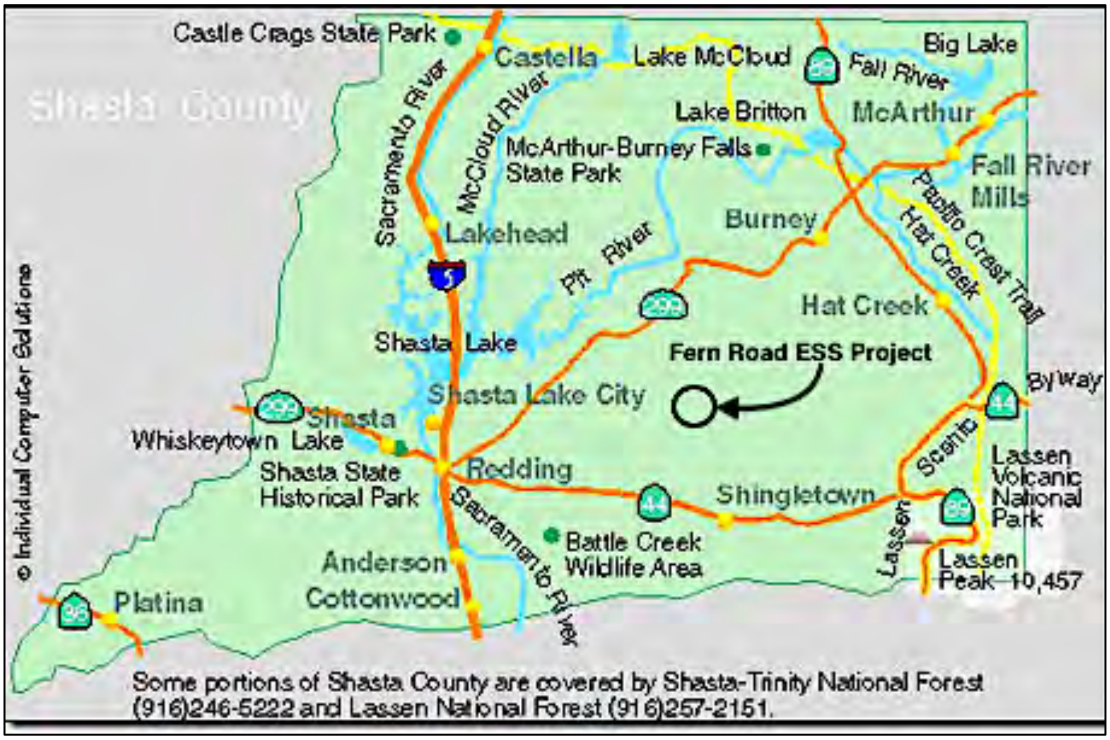
Study Area

This wildfire behavior analysis was conducted in Shasta County, California, at the location shown in Figure 1.

For the purposes of ths assessment there will be two tracts of land comprising the Full Study Area (FSA):

- The 9.16-acre site on which the proposed electrical substation would be constructed, and,
- The FSA comprised of an approximated 1-square mile area around the proposed project site (PPS).

Figure 1. **Proposed Project Site Location, Shasta County, California**



The following Figure 2 shows the location of the PPS and the FSA on the USGS 7.5-minute Whitmore quadrangle and Figure 3. shows an enlargement of the Whitmore quadrangle to better understand the physical setting of the two project-related areas.

Physical Setting

This wildfire behavior modeling effort was conducted for a one (1) square-mile area located in the central Shasta County, California. As seen in Figure 3, (below), it is contained entirely within Sections 11, 12, 13, and 14 of Township 32 North, Range 1 West, of the Mount Diablo Meridian. The center point of the study lies at 40° 38.619' North and 121° 56.249' West. Elevations range from approximately 1,600 feet to 2,120 feet AMSL with a general uphill trend to the north and east. The extreme lower portion of the FSA is drained to the west by Old Cow Creek and in the south-eastern corner Old Cow Creek flows are diverted into an un-named flume/canal. The site on which the substation is to be constructed has a slope gradient less than 5% and is occupied by soils in the Kilarc Series. This soil series is very stony sand-clay loam (KID). Other principal soils series in the extended FSA included Supan very stony loam on slopes from 0%-30% (SuD), Parrish loam on slopes from 15%-30% (PcD), Toomes very stony loam on slopes from 0%-30% (TeD), Cohasset very stony loam on slopes from 0%-30% (CmD), and Aiken loam and very stony loam, both on slopes from 0%-30% (AaD). All soils mentioned above have been described in the NRCS soils surveys conducted for the intermountain area.[3] The PPS is accessible from the single road that bisects the FSA in a north-south direction. Direct access to the PPS is provided by an unimproved naturally surfaced road that enters the PG&E transmission line corridor at a gated entrance and then runs approximately 0.4 miles to the south.

[3] USDA, NRCS. 2000

Figure 2. Project Area on Whitmore Quad Map

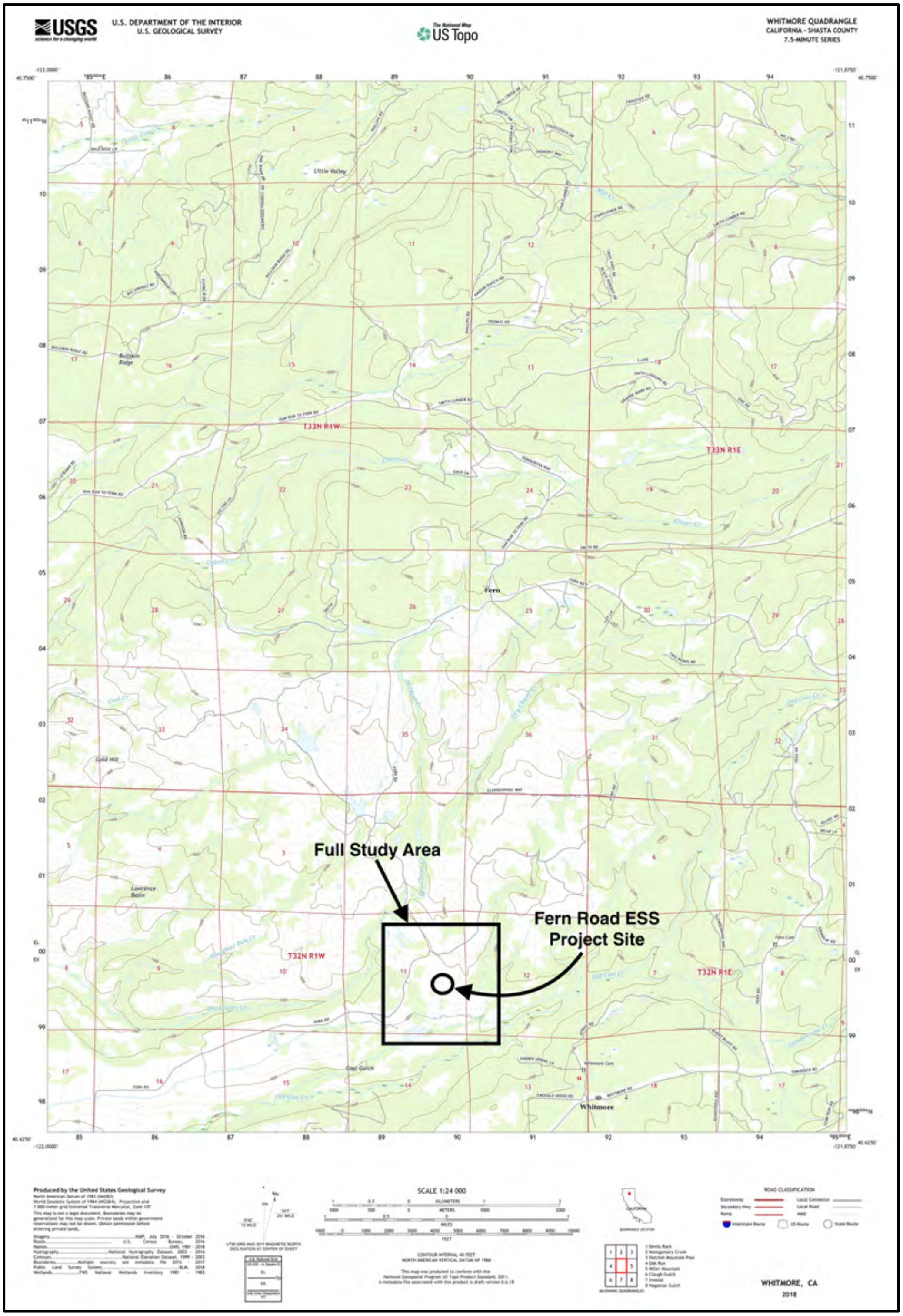
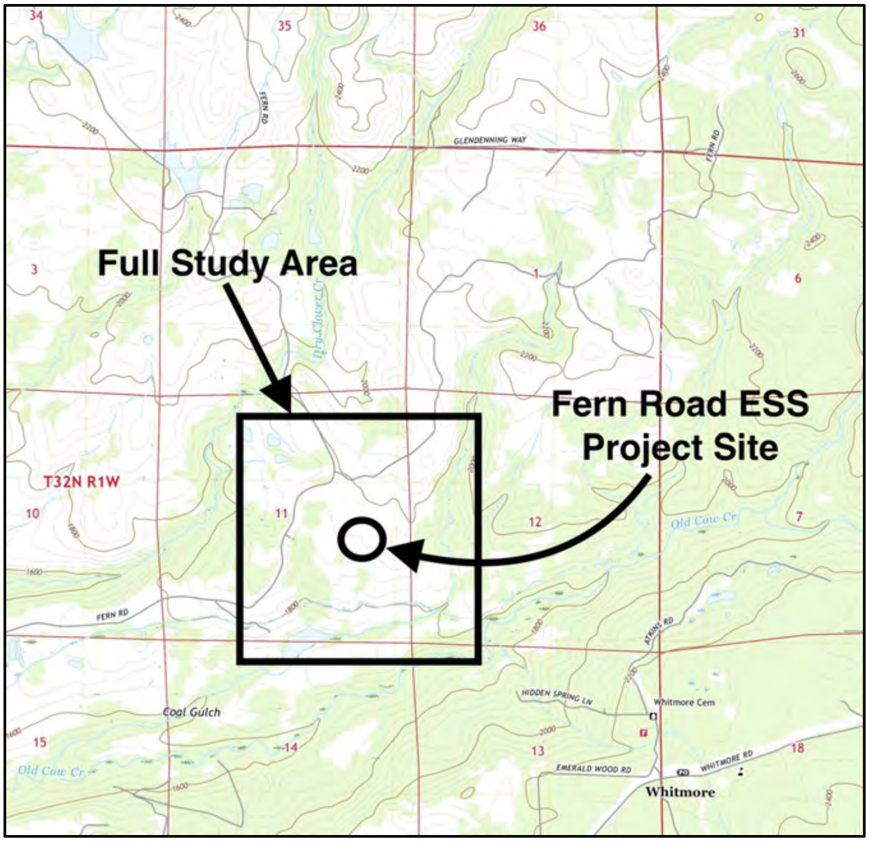


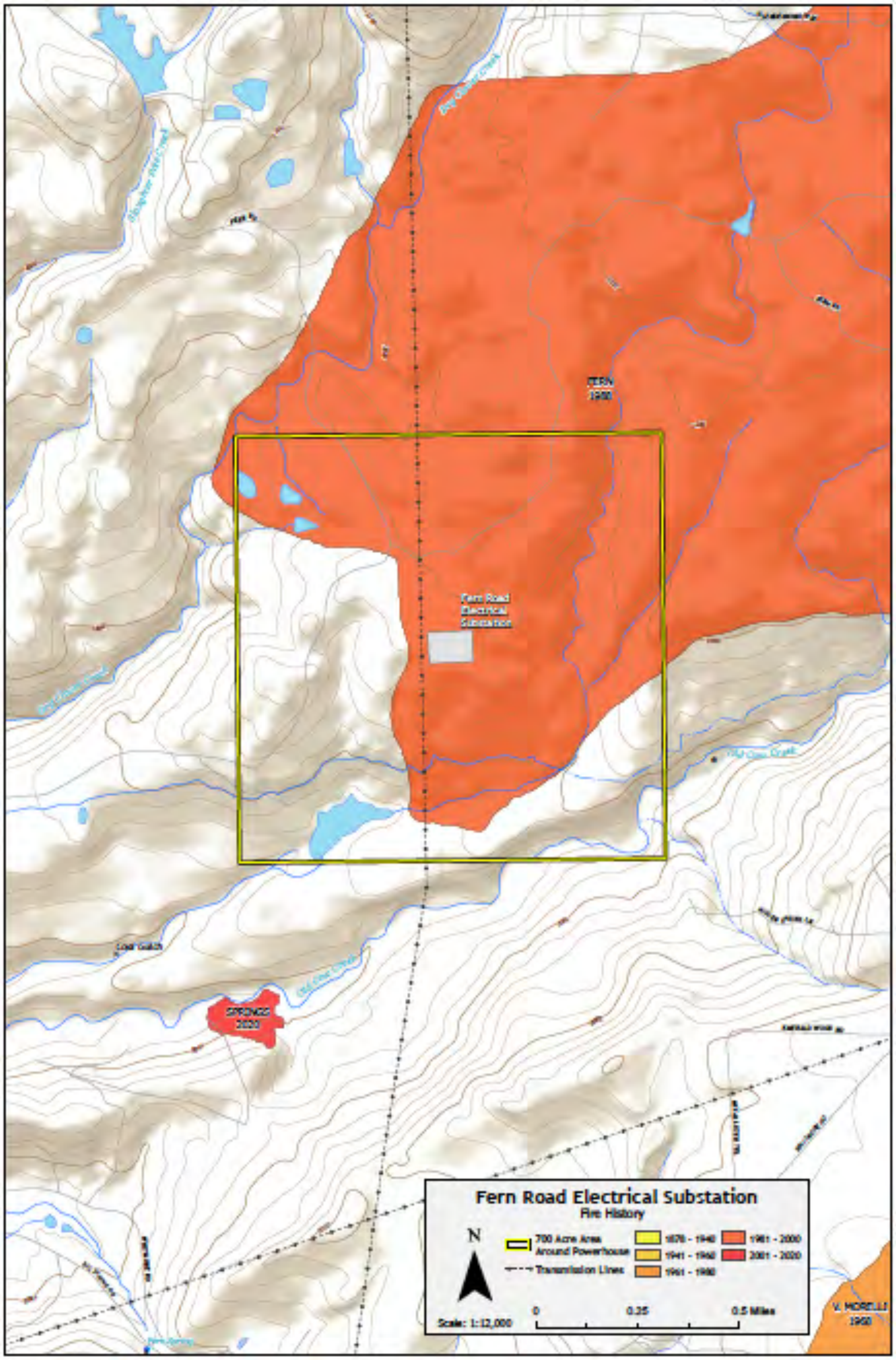
Figure 3. Full Study Area and Project Site Location Detail



Fire History

The only large fire that occurred within the vicinity of the PPS was the Fern Fire in 1988. The western portion of this fire's footprint, and its location with respect to the PPS is shown in Figure 4, below. No information was available regarding the date of this fire, its ignition location, or fire-front advance pattern. A second small fire did occur more recently, the Spring Fire, estimated as covering 40 acres, showed a fire front advance of slightly more than ¼-mile before being brought under control. Again, no publicly-available information was available regarding the dates of this fire, its ignition location, or fire-front advance pattern.

Figure 4. Large Fire History Adjacent to the Full Study Area



A fire-year summary of wildfire causes was presented for the CAL FIRE Shasta Trinity Unit (SHU) in its 2008 Fire Plan.[4] These results are shown in Table 1, below. A full 61% of ignitions were in land use-related activities typical of the area in which the PPS is located including:

- Vehicle and arson sources associated with Fern Road;
- Debris burning and use of equipment associated with the residential and agricultural uses typical of the area, and;
- Lightning.

Table 1. 2000 to 2004 Fire Ignition Sources Within the CAL FIRE Shasta-Trinity Unit

Fire Cause	2000	2001	2002	2003	2004	Totals	Avg #	% Cause
Undetermined	46	47	29	42	20	184	36.80	11.56%
Lightning	13	42	12	14	49	130	26.00	8.17%
Campfire	7	3	12	5	10	37	7.40	2.32%
Smoking	11	18	18	20	10	77	15.40	4.84%
Debris Burning	27	47	33	36	42	185	37.00	11.62%
Arson	39	40	40	24	28	171	34.20	10.74%
Use Of Equipment	57	74	45	68	85	329	65.80	20.67%
Vehicle	15	28	34	20	59	156	31.20	9.80%
Railroad	0	1	0	0	0	1	0.20	0.06%
Powerline	22	23	19	17	9	90	18.00	5.65%
Playing W/ Fire	23	24	18	18	17	100	20.00	6.28%
Other/Misc.	12	21	29	25	45	132	26.40	8.29%
Totals	272	368	289	289	374	1592	318.40	

Botanical Setting

Information regarding the nature and distribution of vegetation formations across the landscape is critical to determining fire behavior and assessing wildfire hazard risks. Vegetation formations are typically described in terms of what individual species are present and what is their comparable dominance within the composition. However, when addressing wildfire issues the species involved are second to consideration of fuel volumes present, relative flammability of the fuels, and how the fuels are structured in space.

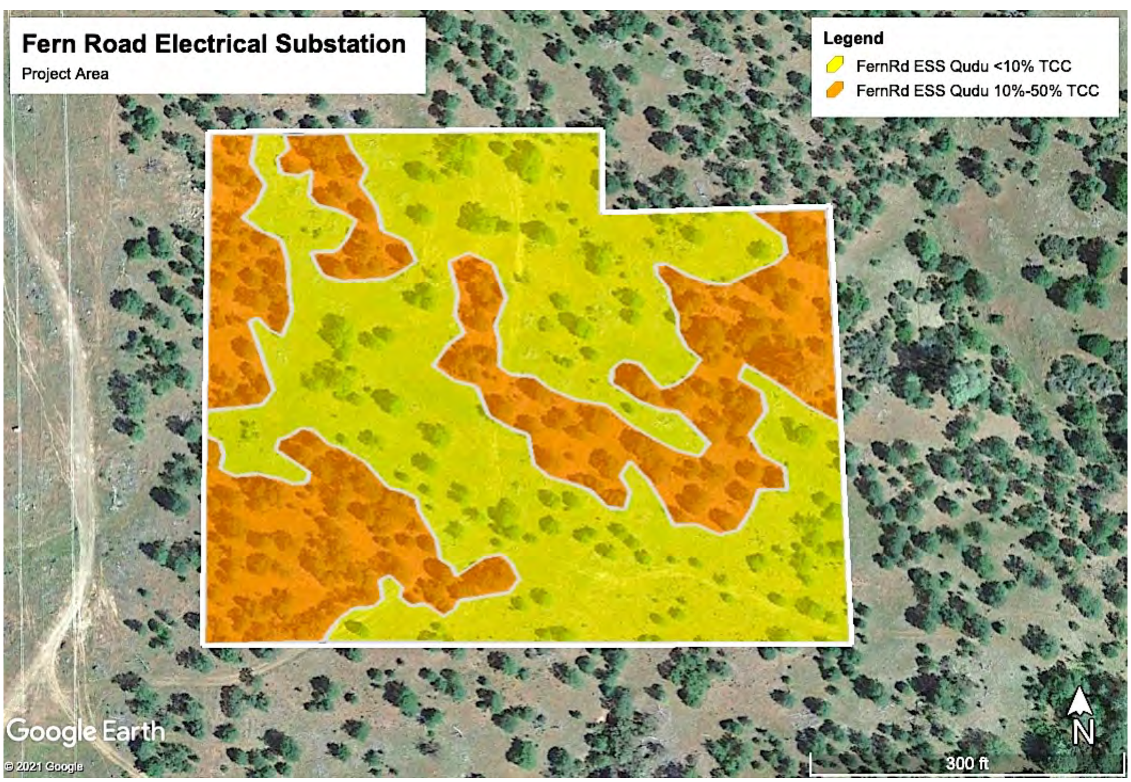
In order to understand this aspect of the setting a mapping effort was completed for both the tract that is the PPS and for a one square mile tract around the PPS, known as the FSA. The mapping completed for this effort was based solely on an interpretation of satellite imagery and the experience of the interpreter. Two principal criteria were employed when identifying wildfire behavior-related ground conditions, 1) an estimate of the tree crown closure (TCC), i.e. the percentage of the ground covered by tree crowns, and 2) the "roughness" of the appearance of the surface of the tree crowns. With respect to crown closure in the Shasta County environment the relationship is straightforward; the fewer trees the more surface area occupied by grass. Grass formations do have a high level of surface fuel continuity and can have rapid spread rates, however the total fuel volumes are very low, they are consumed very quickly, have relatively low intensities, and shorter flame lengths. In formations with grass fuels on the surface and

[4] CAL FIRE. Undated. Pg. 45.

widely-space trees (generally up to 30% TCC) the fire behavior will be more like the grass-based fuel models. In these situations even where there are trees present they are spaced such that, even if the fire travels up the individual tree's fuel column, they don't have neighboring trees to spread fire. On the other hand areas that have high TCC numbers suggests that it is the trees that control the fire behavior with high fuel volumes, longer-burning fuels, higher intensities, and both horizontal and vertical fuel continuities. Where the crown surface looks "rough" this indicates a formation that has a varied mix of species, greater overall canopy heights, large volumes of fuel and well-developed vertical fuel continuity.

Below, in Figure 5, the results of the interpretation are shown for the 9.16-acre PPS. The stands mapped out are two different phenotypes of the same USDA/FEIS[5]-defined California Lower Montane Blue Oak (*Quercus douglasi* or "Qudu)-Foothill Pine (*Pinus sabiniana* or "Pisa")Woodland and Savanna.[6] The difference is one of the types (shaded in light yellow) has a tree canopy closure, on average, less than 10% of the surface and the other (light orange shading) was determined to have a TCC in the range of 10% to 50%. Of the 9.16-acre PPS the type "Qudu <10% TCC" covered 5.50 acres (60% of the surface) and the more densely-treed sites "Qudu 10%-50% TCC" occupied 3.66 acres (40% of the surface).

Figure 5. Vegetation Cover Type for the Proposed Project Site



[5] USDA/FEIS, August, 2021
[6] USDA/FEIS. January 23, 2014.

Full Study Area

Principal Type	Phenotype	Acreage/%
California Northern Coastal Grasslands	Gr/AG	176.4 (29%)
	PG&E Gr/Ag	43.1 (7%)
California Lower Montane Blue Oak-Foothil Pine Woodland and Savanna (Biophysical Settings 0311140, 0611140 and 0711140)	Qudu <10% TCC	13.8 (2%)
	Qudu 10%-30% TCC	67.6 (11%)
	Qudu 10%-50% TCC	26.2 (4%)
	Qudu 30%-50% TCC	42.5 (7%)
	Qudu >50% TCC	3.9 (1%)
Mediterranean California Mixed Oak Woodland	MHdW/C >50% TCC	269.2 (47%)
Other Vegetation/Land Use	Open Water	8.2 (1%)
	Comm/Res	11.8 (2%)
	Gr/Br/Tr	25.9(4%)
	Total	**602.82**

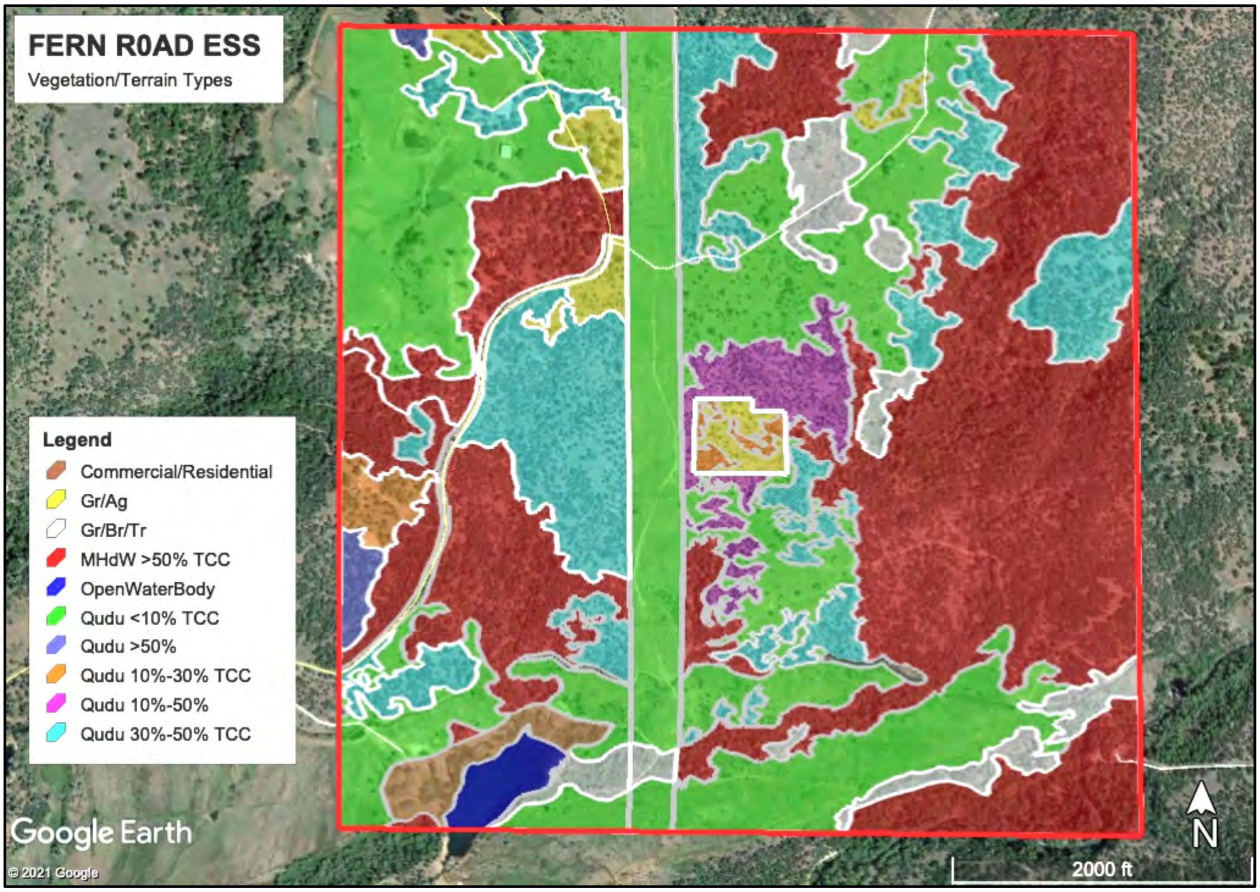
In order to assess the manner of wildfire approach from an offsite location, and its nature (fire behavior) upon arrival at the PPS, a similar mapping effort was completed for the 640-acre FSA. This effort identified three principal USDA/FEIS formations with different phenotypes characterizing two of them. Shown in Table 2, below, are the three principal vegetation types and their phenotypic breakdowns (if applicable), the non-vegetation-related land use types, and the respective surface areas covered in the FSA.

Table 2. Vegetation Cover Types Within the Full Study Area

*Excludes roads,canals, and canal-side gallery formation.

The Northern Coastal Grassland type was actually a combined type (native grasslands and agricultural fields). As the agricultural products in these fields were cereal grains, or feedstocks (hay, alfalfa, etc.), this particular land use can exhibit fire behaviors identical to that of natural grasslands. A map of the vegetation and terrain for the FSA is shown in Figure 6.

Figure 6. Vegetation and Terrain Types Within the Full Study Area



In addition to the completion of the LANDFIRE modeling of fire behavior in the FSA a complementary threat analysis was completed for the combined purposes of making a more general determination of wildfire hazard risk level, including risks that would directly or indirectly threaten the proposed facility and risks that would threaten valued resources in the project's general vicinity. This complementary threat analysis involved: 1) visual interpretation of recent satellite imagery, 2) consideration of the full variability of fire behavior outcomes in each individual Scott/Burgan fuels model[7] and 3) the influence of conditions within the project's regional setting. This complementary threat analysis was performed on the basis of professional experience and judgment and was not supported, (due to project scoping constraints), by field verification.

Although both models provided very valuable results in determining wildfire hazard risk information, each used different types of input information. There were three primary differences between the processes:

1. The pixel-based LANDFIRE model (with a minimum resolution on the order of 30 meters/94 feet) used information averaged over a minimum area of 900 square meters (8,836 square feet/0.2 acres) whereas the LandSat minimum resolution is much finer on the order of 15 meters/48 feet; a surface area of 225 square meters (2,304 square feet/0.05 acres);

[7] USDA, USFS. June, 2005.

2. The LANDFIRE process will include inputs from only up to a practical maximum (if a "nearest-neighbor" smoothing procedure is used) of 9,000 square meters (88,360 square feet/2.0 acres) whereas human integrative interpretation (using convergence of evidence) of the Landsat imagery will allow conclusions based on information from areas even greater than the FSA employed in the analysis, and;
3. The LandSat interpretation process allows for more of a qualitative approach (with a heavy reliance on professional judgment) than the mathematical-formulaic approach upon which the LANDFIRE approach is based.

Vegetation/Terrain Units

Following are the vegetation/land use types identified as a result of the satellite imagery interpretation process for potential ground conditions in the PPS and the FSA. A full range of USDA/ FEIS vegetation community categories were evaluated and those most appropriate to the Shasta County setting were selected based on 1) experienced-based familiarity with the ground conditions in this area of Shasta County and 2) the physiognomy portrayed in the ground photographs of, and species listed as characterizing, the category example. Each selected vegetation community category is described in terms of 1) its crosswalk type(s) in the Scott/Burgan fuels model system,[8] and then, 2) the range of fire behavior specifications in each identified Scott/Bergan type(s).

California Northern Coastal Grasslands (Biophysical Setting 0411310)[9]

This USDA/FEIS is represented by the GR, GR/AG, and GR/Br/Tr V/LUs mapped for this analysis. In this area the agricultural crops were primarily grass/forb (alfalfa) cereal and fodder production with fire behaviors very similar to native grasslands. Furthermore, it was concluded that, even with the presence of some brush and tree species in the mapped units, that presence would not be sufficient to change the dominance of the grassland conditions on the fire behavior.

Scott/Burgan Crosswalk: GR 2 (102); GS 2 (122)

GR 2 – This Scott/Bergan model type is physically very similar but botanically different than the USDA/ FEIS category. It is described as a "low load, dry climate grass" type. For median values of dead fuel moistures and as wind speeds range from 5 to 10 miles per hour the rates of spread range from 666 feet/hour to 3,300 feet/hour, respectively and have flame lengths ranging from 2 to 5 feet, respectively. The ability to gain control over the fire-front advance would have to be considered in the high range due to the low fuel volumes and lack of persistent ember production.

GS 2 – This Scott/Bergan model type is physically different (than GR 2) with the addition of a brush component and botanically different than the FEIS category. It is described as a "moderate load, dry climate grass-shrub" type. For median values of dead fuel moistures and as wind speeds range from 5 to 10 miles per hour the rates of spread range from 666 feet/hour to 1,980 feet/hour, respectively and have flame lengths ranging from 3 to 8 feet, respectively. The ability to gain control over the fire-front advance

[8] *Ibid.*
[9] USDA/FEIS, January 23, 2014.

would have to be considered in the moderate range due to the slightly elevated fuel volumes and a low potential for persistent ember production.

California Lower Montane Blue Oak-Foothill Pine Woodland and Savanna (Biophysical Settings 0311140, 0611140 and 0711140)[10, 11, and 12]

This USDA/FEIS category is represented by the Qulu V/LUs with TCCs less than 30%.

Scott/Burgan Crosswalk: TU 1 (161); TL 2 (182)

TU 1 – This Scott/Bergan model type is physically and botanically similar to the USDA/FEIS category. It is described as a "low load, dry climate timber-grass-shrub" type. One variant of this type can be described as a hardwood type that the example photos show as having TCCs ranging from 10% up to somewhat higher than 40%. For surface-advancing fires with median values of dead fuel moistures, and as wind speeds range from 5 to 10 miles per hour, the rates of spread range from 20 feet/hour to 132 feet/hour, respectively and have flame lengths ranging from 1.25 to 2.00 feet, respectively. In the lower end of the TCC-percentage range stands tend to lack a significant ladder-fuel component and, given the very short flame lengths the possibility of the fire to "crown" is very low. In the upper end of the TCC-percentage range stands can develop a significant ladder-fuel component and yet, even given the very short flame lengths of the surface fire the possibility of the fire to "crown" must be considered at least moderate. The ability to gain control over the fire-front advance would have to be considered in a very high range, unless the fire does crown, would have a very low potential for persistent ember production.

TL 2 – This Scott/Bergan model type is physically and botanically similar to the USDA/FEIS category. It is described as a "low load broadleaf litter" type. This is a hardwood type that the example photos show as having TCCs ranging from 10% up to somewhat higher than 30%. For surface-advancing fires with median values of dead fuel moistures, and as wind speeds range from 5 to 10 miles per hour, the rates of spread range from 333 feet/hour to 999 feet/hour, respectively and have flame lengths ranging from 0.5 to 0.75 feet, respectively. These low TCC-percentage stands tend to lack a significant ladder-fuel component and, given the very short flame lengths the possibility of the fire to "crown" is very low. The ability to gain control over the fire-front advance would have to be considered in a very high range, unless the fire does crown, would have a very low potential for persistent ember production.

Mediterranean California Mixed Oak Woodland (Biophysical Settings 0410290 and 0510290)[13 and 14]

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[10] USDA/FEIS. January 23, 2014.
[11] USDA/FEIS. January 24, 2014.
[12] USDA/FEIS. January 27, 2014.
[13] USDA/FEIS. January 23, 2014a.

[14] USDA/FEIS. January 24, 2014a

This USDA/FEIS category is the closest to conditions occurring in the PSS. It physically has vegetation structures similar to the stands mapped in this analysis but is dis-similar botanically. The stands mapped in this analysis exhibited a much broader range of oak species and the inclusion of a minor component of dry-site confer species (primarily foothill pine (*Pinus sabiniana*) and Ponderosa pine (*P. ponderosa*). The mapped V/LUs included in this FEIS categories were Qudu >30% TCC and MHdW/C >30% TCC.

Scott/Burgan Crosswalk: TU 1 (161); TU 2 (162); TL 2 (182); TL 6 (186), and; TL 9 (189).

TU 1 – This Scott/Bergan model type is physically similar to the USDA/FEIS category but, as described above, is dis-similar botanically. This lack of similarity is most likely due to the relative aridity of the climate in this inner valley regional location. It is described as a "low load, dry climate timber-grass-shrub" type. One variant of this type can be described as a hardwood type that the example photos show as having TCCs ranging from 10% up to somewhat higher than 40%. For surface-advancing fires with median values of dead fuel moistures, and as wind speeds range from 5 to 10 miles per hour, the rates of spread range from 20 feet/hour to 132 feet/hour, respectively and have flame lengths ranging from 1.25 to 2.00 feet, respectively. In the lower end of the TCC-percentage range stands tend to lack a significant ladder-fuel component and, given the very short flame lengths the possibility of the fire to "crown" is very low. In the upper end of the TCC-percentage range stands can develop a significant ladder-fuel component and yet, even given the very short flame lengths of the surface fire the possibility of the fire to "crown" must be considered at least moderate. The ability to gain control over the fire-front advance would have to be considered in a very high range, unless the fire does crown would have a very low potential for persistent ember production.

TU 2 (162) – This Scott/Bergan model type is physically similar to the USDA/FEIS category but, as described above, is dis-similar botanically. This lack of similarity is most likely due to the relative aridity of the climate in this inner valley regional location. This type is described as "moderate load, humid climate, timber-shrub". This is a hardwood type that the example photos show as having TCCs greater than 30%. For surface-advancing fires with median values of dead fuel moistures, and as wind speeds range from 5 to 10 miles per hour, the rates of spread range from 666 feet/hour to 1,650 feet/hour, respectively and have flame lengths ranging from 3.0 to 5.0 feet, respectively. These stands with high (>30% TCC) TCC can develop a significant ladder-fuel component given the moderate flame lengths of the surface fire, the possibility of the fire to "crown" must be considered at least moderate-to-high. The ability to gain control over the fire-front advance would have to be considered in a low-to-moderate range and if the fire does crown, would have a high potential for persistent ember production.

TL 2 – This Scott/Bergan model type is physically similar, in terms of stand structure, and botanically to the USDA/FEIS category. It is described as a "low load broadleaf litter" type. This is a hardwood type that the example photos show as having TCCs ranging from 10% up to somewhat higher than 30%. For surface-advancing fires with median values of dead fuel moistures, and as wind speeds range from 5 to 10 miles per hour, the rates of spread range from 333 feet/hour to 999 feet/hour, respectively and have flame lengths ranging from 0.5 to 0.75 feet, respectively. These low TCC-percentage stands tend to lack a significant ladder-fuel component and, given the very short flame lengths to possibility of the fire to "crown" is very low. The ability to gain control over the fire-front advance would have to be considered in a very high range, unless the fire does crown, would have a very low potential for persistent ember production.

TL 6 – This Scott/Bergan model type is physically similar, in terms of stand structure, to the USDA/FEIS category but it is most likely botanically dis-similar in terms of species and due to the lack of a conifer component. These stands are described as being a "moderate load broadleaf litter" type. This is a hardwood type that the example photos show as having TCCs greater than 30%. For surface-advancing fires with median values of dead fuel moistures, and as wind speeds range from 5 to 10 miles per hour, the rates of spread range from 330 feet/hour to 825 feet/hour, respectively and have flame lengths ranging from 2.0 to 3.0 feet, respectively. These stands with high TCC (>30% TCC) can develop a significant ladder-fuel component given the moderate flame lengths of the surface fire the possibility of the fire to "crown" must be considered at least moderate. The ability to gain control over the fire-front advance would have to be considered in a low-to-moderate range and if the fire does crown would have a high potential for persistent ember production.

TL 9 – This Scott/Bergan model type is physically similar, in terms of stand structure, to the USDA/FEIS category but it is unknown whether it is botanically similar, or not. These stands are described as being a "very high load broadleaf litter" type with the potential for a conifer component as well. This is a hardwood type that the example photos show as having TCCs greater than 30%. For surface-advancing fires with median values of dead fuel moistures, and as wind speeds range from 5 to 10 miles per hour, the rates of spread range from 330 feet/hour to 1,188 feet/hour, respectively and have flame lengths ranging from 4.0 to 6.0 feet, respectively. These stands with high (>30% TCC) TCC can develop a significant ladder-fuel component given the moderate flame lengths of the surface fire the possibility of the fire to "crown" must be considered at least moderate-to-high. The ability to gain control over the fire-front advance would have to be considered in a low-to-moderate range and if the fire does crown would have a high potential for persistent ember production.

Commercial/Residential

This V/LU type includes lands used for commercial or residential purposes. These locations are generally dominated by building footprints, pavement, and/or permanently cleared areas. In standard fuel models these conditions are considered to be "non-burnable" from the standpoint of wildfire behavior.

Scott/Burgan Crosswalk: NB-1 (91)
There is one tract of land occupied by this V/LU that qualifies as being in this Scott/Burgan classification. It is an 11.8-acre facility of both residential and commercial uses, most likely associated with the reservoir and canal/flume facilities located on the southern edge of the FSA. There were other locations where there were residential- and agricultural-related facilities, however they did not provide significant discontinuities with the surrounding vegetation types or a corresponding alteration of the fire behavior.

Open Water

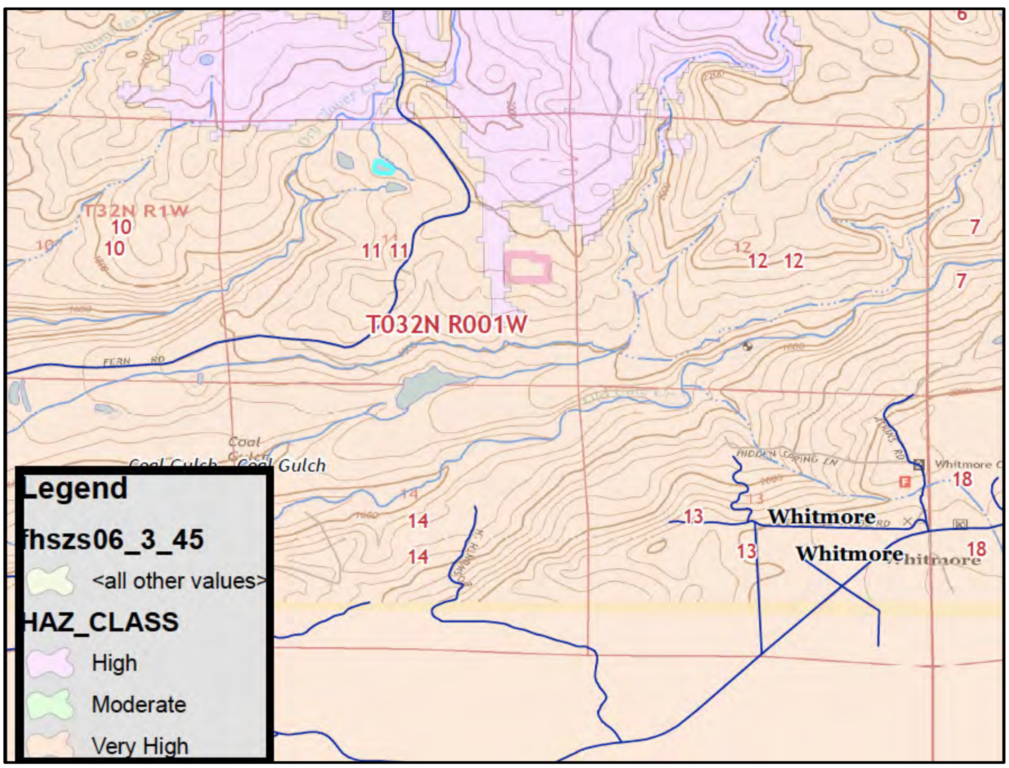
In standard fuel models these conditions are considered to be "non-burnable" from the standpoint of wildfire behavior.

Scott/Burgan Crosswalk: NB 8 (98)
There is no fire behavior associated with this V/LU

Jurisdictional Setting

The PPS is in an area designated by CAL FIRE as a State Responsibility Area (SRA), meaning they have responsibility for initial response to a wildfire incident.[15] Furthermore, the PPS, indicated by the plum-colored boundary in the right ¼ of Section 11 in Figure 7, is also located in an area designated by CAL FIRE as a Very High Fire Hazard Severity Zone.

Figure 7. Very High Fire Hazard Severity Zone Designation



Emergency Response Apparatus

In terms of wildfire risk, as related to emergency incident response, two very important elements that must be considered when making the assessment for a specified location are:

- The amount of time needed for emergency response resources to access the site of a wildfire incident, and;
- The nature of the resources that are available for the response.

[15] CAL FIRE, FRAP. August, 2021.

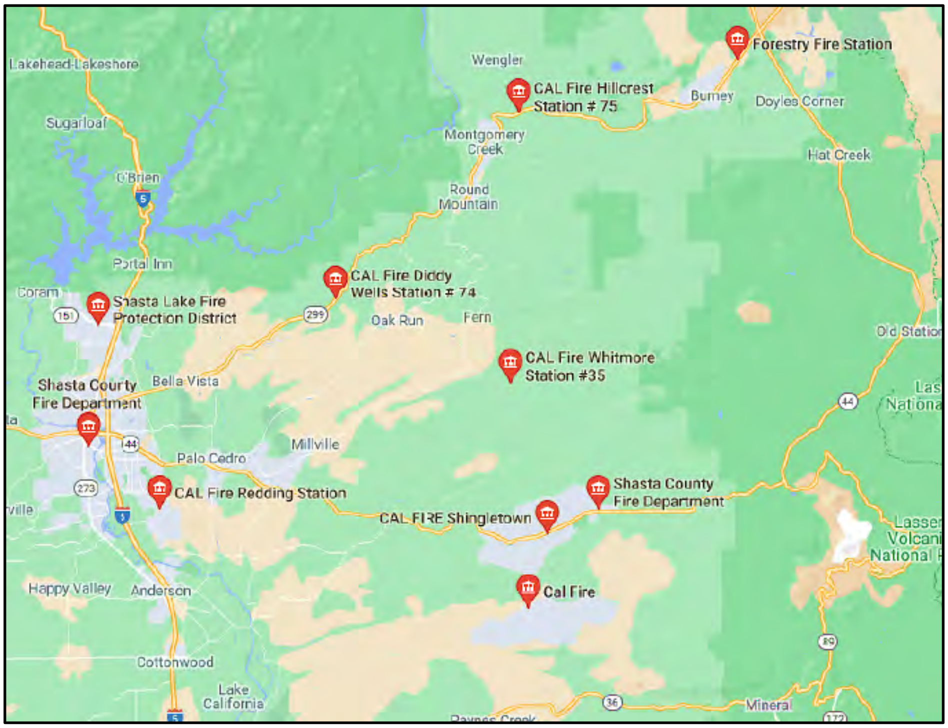
The amount of time required, from station roll-out to arrival at the incident location, is a result of the distance that needs to be traveled and the condition of the roads, with respect to their use by emergency equipment and personnel. Below, in Table 3, is a summary of stations involved in dispatching wildfire response that are within a reasonable distance of the PPS. The table shows the station name, the agency (or cooperating agencies) administering the station, the distance to the PPS measured along the shortest route available, and an estimate (based on professional judgment considering the condition of the roads comprising the route and emergency equipment performance) of the response time. In addition to this summary a full description of the road segments comprising the route is presented in Appendix B. Also in Appendix B is a listing of the vehicle types for each station, where the information was publicly available.

Table 3. Emergency Response Stations

Station	Agency	Distance	Estimated Response Time (Minutes)
Whitmore Station #35	CAL FIRE	8.89	12-15
Millville	Municipal Town Fire Department	15.30	20-22
Palo Cedro Station #32	Shasta County FD	19.46	25-28
Wells Station #74	CAL FIRE	25.50	50-55
Hillcrest #75	CAL FIRE	26.00	55-55
Redding, W. Cypress	CAL FIRE	27.40	35-38
Shingletown	CAL FIRE	33.30	40-45
Burney	Burney FPD/CAL FIRE	40.20	70 – 80
Manton	CAL FIRE	42.10	65-70
Hat Creek FD	Hat Creek	76.86	100- 120

Figure 8 is a map highlighting the location of response stations listed in Table 3.

Figure 8. Location of Response Stations Adjacent to the Proposed Project Site



LANDFIRE MODEL INPUTS

Wildfire behavior modeling programs run on user-specified information inputs. Industry-standard fire behavior models utilize a pre-determined set of inputs and it is up to the user to provide the full set. The input information types, and their sources, used in this analysis are described in the following sections.

Climatological Influences

A variety of climatological factors need to be considered when modeling fire behavior. These factors include, but are not limited to, wind direction and speed, atmospheric temperature and relative humidity.

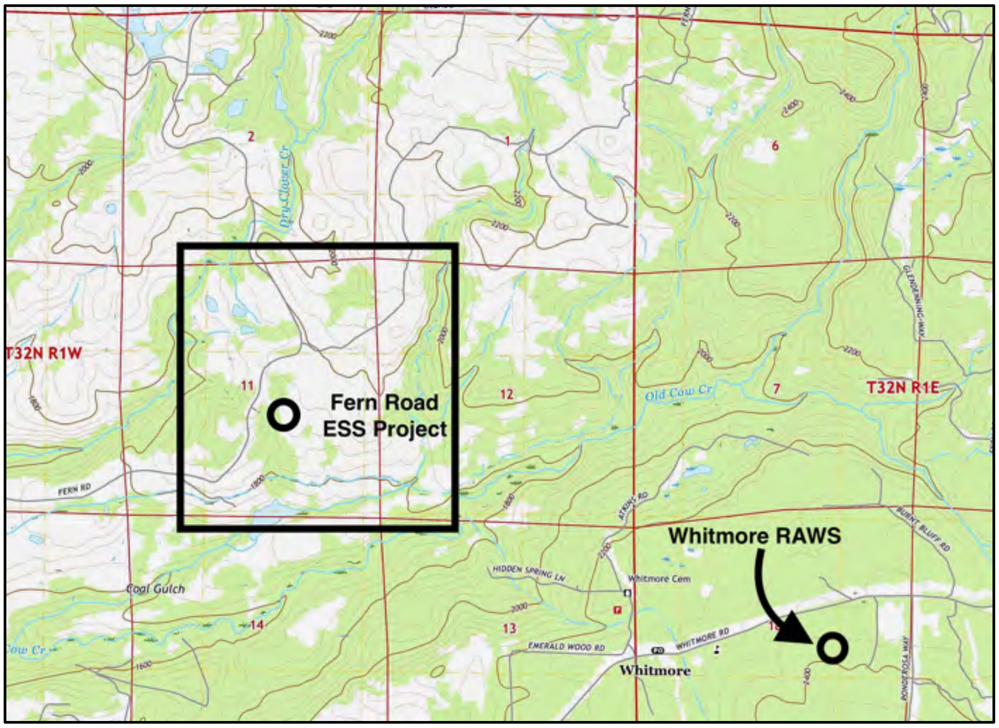
Climatological Influence – Wind

The Whitmore RAWS [WITC1] meteorological station was chosen as the primary source of atmospheric condition data due to the fact that it offered:

- Access to the full complement weather-related data used as inputs in the modelling process;
- All of the other stations' locations were at a distance that reduced their ability to represent conditions at the project site.

The Whitmore RAWS station is located approximately 1.5 miles to the southeast, near the community identified as "Whitmore" as shown in Figure 9, an enlargement of a portion of the USGS 7.5-minute Whitmore topographic map.

Figure 9. Location of the Whitmore Remote Access Weather Station



The Whitmore RAWS is located approximately 0.82 miles due east of the town center and at an elevation of approximately of 2,420 feet AMSL. With the 500-foot difference in elevation between the PPS and the RAWS station there is no intervening terrain that could lead to a disruption of regional weather influences. The weather-related data from this station was selected for use in the ITFDSS modelng because this combination of physical closeness and lack of intervening topographic features was not a characteristic of any of the other weather stations in the vicinity.

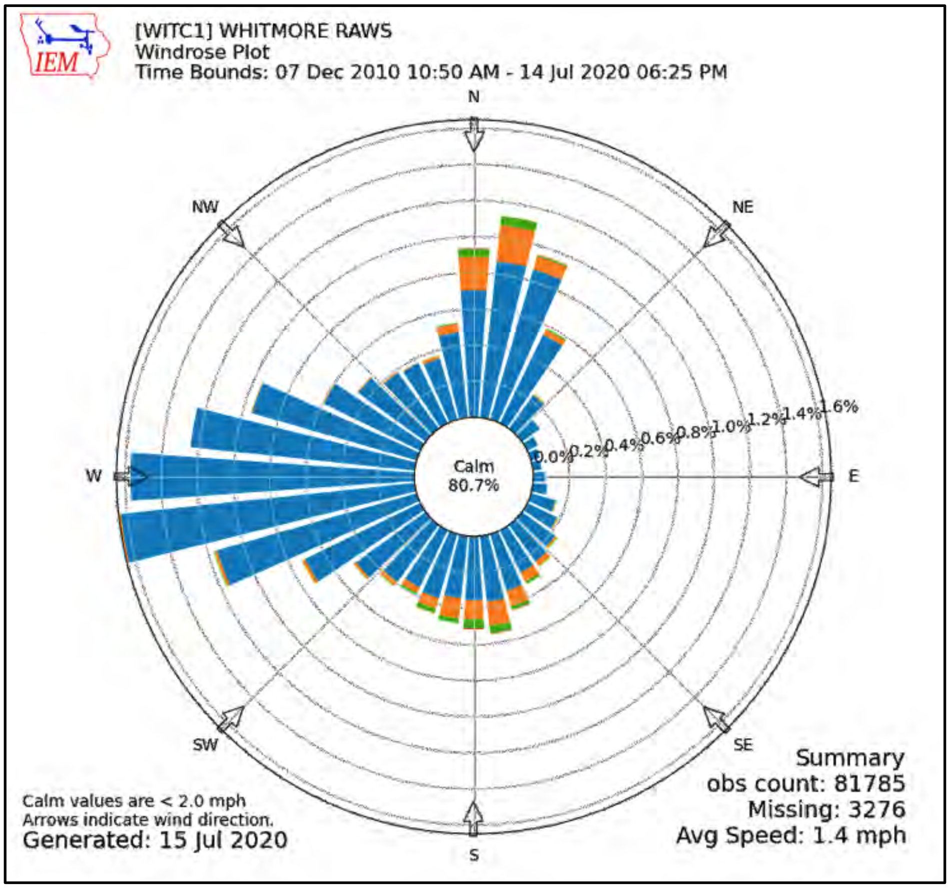
Wind Roses

Wind Rose data was available as part of the Whitmore RAWS database. Wind Roses show wind directs and velocities for defined time periods, The Whitmore RAWS Wind Roses database provides:

- A Wind Rose that is an aggregation of daily averaging of the wind components for a period starting on December 7. 2010 and ending on July 30, 2021, and,
- On an annual basis, a monthly-applicable Wind Rose.

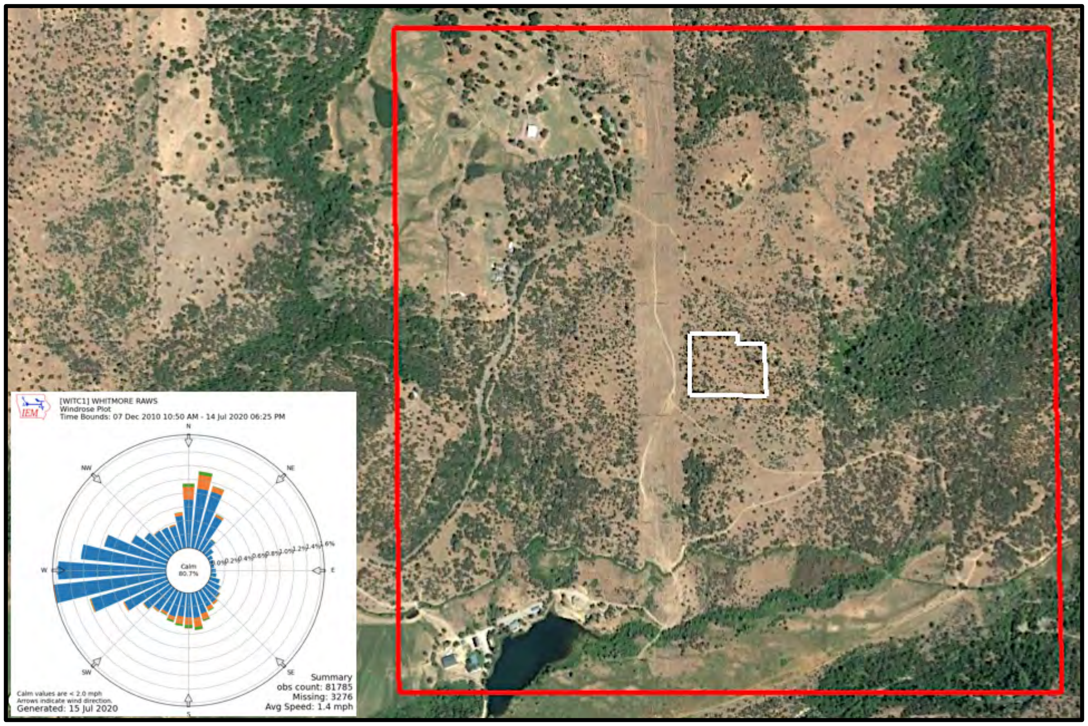
The aggregated Wind Roses (shown in Figure 10 below and the inset in the following Figure 10) shows clearly two lobes that can be interpreted to indicate prevailing winds.

Figure 10. Wind Roses Data for the Whitmore Remote Access Weather Station



The aggregated Wind Rose data shows a primary lobe of winds originating from west of the study area and a secondary lobe from the north-northeast. It is notable that the western-originated winds are more constant at a lower rate of speed (2-5 mph) whereas, the winds from the north-northeast attain a wider range of speed variability (2-10 mph). The shifting pattern of prevailing winds seasonally is very informative for this station. From October through February (generally considered the "non-fire" season) the monthly Wind Roses (for the 10 ½-year data collection period) showed the north-northeast originated winds to be prevailing. However, in the March-to-September period (generally considered to be the "fire season") the prevailing winds shift completely to a western origination. The aggregated Wind Rose chart, and those for individual months is presented in Appendix C to this report. A visual presentation of the location of the proposed project area (white outline), the full study area (red outline), and the Wind Rose inset, is shown in Figure 11.

Figure 11. Wind Roses Data and Full Study Area



Climatological Influence – General Fire Weather

The Whitmore RAWS was used to create the fire behavior analysis. Weather data from 2000 through 2020 during the months of May through October was analyzed to create the inputs of fuel moisture to run the fire behavior models. The IFTDSS program chose Whitmore RAWS for its weather analysis for the 97th percentile weather which is a worst-case weather:

- 1 Hour Fuel Moisture was 2%,
- 10 Hour was 3%
- 100 Hour was 5%
- Live herbaceous 30%
- Live woody was 60%
- The wind specifications utilized were: 9 mph at 20 feet about the ground and from bearings ranging between 259° and 270°.

These weather conditions could be experienced in late summer early fall periods on typical warm dry days. The Whitmore RAWS data was further analyzed to support the IFTDSS program through Fire Family Plus. FireFamily+ (FF+) is a software package used to calculate fuel moistures and indices from the US National Fire Danger Rating System (NFDRS) using daily fire weather observations primarily from the Whitmore RAWS.

FIRE BEHAVIOR MODELING

The intent of the fire behavior assessment is for the development of a risk assessment that will allow the client to evaluate the need for treatments that will reduce the impacts of a wildfire on the Fern Road Power station.

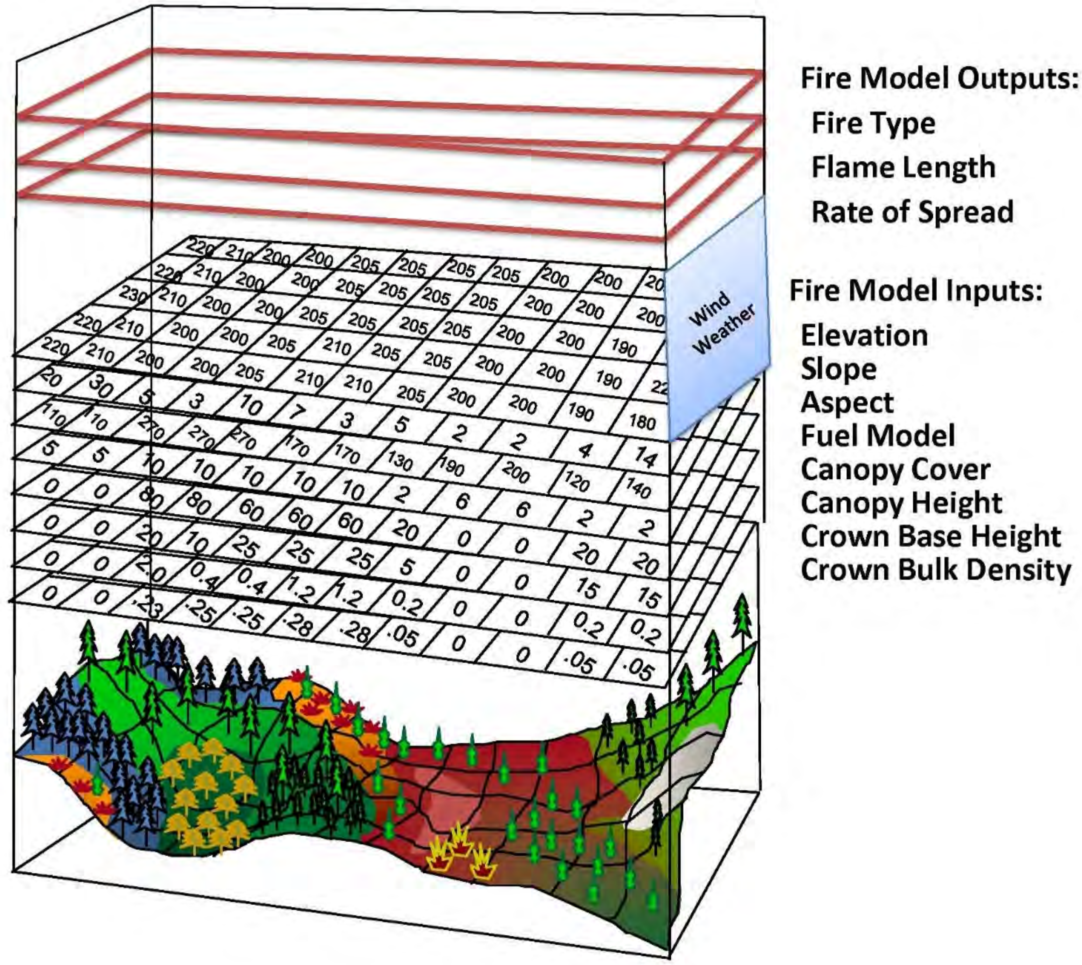
Fire Behavior Model Used for this Analysis

The modeling approach used for this WHR assessment is comprised of the following elements:

- A defined area on the ground;
- Model inputs comprised of a defined number of layers of specific information types (also referred to as attributes) that are geo-referenced to the defined area, and;
- Reporting formats.

Figure 12 graphically depicts the architecture of the fire behavior model, LANDFIRE Version 2014, employed in this assessment. The bottom layer represent the defined area of the landscape (also referred to as the FARSITE landscape). This layer is comprised of a grid of pixels (the black-lined checkerboard). These pixels, measuring approximately 98 feet on a side (approximately ¼ of an acre), represent the minimum mapping area (MMA) for which a single averaged attribute is generated. The full FSA was comprised of a little over 2,900 individual pixels. Along the right side of the figure are the information types used as inputs and the model outputs. The inputs are divided into those that are inputted for each of the individual pixels (elevation, slope, aspect, etc.) and those that are held constant for the entire grid (wind and other fire-related weather parameters). The surface fuel data and mapping done for this document used spatial input data that was randomly ground verified. This allows decision makers to have the best information possible on potential fire behavior and expected losses in the analysis area.

Figure 12. Diagram of Model Inputs and Outputs



Interagency Fuels Treatment Decision Support System

The Interagency Fuels Treatment Decision Support System (IFTDSS) is a web-based application designed to make fuels treatment planning and analysis more efficient and effective. IFTDSS provides access to data and models through one simple user interface. It is available to all interested users, regardless of agency or organizational affiliation.

IFTDSS is designed to address the planning needs of users with a variety of skills, backgrounds, and needs. A simple and intuitive interface provides the ability to model fire behavior across an area of interest under a variety of weather conditions and easily generate downloadable maps, graphs, and tables of model results. Additionally, the application provides a step-by-step process for testing a variety of fuels treatment impacts (e.g., thin, clear cut, prescribed burn) on fire behavior and comparing results to determine which modeled treatment best achieves desired results in terms of reduced fire behavior potential. It can be used at a variety of scales from local to landscape level.[16]

[16] The following web pages can provide a user the intent and history of the program:

This program uses LANDFIRE as its basic modeling program[17] with numerous enhancements. LANDFIRE is a fire behavior mapping and analysis program that computes potential fire behavior characteristics (e.g., spread rate, flame length, fireline intensity, etc.) over an entire FARSITE landscape while holding weather and fuel moisture conditions constant.

- LANDFIRE software creates raster maps of potential fire behavior characteristics (spread rate, flame length, crown fire activity, etc.) and environmental conditions (dead fuel moistures, mid-flame wind speeds, and solar irradiance) over an entire FARSITE landscape. These raster maps can be viewed in LANDFIRE or exported for use in a GIS, image, or word processor.
- LANDFIRE is not a replacement for FARSITE or a complete fire growth simulation model. There is no temporal component in LANDFIRE. It uses spatial information on topography and fuels to calculate fire behavior characteristics at one instant.
- It uses the same spatial and tabular data as FARSITE:
  - Landscape (.LCP) File,
  - Initial Fuel Moistures (.FMS) File,
  - optional Custom Fuel Model (.FMD),
  - optional Conversion (.CNV),
  - optional Weather (.WTR), and
  - optional Wind (.WND) Files.
- It incorporates the following fire behavior models:
  - Rothermel's 1972 surface fire model,
  - Van Wagner's 1977 crown fire initiation model,
  - Rothermel's 1991 crown fire spread model, and
  - Nelson's 2000 dead fuel moisture model.
- LANDFIRE runs under Microsoft Windows operating systems (Windows 95, 98, me, NT, 2000, and XP) and features a graphical user interface.
- Users may need the support of a geographic information system (GIS) analyst to use LANDFIRE because it requires spatial coincident landscape raster information to run.

LANDFIRE is widely used by the USDI National Park Service, USDA Forest Service, and other federal and state land management agencies in support of fire management activities. It is designed for users familiar with fuels, weather, topography, wildfire situations, and the associated terminology. Because of its complexity, only users with the proper fire behavior training and experience should use LANDFIRE where the outputs are to be utilized for making fire and land management decisions.

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https://iftdss.firenet.gov/landing_page/about.html https://iftdss.firenet.gov/landing_page/history.html

[17] USDA/USDI. July, 2021.

Fire Behavior Outputs

A number of fire behavior outputs are generated by LANDFIRE.

Wildland Fire Behavior

The wildland fire behavior analysis developed for the Fern Road Power Station was designed to meet the following objective: To examine the existing fire hazard and potential losses in the event of a wildfire. Landfire data[18] was used to provide the spatial data for the modeling. Which includes elevation, slope, aspect, fuel model, canopy cover height, crown base height and crown bulk density.

Three important fire behavior outputs are derived from LANDFIRE and were used in designing the resistance to control maps and tables for the analysis:

- **Flame Length** - used to determine suppression tactics based on how close you can get to the fire;
- **Fire Type -** based on the flame length and availability of ladder fuels, the fire can be a surface, torching, or actively crowning wildfire, and;
- **Rate of Spread -** The speed at which the fire front advances, generally calculated for surface fires.

Flame Length

Flame length is a good visual indicator of fire behavior and is easier to interpret what suppression action can be implemented. Table 4 summarizes flame length interpretations.

Table 4. Flame Length Interpretations

Flame Length	Fire Suppression Technique	Interpretation
Less Than 4 feet		• Fire can generally be attacked at the head or flanks by persons with hand tools and or engines • Handlines should hold the fire
4 to 8 feet		• Fire is too intense for direct attack on the head by persons using hand tools • Handlines cannot be relied on to hold the fire • Equipment such as dozers, fire engines, and retardant aircraft can be effective
8 to 11 feet		• Fire may present serious control problems --torching out, crowning, and spotting • Control efforts at the fire head will probably be ineffective
Over 11 feet		• Crowning spotting and major fire runs are probable • Control efforts at the head of the fire are ineffective

[18] 2014 version.

Figure 14 is a photo of how flame length is visually interpreted.

Figure 13. Flame Length

Fire Type
Fire type, also referred to as crown fire activity is an important output from LANDFIRE. It considers multiple factors to determine if the fire is confined to the surface, passively crowning (torching), or actively crowning in any particular pixel comprising the fuels grid.

- **Fire Type 1** is a surface fire; the fire is generally on the ground and has a high likelihood of initial attack success.
- **Fire Type 2** is a passive crown fire, (torching and short-range spotting).
- **Fire Type 3** is an active crown fire, (fire actively moving in the crowns of trees with mid to long range spotting).

Rate of Spread
This is a measure of how fast a fire front moves across a landscape. It is typically measured in feet, meters or chains (a land surveyors measure equal to 66 feet). There are two primary mechanisms involved: Direct fuel continuity and spotting. Fire advance where there is some level of fuel continuity involves the presence of the conditions used as inputs to the model. Fire front advance through spotting is most directly influenced by: 1) wind speed, 2) a source capable of producing sufficiently viable embers, and 3) fuel ignitability conditions at the landing point of embers. This model analysis addresses horizontal rates of spread for surface fires.

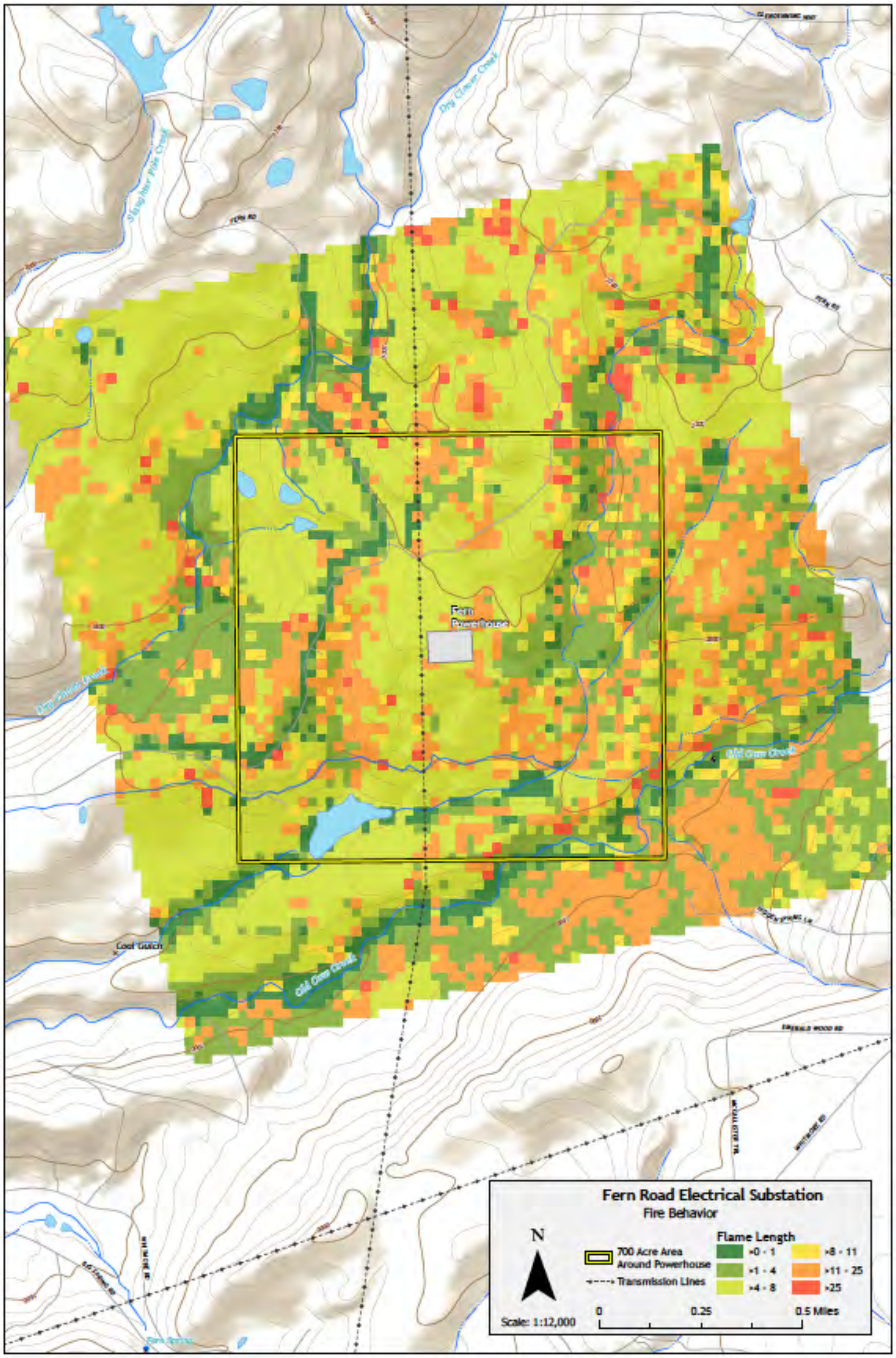
Map Products

The LANDFIRE program generates color-coded maps for each of the three core fire behavior characteristics: Flame length, fire type, and rates of spread. These maps are presented in Figures 13, 14 and 15.

Flame Length

The flame length map shown in Figure 13 indicates that lands within 1,000 feet on the northern, western, and southern flanks of the PPS are characterized by flame lengths in a 4'- 8' range. On the eastern flank the predominant lengths are in the 1'- 4' range with some isolated pixels in the 11'- 25' range. Once again, this model generated flame lengths for surface fuel-driven fires and did not include consideration of fires in formations wth vertical structures.

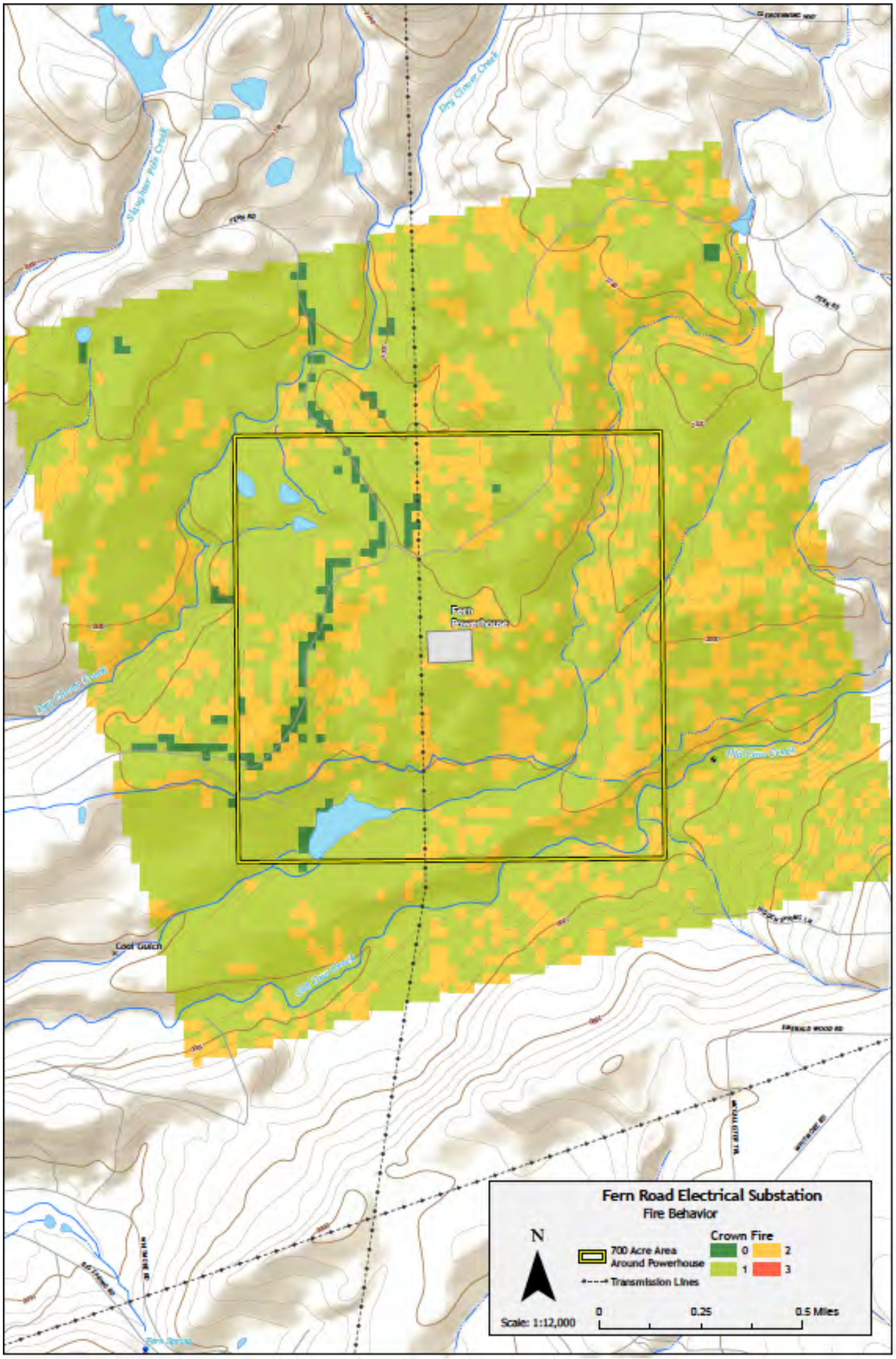
Figure 13. Flame Length



Fire Type

As shown in Figure 14 the entire FSA was determined to be Fire Types 1 and 2. Again, lands within 1,000 feet on the northern, western, and southern flanks of the PPS are fully dominated by Fire Type 1 conditions and on the eastern flank some pixel groups with a Type 2 designation.

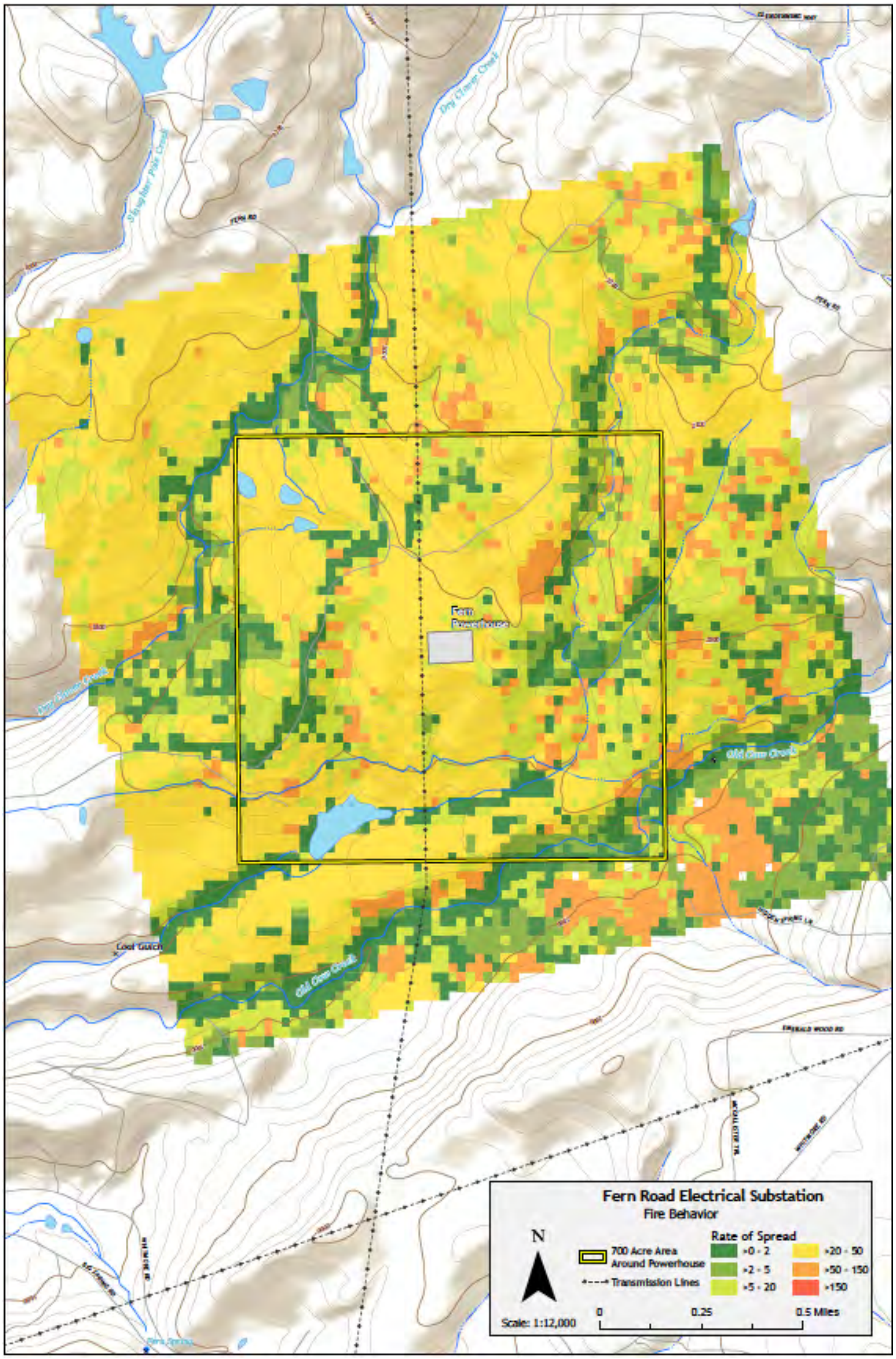
Figure 14. Crown Fire



Rate of Spread

As shown in Figure 15 the rates of spread in the vicinity of the PPS are in a 20 – 50 chain/hour range, typical for grass dominated formations.

Figure 15. Rate of Spread



The complete set of fire behavior component reports, including the maps and summary information, can be found in Appendix D.

PROJECT RESULTS, CONCLUSIONS AND RECOMMENDATIONS

Results: CPUC/PEA Information Requirements

Following are summaries of the results for the five CPUC/PEA task areas included in the scope of work for this project. The following five sections are summaries and where greater detail is provided in other areas of this report they are referenced.

Requirement 1: Fuel modeling using Scott Burgan fuel models, or other model of similar quality.

LANDFIRE Fuel Model Results

A summary of the results of the IFTDSS fire behavior modeling results that were pertinent to both assessing the risk, and identifying mitigative management, is presented in the nine following Tables 5 through 13 and subsequent discussions. The tables present the raw acreages for each of the derived fire behavior-related classifications and then the percentage of the FSA it occupies.

Table 5 shows the areas of the of the Scott/Bergan fuel model types that were entered into the modeling process from the existing IFTDSS LANDFIRE database. A majority of the pixels for the FSA extracted from the database, exactly 80%, were from three fuel models:

- GS2 – Moderate Load, Dry Climate Grass-Shrub;
- SH5 – High Load, Dry Climate Shrub, and;
- SH7 – Very High Load, Dry Climate Shrub

Notable was the very low percentage of acreage (less than a tenth of a percent) occupied by a grass/forb formation

Through direct experience with ground conditions in this portion of the Sierra Nevada foothills these high percentages of the three types indicated, along with the extremely low presence of a grass/forb formation, raised questions within the assessment team as to the adequacy of representation of true existing ground conditions. As described in the "Botanical Setting" section of this report (starting on Page 9) a supplemental analysis was conducted regarding the vegetation and land-use types present and the compatibility of the results from the two analyses are discussed in a following section in this report.

Table 5. Scott/Bergan Fuel Models Identified in IFTDSS Fire Behavior Analysis

Area Covered	Scott/Bergan Fuel Models[19]									
	NB1	NB9	GR1	GS1	GS2	SH5	SH7	TL2	TL3	TL6
Acres	19	10	5	3	190	277	101	6	51	41
%	2.7	1.4	0.07	0.04	26.8	39.0	14.2	0.08	7.2	5.8

[19] Scott/Bergan. 2005 citation

Table 6 presents the results for the number of acres (and full area percentages) characterized by ground conditions influencing flame length. Again the high percentage of relatively high flame lengths is usually indicative of lands with heavier volumes of medium-sized materials which is consistent with the presence of SH5 and SH7 fuels models but not with area dominated by grass or low brush formations.

Table 6. Summary of Flame Length Classes Identified in IFTDSS Fire Behavior Analysis

Area Covered	Flame Length Class					
	< 1'	1' – 4'	4' – 8'	8' – 11'	11' – 25'	> 25'
Acres	57	71	170	17	355	21
%	8.0	10.0	24.0	1.0	50.0	3.0

In this situation (Table 7) canopy cover is referring to the leafy portions of tree species. The acre-dominated percentage is not unusual for the mix of formations typically found at locations in the foothills of the westside of the southern Cascade mountain range.

Table 7. Summary of Canopy Cover Percentage Classes in IFTDSS Fire Behavior Analysis

Area Covered	Canopy Cover Percentage Class						
	0	10 - 20	20 - 30	30 - 40	40 - 50	50 - 60	60 - 70
Acres	297	19	170	165	23	35	1
%	42.0	3.0	24.0	23.0	3.0	5.0	0.0

Stand height is generally a measure of the height of a formation dominated by tree species and is most important in assessing risk posed by a vertical fuel column. Once again, the acre-dominated percentage, as shown in Table 8, is not unusual for the mix of formations typically found at locations in the foothills of the westside of the southern Cascade mountain range.

Table 8. Summary of Stand Height Classes Identified in IFTDSS Fire Behavior Analysis

Area Covered	Stand Height Class (meters/feet)			
	0/0	5-12.5/16-41	12.5-27.5/41-89	27.5-50/89-162
Acres	297	69	243	101
%	42.0	10.0	34.0	14.0

As with total stand height canopy base height is, again, most important when vertical fuel columns have developed. As shown in Table 9, the 91% occurrence in classes from 0 to 3 feet is generally well representative of a landscape dominated by grass, low shrub, and oak stands comprised of the species typically found at these locations.

Table 9. Summary of Canopy Base Height Classes in IFTDSS Fire Behavior Analysis

	Canopy Base Height (meters/feet)

Area Covered	0/0	0-0.5/0-2	0.5-1/2-3	1-1.5/2-5	1.5-4/5-13	4-10/13-33
Acres	297	80	267	1	1	63
%	42.0	11.0	38.0	0.0	0.0	9.0

The results presented in Figure 10 well represents the "elongated table top" topographic situation that characterizes the project's setting. Furthermore, a high percentage of the 93% of lesser slopes (0% to 15%) is shown to the west of the project site; the direction from which prevailing winds originate.

Table 10. Summary of Slope Percentage Classes in IFTDSS Fire Behavior Analysis

Area Covered	Slope Percentage Class						
	0	0 - 5	5 - 10	10 - 15	15 - 20	20 - 25	25 - 30
Acres	3	287	263	111	29	14	3
%	0.0	40.0	37.0	16.0	4.0	2.0	0.0

Rate of spread is one of the most important fire behaviors contributing to level of risk. The results of the model, summarized in Table 11, show a significant majority of the pixels comprising the FSA are in high spread rate classes. This result indicates a clear dominance of the project's setting by formations that are characterized by small diameter "flashy" fuels. These formation have fuels that ignite easily, are consumed very quickly, have lower fire intensities, and are more easily brought under control.

Table 11. Summary of Spread Rate Classes in IFTDSS Fire Behavior Analysis

Area Covered	Spread Rate Class (feet/hour)				
	NB & 0-132	132 - 330	330 - 1320	1320 - 3300	3300 - 9990
Acres	111	16	168	291	124
%	15.0	2.0	24.0	41.0	17.0

It is generally a standard "rule of thumb" that lands occupied by fuels that are small in size and low in volume are easy to ignite but have fires that burn with lower intensities. Whereas, lands where fuels are in larger diameter classes and with higher volumes the results include a relatively high resistance to ignition, but if ignited, will burn intensely with longer durations. In this project's setting it is unusual that 53% of the lands are characterized by the high intensities shown in the results summarized in Table 12.

Table 12. Summary of Fire Intensity Classes in IFTDSS Fire Behavior Analysis

Area Covered	Intensity Class (Btu/ft-sec)				
	NB & 0-5	5 – 100	100 - 500	500 - 1000	1000 - 6175
Acres	30	67	68	85	289
%	4.0	8.0	10.0	12.0	41.0

Fire that burns in the crown portions of trees can be one of the most dangerous types of fire due to its resistance to control. In non-burnable situations (pavement, bare ground, water surfaces, etc.), where there is no tree overstory, or where there is a lack of vertical fuel continuity linking the surface to the crown area, fire advances as a "Surface" type.

In situations where surface fire intensity is sufficient to ignite tree crowns, individually or in groups, but winds are not sufficient to support propagation from tree to tree this situation is referred to as having a "Passive Crown Fire" potential. Lastly, where surface and crown fire energy are linked andsurface intensity is sufficient to ignite tree crowns, and fire spread and intensity in the tree crowns encourages surface fire spread and intensity, this situation is referred to as having an "Active Crown Fire" potential.

The results shown in Table 13 are indicative of a landscape system dominated by vegetation formations with either a lack of crown presence or significant vertical separation of the surface fuels from the crown fuels. It is notable that the model, given the set of input parametes, yielded no indication of the potential for Active Crown Fire activity.

Table 13. Summary of Crown Fire Classes in IFTDSS Fire Behavior Analysis

Area Covered	Crown Fire Activity Class			
	Non-Burn	Surface	Passive	Active
Acres	30	388	291	0
%	4.0	55.0	41.0	0.0

Comparison of the LANDFIRE Model and Image Interpretation Process Results

Comparative results regarding the surface area covered by related fuel model types from each of the two analysis approaches (interpretation of Google Earth satellite imagery and the LANDFIRE analysis model) are presented in Table 14. The individual types identified in each of the approaches, Vegetation/Land Use from the satellite interpretation process and the standard Scott/Bergan fuel models from the LANDFIRE approach, were placed into three groups. The groups were comprised of fuel model types with significant similarities of wildfire behavior. For example, the low to low-moderate risk level associated with the four standard Scott/Bergan fuel models in the first grouping (NB1, NB9, GR1, and GS1) most closely matched up with the four satellite-identified V/LU types. On the other hand the three standard fuel model types associated with higher levels of wildfire damage risk (TL2, TL3, and TL6) matched up with the more heavily wooded types (the blue oak (Qudu) and mixed hardwood formations).

Table 14. Comparison of Surface Areas Occupied by Cross-Walked Fuel Models

GE Satellite Image	Surface Coverage %	Surface Coverage %	LANDFIRE Model
Gr/Ag	36.7	4.2	NB1
Qudu<10% TCC			NB9
OpenWater			GR1
Comm/Res			GS1
Gr/Br/Tr	3.8	80.0	GS2
			SH5
			SH7
Qudu 10%-30% TCC	59.4	13.1	TL2
Qudu 10%-50% TCC			TL3
Qudu 30%-50% TCC			TL6
Qudu >50% TCC			
MHdW/C >50% TCC			
Total	99.9	97.3	Total

The disparities in surface coverage results is notable in all three groupings and raises questions about the sensitivity of the approaches. The answer may lie in two primary differences in the approaches:

- the minimum mapping area specifications, and,
- the concept of convergence of evidence.

As previously discussed the LANDFIRE approach has a minimum mapping area of a little less than ¼ acre (9,332 square feet). In contrast the interpretable minimum mapping area for the satellite imagery available on the Google Earth platform is on the order of 10 square feet. The result is that, given an experienced interpreter, the satellite image interpretation offers the ability to make much finer distinctions in ground conditions. The concept of convergence of evidence involves the use of a broader context of information from surroundings to increase point-specific interpretation accuracy; it is a highly integrative process. This is a basic characteristic of synoptic imagery (such as the Google Earth satellite images); supplying a significant volume of information about surrounding conditions to increase point-specific identification accuracy. The model-driven pixel-based identification procedures offer an insignificant opportunity for integrated indentification. There are "smoothing" or "nearest neighbor" operations that can integrate results from adjacent pixels (generally only from the surrounding eight pixels) but again the information is aleady a smoothed product due to the large minimum mapping area.

Again, determination of the robustness of the results from either one of the analysis procedures is severely constrained by the inability to conduct field verifications.

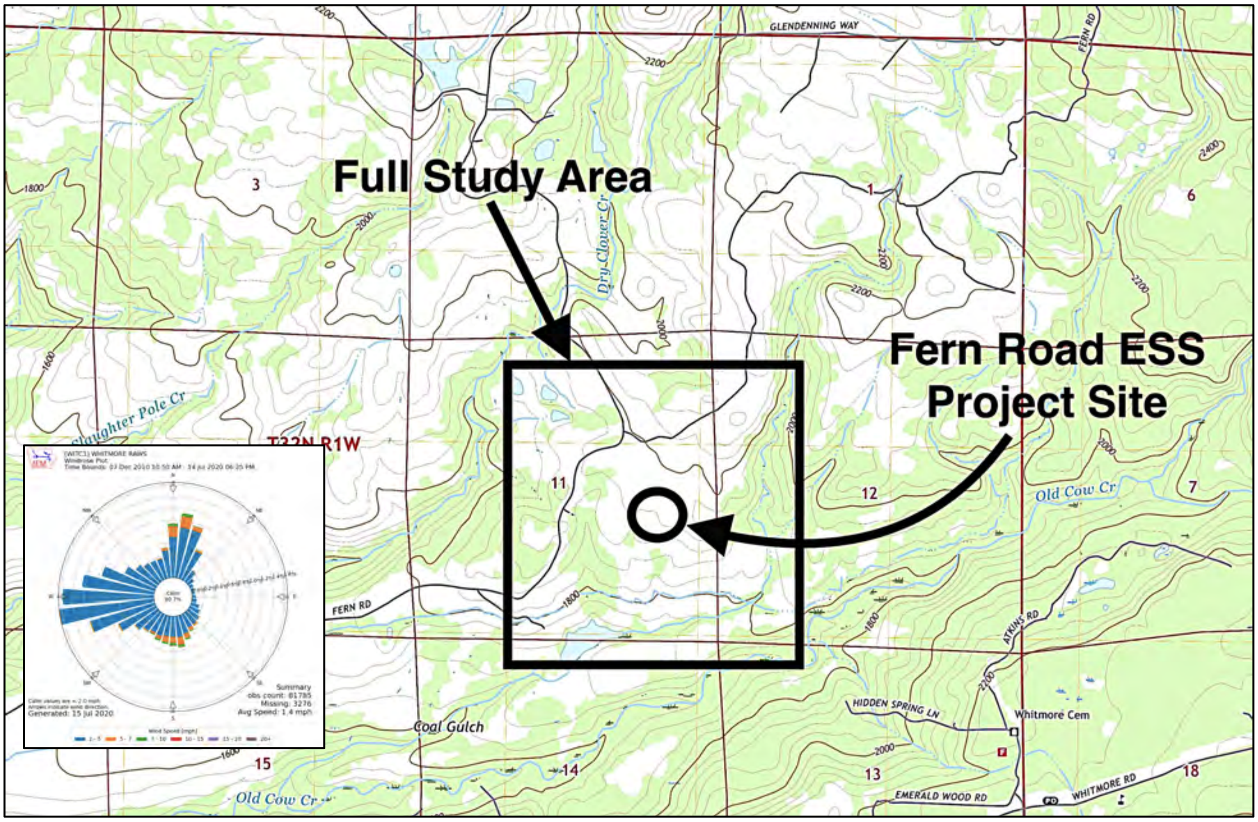
<u>Requirement 2</u>: Values of wind direction and speed, relative humidity, and temperature for representative weather stations along the project alignment for the previous 10 years, gathered hourly.

A single weather station with a reasonably close relationship with the project site is the Whitmore RAMS site. Figure 11 shows the wind orientation and speed in relation to the site and surrounding conditions shown on the satellite imagery, acquired on April 28, 2021 and available through the Google Earth platform. A monthly breakdown for the Whitmore RAWS wind rose data is shown in Appendix C. Hourly data was not acquired as it was available only with special permission and the process needed to gain access exceeded the project's time horizon. Relative humidity and ambient temperature data were not required as inputs into the LANDFIRE modeling process and was not acquired.

<u>Requirement 3</u>: Digital elevation models for the topography in the project region showing the relationship between terrain and wind patterns, as well as localized topography to show the effects of terrain on wind flow, and on a more local area to show effect of slope on fire spread.

A standard digital terrain model was used as input for the IFTDSS LANDFIRE fire behavior modeling process. Figure 16. Shows the same Wind Rose information within the context of the topographic base and in relation to the elements of the project site.

Figure 16. Wind Rose Information from the Whitmore RAMS Within the Topographic Situation



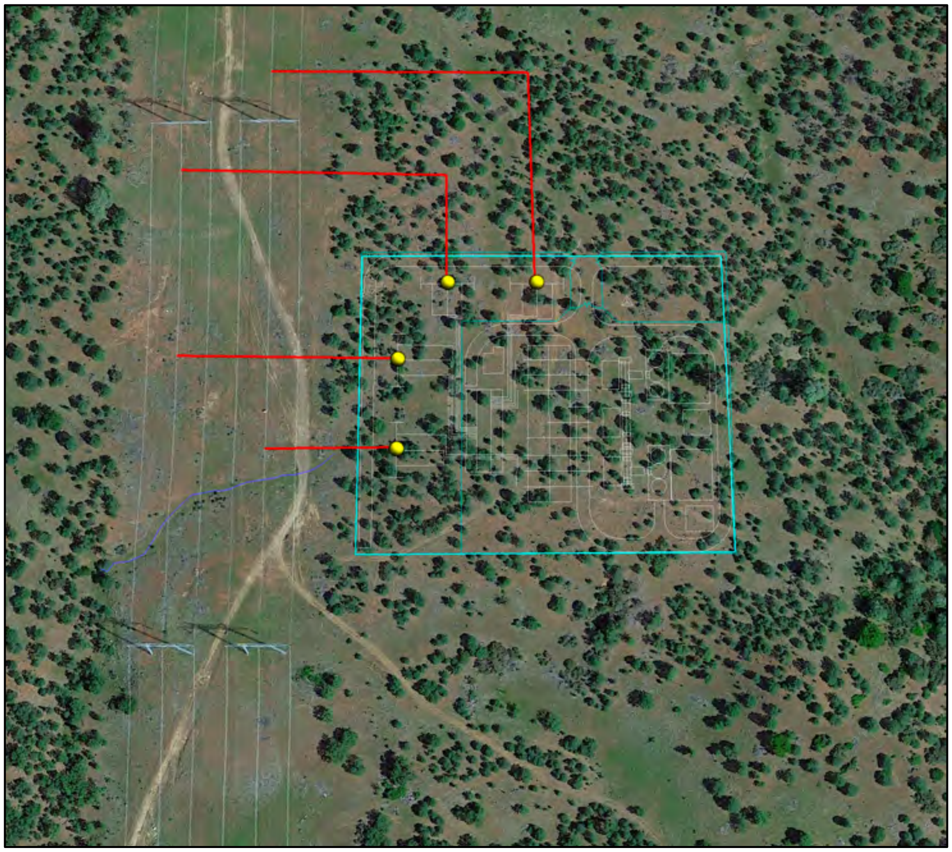
Requirement 4: Describe vegetation-related fuels within the project vicinity and provide the locational data in an appropriate geo-referenced map format for the project vicinity. USDA Fire Effects Information System or similar data source should be consulted to determine high-risk vegetation types.

The procedures and deliverables are described and presented in full detail in the "Botanical Setting" section starting on Page 8 of this report.

Requirement 5: Include new electrical lines in modeling.

A set of 500 kV transmission lines will be required to route the power to, and from the proposed Fern Road Substation. The location of these lines are shown n Figure 17.

Figure 17. Location of additional 500 kV tie in lines.



All four sets of tie-in lines (locations indicated by the solid red lines) will pass over blue oak woodlands with tree canopy closures in a range between 10% and 50% (See Table 2, Page11 of this report). The critical fire behavoir that must be considered is that this vegetation type could generate flame lengths from 8' to 11' (possibly up to 15' considering the non-luminous highest temperature point at the upper tip of the flame) with temperatures reaching 1,880°F. Given the average total crown height of 35' this could generate significant heating up to a height of 50'.

Assessment of Wildfire Risk

Evaluation of the LANDFIRE fire behavior model results showed:

- A higher percentage of the FSA is occupied by fuel model types that would result in moderate to moderately high levels of risk for damage from wildfire;
- The fuel models that would have a greater contribution to elevated risk lie to the east of the project, are up-slope, and downwind of prevailing winds.

Evaluation of the full results from the fire behavior model indicate that:

- Risk level to the project site would be in the low to moderate classes, and,
- Risk levels, should there be an on-site ignition with uncontrolled spread, to lands to the east of the project site would be in moderate or moderately-high classes.

A more general assessment of wildfire hazard risk level was competed that used the results of the fire behavior modeling as a principal input. Additional inputs in the analysis considered included the regional topography, prevailing winds, potential sources of wildfire ignition, and emergency response specifications. For the purposes of this more generalized analysis the mapped vegetation/land use types (V/LU) (See Table 2 and Figure 6) were placed into three categories related to their contribution toward elevating the wildfire-related risk: Greater, moderate, and low.

The V/LUs that were considered to have a greater contribution to high risk levels (primarily due their respective behaviors over the terrain being crossed) included:

- MHdW/C >50% TCC;
- Qudu 30%-50% TCC, and;
- Qudu >50% TCC.

Those that contributed more moderate influences included:

- Qudu <10% TCC;
- Qudu 10%-30% TCC;
- Qudu 10%-50% TCC, and;
- Gr/Br/Tr

Those that would result in a low level of contribution (or none at all) included:

- Gr/AG;
- Qudu <10% TCC;
- Open Water, and;
- Comm/Res.

The analysis examined the risk situation from two different standponts: 1) conditions that posed a risk to the ESS facility, and 2) setting elements that would be at risk should a fire ignite within the PPS and move onto adjacent lands.

<u>Risks to the Proposed Project Site</u>

Six aspects were considered when assessing the potential wildfire hazard risk posed to the PPS: 1) prevailing winds, 2) topographic influences, 3) the fire behavior of each mapped V/LU, 4) the distribution of each of the mapped V/LUs over the landscape in the vicinty of the PPS, 5) the location of potential sources of wildfire ignition, and 6) the emergency response times (especially related to the rate-of-spread specifications of each of the involved V/LU). Given the pattern of the prevailing winds and regional topographic slopes it is reasonable to expect that wildfire will approach from a location to the west. In addition the most likely sources of ignition lay to the west of the PPS and included Fern Road and several residential/agricultural facilities. Although Fern Road must be considered a potential source of wildfire ignition it is also the only approach route for ground attack emergency response. An examination of the mapped V/LUs on the portions of the full study area to the west of the ESS facility showed that:

- A total of 64.4 acres (24% of the area examined) were occupied by V/LUs in the “greater contribution” category and none of those acres were immediately adjacent to the PPS;
- A total of 55.9 acres (21% of the area examined) were occupied by V/LUs in the “moderate contribution” category and a very few (less than an acre) of those acres were immediately adjacent to the PPS, and lastly;
- A total of 148.7 acres (55% of the area examined) were occupied by V/LUs in the low category, with essentially all of the immediately adjacent lands in these categories.

The basic conclusion in this situation is that the PPS would be essentially buffered by:

- A landscape occupied by V/LUs that would generate fire behaviors that would pose no more than a low-to-moderate risk to the ESS facility, and,
- The location of Fern road would provide immediate access and a strategic point from which to implement fire control actions.

In consideration of these two conditions it was concluded that the overall risk to the PPS would be in the low-to-moderate range.

Risks Posed by an On-Site Ignition

Should a fire be ignited within the boundaries of the PPS the same influences of prevailing winds and regional topography would push the fire front to the east and northeast. In this case an examination of the mapped V/LUs on the portions of the FSA to the east of the PPS showed that:

- A total of 225.0 acres (62% of the area examined) were occupied by V/LUs in the “greater contribution” category and some of these acres were in direct contact with the perimeter of the PPS;
- A total of 39.4 acres (11% of the area examined) were occupied by V/LUs in the “moderate contribution” category and a significant number of these acres were immediately adjacent to the PPS, and lastly;
- A total of 96.6 acres (27% of the area examined) were occupied by V/LUs in the low category, with essentially none of these acres immediately adjacent to the PPS.

The basic conclusion in this situation is that the PPS has immediate adjacency to a landscape occupied by V/LUs that would generate fire behaviors that would pose a high-to-very high wildfire hazard risk to areas and resources to the east of the project site.

Recommended Wildfire Risk-Reducing Actions

Wildfire is a significant issue, and one with increasing prevalence, in Shasta County. The two principal conclusions regarding WHR risk levels were that: 1) there would be an overall low to moderate risk to the proposed PPS and 2) a moderate-to-high risk to resources to the east and northeast should an ignition associated with the station or connecting lines occur. In this situation implementing pre-incident risk reduction activities would be warranted and, if implemented, would reasonably result in reduced risk levels. In following sections six specific actions with risk-reducing effects are identified for consideration.

FR-RRA 01: Under-line Clearing and Maintenance

It is recommended that vegetation that is a component of fuels model types capable of generating flame lengths greater than 12 feet be removed from the surface of the corridor containing the full set of transmission lines. This would include all woody vegetation types whose maximum average canopy height exceeds 6 feet. If PG&E standards for under-line clearing and maintenance are implemented the present conditions on the site would not be an issue.

FR-RRA 02: Livestock Grazing

It has been determined that within the FSA and the PPS, due to a combination of the presence of more flammable vegetation formations (primarily those with significant grass components) and land uses that could cause fire ignition, risk of ignition is high. The primary action that would mitigate this risk is removal of the flammable fuels. One approach is provided by the use of livestock grazing. It is recommended that grazing programs be designed (timing and location) and implemented (or current levels of grazing pressure be augmented) so as to remove grass and forb vegetation immediately adjacent to the PPS prior to the commencement of fire season.

FR-RRA 03: Perimeter Fencing

It is recommended that the perimeter of the facility be enclosed with non-flammable materials. There would be two principal purpose to this action:

- Shield on-site elemnts of the facility from radiant heating damage from approaching fires, and,
- Contain any on-site ignitions from escaping into surrounding areas.

FR-RRA 04: On-Site Emergency Water Storage and Delivery System

Primarily as a result of the isolation and correspondingly high emergency response times consideration should be given to developing on-site water storage capabilities. It is specifically recommended that design of the facility include emergency water storage. The recommended system design would include an above-ground metallic tank with no less than 1,000 gallons of storage capacity.

FR-RRA 05: Construction and Materials Utilized

Again, in response to the need for resistance to fire during prolonged emergency response times, it is recommended that any facility-related constuction be designed, and constructed with materials, so that resistance to wildfire ignition and consummation be addressed.

FR-RRA 06: Access Assurance

If agreements with agencies providing emergency wildfire response regarding access through the gated entrance off of Fern Road are either not in place, or insufficient in terms of action details, it is recommended that the current status be critically evaluated and actions taken to assure access.

FR-RRA 07: Addressing WHR in a Cooperative Manner

As, in this instance, risk is a "two-way street" it is recommended that the operators of the proposed electrical sub-station open discussions with neighboring ownerships with the sole purpose of working together to reduce the WHR for all parties involved.

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APPENDIX A

Team Member Resumes

Tad Mason, Registered Professional Forester and CEO
Mr. Mason has over 41 years of experience in the fields of hazardous fuels reduction, natural resources management, bio-energy project development, and cellulosic fuels/feedstock supply chain development. He has hands-on experience in all aspects of natural resources management, from preparation of fuels reduction plans to advising decision makers on key land management/resource utilization policies.

Mr. Mason has served as the CEO of TSS Consultants since 2005, and is a Registered Professional Forester (License #2156) in the state of California (since 1987). He leads a team of professionals who are well versed in the tasks required to successfully implement landscape-scale fuels treatment projects, structural hardening assessments and analysis of external fire suppression strategies. Mr. Mason also assists clients with development and implementation of communications plans targeting stakeholders, peer groups and state/federal policymakers. Community support is an integral component of every successful natural resource management project.

Mr. Mason and TSS Consultants have managed projects throughout North America (28 states and 6 provinces) for a diverse set of clients, including private landowners, public resource management agencies, Indian Tribes, private sector enterprises, public utilities, private investment firms and community stakeholder groups.

Mr. Mason received his B.S. degree in Forestry from the University of California at Berkeley in 1979. He is an active member of the Northern California Society of American Foresters and the California Licensed Foresters Association. Mr. Mason has served on numerous committees and task forces, including the Western Governors' Association Biomass Task Force, University of California Forest Products Laboratory Advisory Board, Western Governors' Association Forest Health Advisory Committee, California Forest Products Commission Board of Directors, University of California Woody Biomass Utilization Work Group, California Oak Mortality Task Force, and the University of California Forest Biofuels Work Group.

Mr. Mason's professional and community service recognition include the California Board of Forestry Francis H. Raymond Award, William Main Distinguished Visitor Lecturer (University of California at Berkeley), Society of American Foresters Fellow Award, Northern California Society of American Foresters Forestry Achievement Award, the American Pulpwood Association Forestry Activist Award and the California Association of Resource Conservation Districts Forestry Award.

Steven J. Daus, Ph.D.

PROFESSIONAL EXPERIENCE

International Experience

After receiving his Doctorate Dr. Daus entered into international work. Between 1979 and 1998, as both a short- and long-term contractor for private companies and international agencies he participated in development and regulatory compliance projects in 12 countries throughout south-east Asia, the Indian sub-continent, and Africa. Elements common to all of these projects included, project identification and detailed scoping, regulatory compliance, project implementation assistance, and mentorship-based technology transfer. Two representative projects were:

Forestry and Land Use Mapping Project (1981 to 1988) - In the host country of the Republic of Niger, with the client being the United States Agency for International Development (USAID), Dr Daus was part of a project team (in which he functioned as the national survey team lead) that 1) conducted remote sensing aided field surveys for forestry, woodland, range, and soils resources, 2) produced county-wide resource maps, 3) identified potential projects, 4) vetted the potential projects with respect to administrative capacity to carry them out, regulatory compliance, and site suitability, and 5) provided implementation assistance.

Madagascar National Parks Expansion Project: Assessment of Institutional Capability and Environmental Compliance Requirements (1998) - In the host country of the Malagasy Republic, again with the client being the United States Agency for International Development (USAID), Dr Daus was part of a project team that evaluated previously identified national parks expansion projects, which would be funded through USAID, for, 1) the capability of the Malagasy Republic's administrations and associated organizations to carry out the proposed projects, and 2) conduct impact reports in order to assure that the environmental impact compliance requirements contained in Part 22 of the Code of Federal Regulations (CFRs) would be met.

National Experience

Fire Hazard and Fuels Reduction

Since 1990 Dr. Daus has served clients requiring the expertise of an experienced wildland fire and fuels planning and management specialist. In this time span he has provided his services to individual landowners, community groups, residential developers, federal, state, and county agencies, and non-governmental organizations. He has provided project assistance to clients that have been privately funded, California State funded, or supported through grants (various CAL FIRE programs and federal sources: USDA, FEMA, etc.). The specific services provided, along with the client(s), were as follows:

Preparing Community and Local Wildfire Protection Plans – Plans generated for the Forest Meadows residential community (Forest Meadows Owners Association, Murphys, Calaveras County) and the Big Sur community (Big Sur Land Trust/Big Sur Volunteer Fire Brigade (Big Sur, Monterey County);

Preparing grant applications for fuels modification projects – Assisted in the preparation of grant applications for the following clients:

- Forest Meadows Owners Association/Murphys Fire Protection District. Result: Funded
- South Skyline Firesafe Council. Result: Funded
- Soquel Firesafe Council/Santa Cruz County Resource Conservation District. Result: Funded
- Monterey Fire Safe Council/Big Sur Community Emergency Response Team. Result: Funded

Coordinating scope of work implementation for funded projects – Implemented stakeholder collaboration, prepared site-appropriate fuels treatment prescriptions, assisted with bidding and contracting processes, solicited landowner involvement (when called for), completed pre-operational field preparation, provided in-field oversight of operations, and prepared progress status reporting, for the following jobs and clients:

- Lake Davis Shaded Fuel Break. USDA/FS, Plumas National Forest, Beckwourth Ranger District;
- Forest Meadows Hazardous Fuels Reduction. Murphys Fire Protection District/Forest Meadows Owners Association;
- Rams Horn/Shake Ridge Fuels Reduction. Amador Fire Safe Council;
- Antelope Fuels Reduction. Amador Fire Safe Council;
- Jackson Fuels Reduction. Amador Fire Safe Council;
- Mt. Tallac Village Hazardous Fuels Reduction. South Lake Fire Department;
- Springwood Hazardous Fuels Reduction. South Lake Fire Department;
- Bijou Hazardous Fuels Reduction. South Lake Fire Department;
- Skyline Blvd (SR 35) Hazardous Fuels Reduction. South Skyline Fire Safe Council;
- Kings Creek Truck Trail Hazardous Fuels Reduction. Soquel Fire Safe Council/Santa Cruz County Resource Conservation District Provided assistance to the Diablo Fire Safe Council, with funding provided by CAL FIRE's Santa Clara Unit, regarding their identification and prioritization of projects for seeking funding. Provided a standardized approach based on a multivariable rubric.
- For the Stanford Linear Accelerator group, Palo Alto, CA, completed a hazardous fuels assessment for a high-

- tension transmission line under federal jurisdiction; in a situation that would also have State of California jurisdictional complications. Based on the results of the assessment a proposed mitigation plan, including hazardous fuels treatment prescriptions, stakeholder collaboration approaches, and scope of work for the contracting process, was prepared and delivered to the client;
- Prepared a wildfire hazard risk assessment for twelve project sites in the City of Calabasas, Los Angeles County. Identified on-project and off-site fire hazard risks, determined risk-off setting management action, and completed Section 20 of the CEQA Initial Study Checklist to assure compliance, and;
- Prepared and delivered an administrative draft report regarding wildfire risk and strategic risk reducing management optins for a reginal park in Sonoma County, California.

Regulatory Compliance

National Environmental Policy Act (NEPA) – In the mid-1990's, as a sub-contractor to Jones & Stokes Associates (JSA), of Sacramento, CA, Dr. Daus participated in the preparation of an Environmental Assessment (EA) for a project identified by the Quincy Library Group and funded under the Healthy Forest Restoration Act. Subsequently, as a direct employee and Bureau of Land Management (BLM) Program Manager at JSA, Dr. Daus participated on multi-disciplinary teams that:

- Designed and delivered to BLM Field Office planning teams a four-day course covering the preparation of Land and Resource Management Plans (LRMP) that comply with NEPA requirements, and,
- Produced several Field Office LRMPs and a Management Plan for a newly designated national monument.

California Environmental Quality Act (CEQA) – As an independent contractor, a sub-contractor to Aperio, Inc of Dorrington/San Ramon, and In five years as the Staff Forester and Project Manager for JSA, Dr. Daus has worked with project teams to prepare specific discipline sub-studies, Negative Declarations, Mitigated Negative Declarations, and Environmental Impact Reports. These documents were produced for a spectrum of project types including, 1) rural residential developments, 2) school construction (new and expansion), 3) rural water system (new and expansion), 4) rural wastewater treatment (new and expansion), and 5) rural road systems.

Oak Woodlands

Since the passage of California's Oak Woodlands Conservation Act, and a companion CEQA section, Dr. Daus has worked with private individuals, commercial interests, and county governments to produce more than 25 oak woodland impact assessments and prepare mitigation/monitoring plans in 8 California counties.

EDUCATION

Ph.D., Quantitative Analysis of Ecological Systems, University of California, Davis, 1979
M.S., Wildland Resource Science: Forestry, Range Sciences and Remote Sensing, University of California, Berkeley, 1974
B.S., Forestry and Range Sciences, University of California, Berkeley, 1972

Dr. Daus continues to keep his skills current through continuing professional education in programs offered by organizations such as the University of California Extension, California Licensed Foresters Association, American Planning Association, and the Society of American Foresters.

PROFESSIONAL REGISTRATIONS AND LICENSES

California Registered Professional Forester, No. 2524 (retired)
CAL FIRE Archaeological Survey Certificate, Nos. 152R and 153R (retired)
Society of American Foresters, Certified Forester Candidate (in process)

Professional Affiliations (Past and Present)
California Chapter of the American Planning Association
California Licensed Foresters Association
California Oak Foundation
Northern California Chapter of the Society of American Foresters

Barry Callenberger

With over 49 Years of wildfire experience, Barry has worked as a firefighter, Hotshot Crew Superintendent, district fuels officer, Type I Incident Commander and Operations Section Chief, and as deputy regional chief for the US Forest Service in California. Since 1997, Barry has worked in the private sector, consulting on numerous wildland hazard mitigation and ecological restoration projects across the western United States.

As owner and principal of WILDLAND Rx, Barry has provided wildfire expertise to a wide range of clients including the US Army, the Tahoe Regional Planning Agency, the US Forest Service, and numerous community-based firesafe councils in California and Nevada. From 1997-2004 he ran the Prescribed Fire and Fuels Management Division of North Tree Fire – a private wildland fire contracting company. In this role, he managed contracts for prescribed fire and fuels management, developed prescribed fire burn plans, provided direction on suppression approaches, conducted fuels analysis, and managed heavy equipment and burn personnel on prescribed burns and fuels projects.

Mr. Callenberger is skilled in the use of fire behavior analysis computer programs such as BEHAVE, FARSITE FLAMMAP, NEXUS, FUELS MANAGEMENT ANALYIST PLUS, FIREFAMILY Plus, NFSPUFF, SASEM, RAMS, PCHA, IIAA, and FOFEM. To see a detailed C.V. for Barry, click here:

Community Planning and Community Wildfire Protection Plans

Plumas Corporation, Plumas County Fire Safe Council

Validation of existing fuel profiles, analysis of expected fire behavior using BEHAVE and FLAMAP, identification and mapping of fuel treatment projects, and prioritization of fuels treatment projects for the county.

Community Wildfire Protection Plan for the California Portion of the Lake Tahoe Basin

Worked with Steve Holl Consulting and C.G. Celio and Sons in the development of the CWPP providing support for meetings and Fire hazard analysis, project prescription and locations

Tahoe Basin California

Developed a fuels treatment strategy for the seven fire protection districts within the Tahoe Basin. Presented the strategy to the fire districts and the community.

Hoopa Valley Tribal Forestry

Wrote a Fuels Management Plan and the necessary NEPA documentation for the Hoopa Valley Reservation which allowed them to create a funding stream for fuels treatment projects. Prioritized projects to provide wildland fire safety for resources and the community.

Amador County Fire Safe Council

Fuel reduction project layout and administration of contracts for fuels reduction. Wrote a Community Wildfire Protection Plan for town of Volcano.

El Dorado Fire Safe Council
Wrote Community Wildfire Protection Plans for Grizzly Flat, (and updated the original CWPP twice), Diamond Springs/Eldorado FPD, El Dorado County FPD, Gold Hill Estates, Georgetown FPD, Volcanoville, Royal Equestrian Estates Fire Plan. Provided support for meetings and Fire hazard analysis, project prescription and locations for the current El Dorado County CWPP.

California Department of Forestry and Fire Protection, Cameron Park Fire District
Developed risk and hazard maps for Cameron Park and modeled fire behavior for community meetings using FARSITE and FLAMMAP

Tahoe Regional Planning Authority
Combined all the Tahoe Basin Community Wildfire Protection Plans into one document.

Tulare County Community Wildfire Protection Plan
Worked with Steve Holl on the CWPP for the communities of the Tulare County foothills in the development of the CWPP providing support for meetings and Fire hazard analysis, project prescription and locations.

Yuba County Foothill Community Wildfire Protection Plan
Worked with Deer Creek Resources in the development of the CWPP providing support for meetings and Fire hazard analysis, project prescription and locations

Sierra County Community Wildfire Protection Plan
Developed the CWPP for all of the private lands in Sierra County Worked with Deer Creek Resources in the development of the CWPP providing support for meetings and Fire hazard analysis, project prescription and locations

Truckee Fire Protection District Community Wildfire Protection Plan
Created a CWPP for the Truckee Fire District with the help of Deer Creek GIS that included the communities within the Truckee Fire District. Worked with Deer Creek Resources in the development of the CWPP providing support for meetings and Fire hazard analysis, project prescription and locations

Wheeler Crest Community Wildfire Protection Plan
Worked with Deer Creek Resources on the development of the CWPP for two communities in the southern end of Mono County and provided the community with a hazard evaluation of the private parcels in the communities

Barry is one of only a few private contractors that is currently qualified by the US Forest Service as a Prescribed Fire Planner and Burn Boss I.

APPENDIX B

RESPONSE APPARATUS

Roads and response time
Emergency Response Equipment

Agency	Station	Equipment	Route	Distance (mi)	Total Distance
CAL FIRE	Wells Station #74	Engine 2485	299 to Oak Run Rd	5.51	25.50
			Oak Run Rd to Buzzards Roost	1.68	
			Buzzards Roost to Phillips Rd	3.21	
			Phillips Rd to Oak Run Rd	7.60	
			Oak Run Rd to Fern Rd	3.30	
			Fern Rd to ESS	4.20	
CAL FIRE	Hillcrest #75	Engine 2462	299 to Buzzards Roost	8.20	26.00
			Buzzards Roost to Phillips Rd	2.70	
			Phillips Rd to Oak Run Rd	7.60	
			Oak Run Rd to Fern Rd	3.30	
			Fern Rd to ESS	4.20	
CAL FIRE	Whitmore #35	Engine 2467 Engine 2476	Whitmore Rd to Fern Rd	4.79	8.89
			Fern Rd to ESS	4.10	
CAL FIRE	Shingletown	Engine 2477 Engine 2460	44 to Old 44 Rd	17.20	33.30
			Old 44 Rd to Whitmore	0.90	
			Whitmore to Fern Rd	11.10	
			Fern Rd to ESS	4.10	
CAL FIRE	Manton	No Information	A6 to Wildcat Rd	6.71	42.10
			Wildcat Rd to Black Butte	5.59	
			Black Butte to SR44	3.50	
			SR 44 to Old 44 Rd	10.20	
			Old 44 Rd to Whitmore Rd	6.90	
			Whitmore Rd to Fern Rd	11.10	
			Fern Rd to ESS	4.10	
Burney Fire Department / CALFIRE	Burney #14	Engine 2461 Engine 2483 Dozer Transport 2442	299 to Buzzards Roost	22.50	40.20
			Buzzards Roost to Phillips Rd	2.70	
			Phillips Rd to Oak Run Rd	7.60	
			Oak Run Rd to Fern Rd	3.30	
			Fern Rd to ESS	4.10	
CAL FIRE	Redding, W. Cypress Ave.		SR 44 to Old 44 Dr	12.20	27.40
			Oak Run Rd to Fern Rd	11.10	
			Fern Rd to ESS	4.10	
			Fern Rd to ESS	4.10	
			Oak Run Rd to Fern Rd	11.10	
			Fern Rd to ESS	4.10	
			Fern Rd to ESS	4.10	

Agency	Station	Equipment	Route	Distance (mi)	Total Distance
Hat Creek Fire Department	Burney	Engine 2461 Engine 2483 Dozer Transport 2442	SR 69 to SR 44	26.20	76.86
			SR 44 to Whitmore Rd	34.50	
			Whitmore Rd to Fern Rad	12.00	
			Fern Rd to ESS	4.10	
Municipal	Millville Town FD	No Information	Whitmore Rd to Fern Rd	11.20	15.30
Shasta County Fire Department	Palo Cedro Station #32	No Information	SR 44 to Old 44 Dr	4.26	19.46
			Whitmore Rd to Fern Rd	11.10	
			Fern Rd to ESS	4.10	
CAL FIRE	Benton Field Redding Station: Air Attack	Engine 2479 Engine 2487 Dozer Transport 2444 Type 2 Air Attack Program equipment	n/a	24.0 (air miles)	
USFS	Benton Field, Redding, Air Attack	USFS Air Attack Program equipment	n/a	24.0 (air miles)	

APPENDIX C

Whitmore RAWS Wind Rose Data

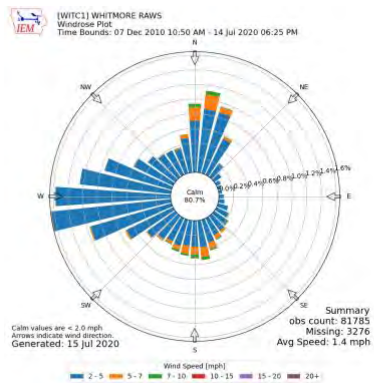
Wind Roses

Scroll down this page for monthly climatologies!

Wind roses are an information packed plot providing frequencies of wind direction and wind speed. A wind rose can quickly indicate the dominant wind directions and the direction of strongest wind speeds. The IEM has generated these wind roses based on our archive. The archive does contain errors and non representative data, so please use care when using these plots. In general, data from the airports is of good quality and representative of the local surrounding area.

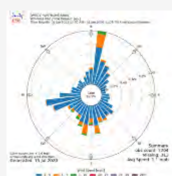
Yearly Climatology:

View raw data

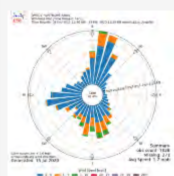


Monthly Climatology: (click thumbnail)

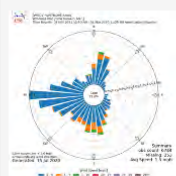
January View raw data



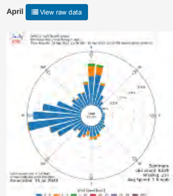
February View raw data



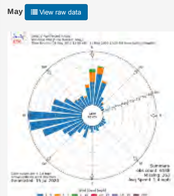
March View raw data



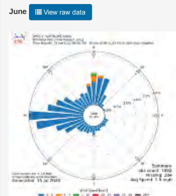
April View raw data



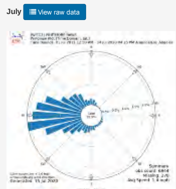
May View raw data



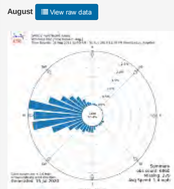
June View raw data



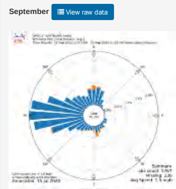
July View raw data



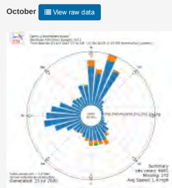
August View raw data



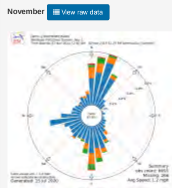
September View raw data



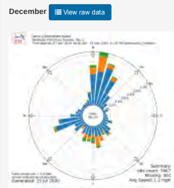
October View raw data



November View raw data



December View raw data



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APPENDIX D

IFTDSS Report

Report: Auto97th
Landfire Version: LANDFIRE 2014
Landscape Name: Fern 3 Landscape
Acres: 710

Prepared for: Barry Callenberger
8/9/2021, 11:11:09 AM

Model Parameters

Run Name: Fern 3 - Auto97th

Model Type: Landscape Fire Behavior (Basic)

Run Date: Aug 9, 2021 12:01:41 PM

Wind Type: Gridded Winds

Wind Speed: 9 mph

Wind Direction: 270 deg

Crown Fire Method: Scott/Reinhardt

Foliar Moisture: 100

Conditioning: On - Extreme - Southern Cascades

Conditioning start: , NaN/NaN/NaN **Days conditioned:**

Conditioning start: 1300, 7/13/2009

Conditioning end:1500, 7/17/2009

Station Name: WHITMORE

Station Observation Start Date: Jun 19, 1993 12:00:00 AM

Station Observation End Date: Oct 4, 2016 12:00:00 AM

Station Elevation: 2450

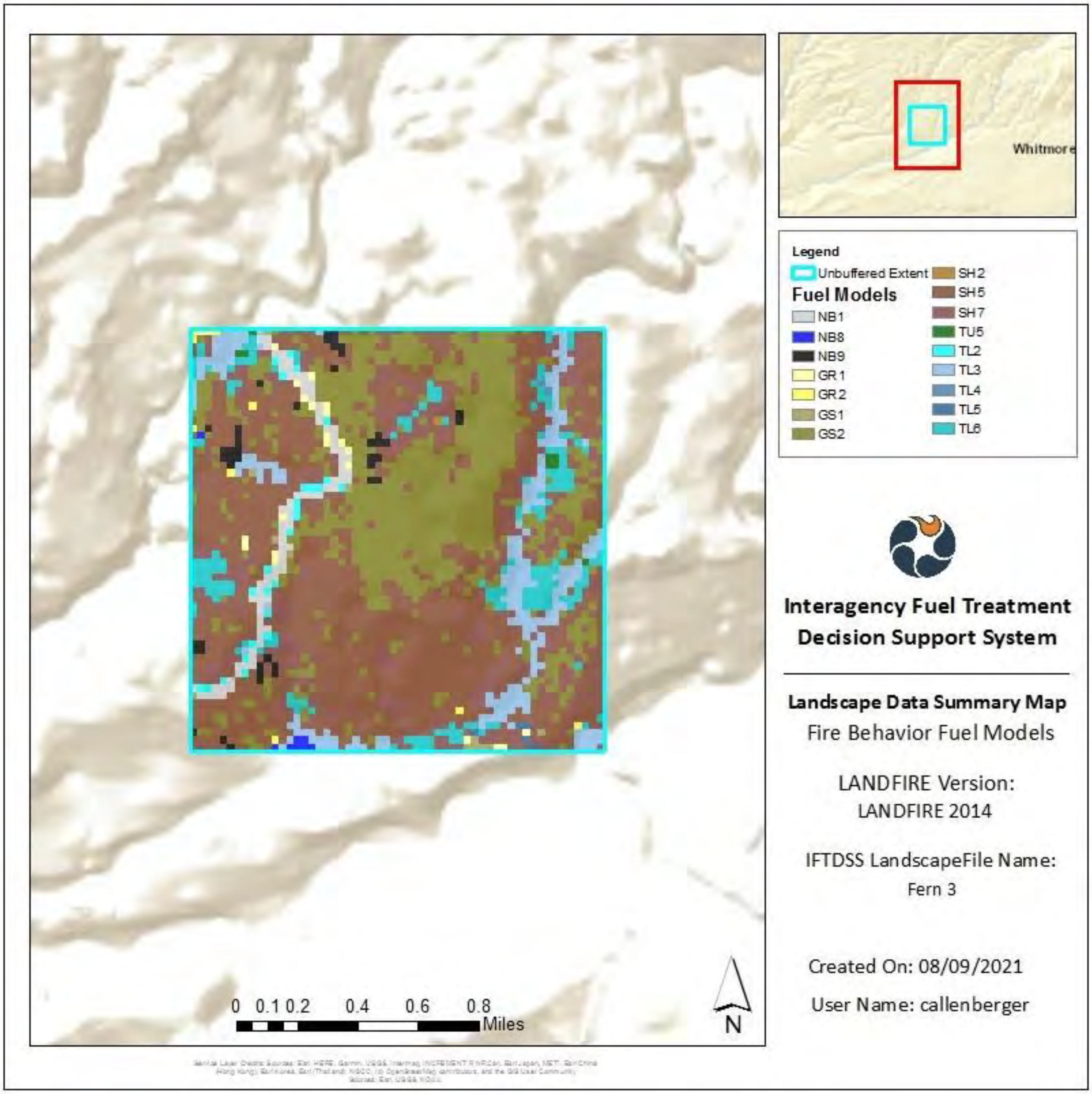
Station Aspect: 7

Station Latitude: 40.6195

Station Longitude: 121.8995555

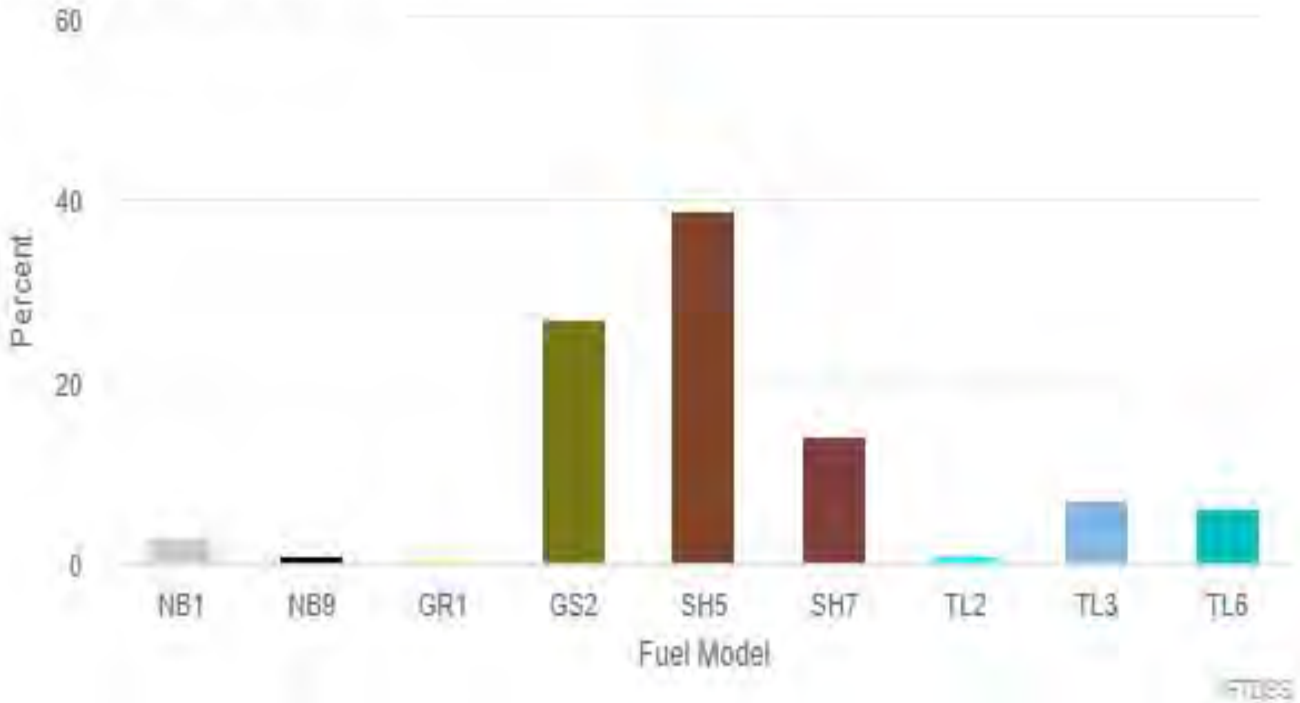
Fuel Model	1 Hr Fuel Moisture	10 Hr Fuel Moisture	100 Hr Fuel Moisture	Live Herbaceous Fuel Moisture	Live Woody Fuel Moisture
All	2	3	5	30	61

Fuel Model (FBFM)



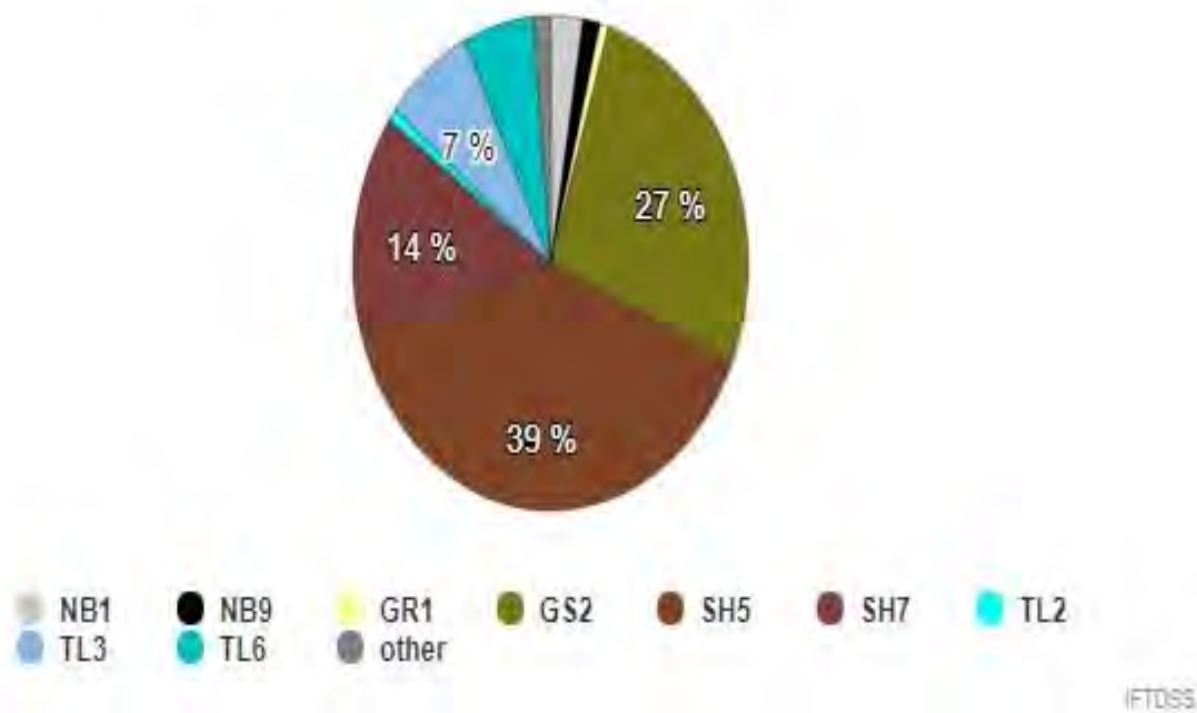
Fuel Model Data Summary within "Fern 3" Landscape

Source Landscape Name: Fern 3
Landfire Version: LANDFIRE 2014
Source Landscape Acres: 710
Model Name: Fern 3 - Auto97th
Distribution under 1% not shown



Fuel Model Data Summary within "Fern 3" Landscape

Source Landscape Name: Fern 3
Landfire Version: LANDFIRE 2014
Source Landscape Acres: 710
Model Name: Fern 3 - Auto97th

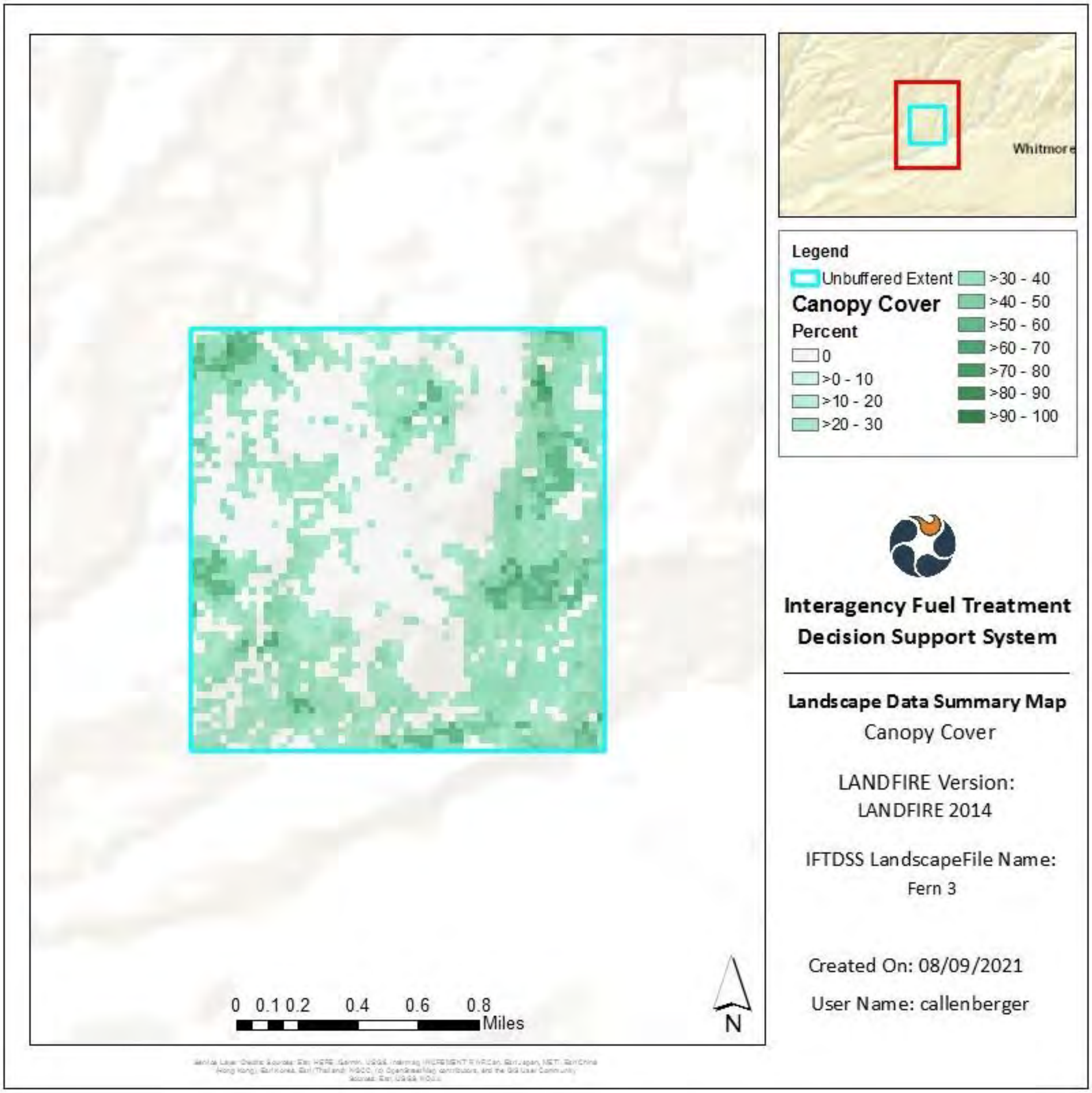


Fuel Model	Pixel Count (freq)	Acres In LCP	Percent In LCP
NB1 (91)	84	19	3
NB8 (98)	8	2	0
NB9 (99)	45	10	1
GR1 (101)	23	5	1
GR2 (102)	9	2	0
GS1 (121)	12	3	0
GS2 (122)	856	190	27
SH2 (142)	1	0	0
SH5 (145)	1245	277	39

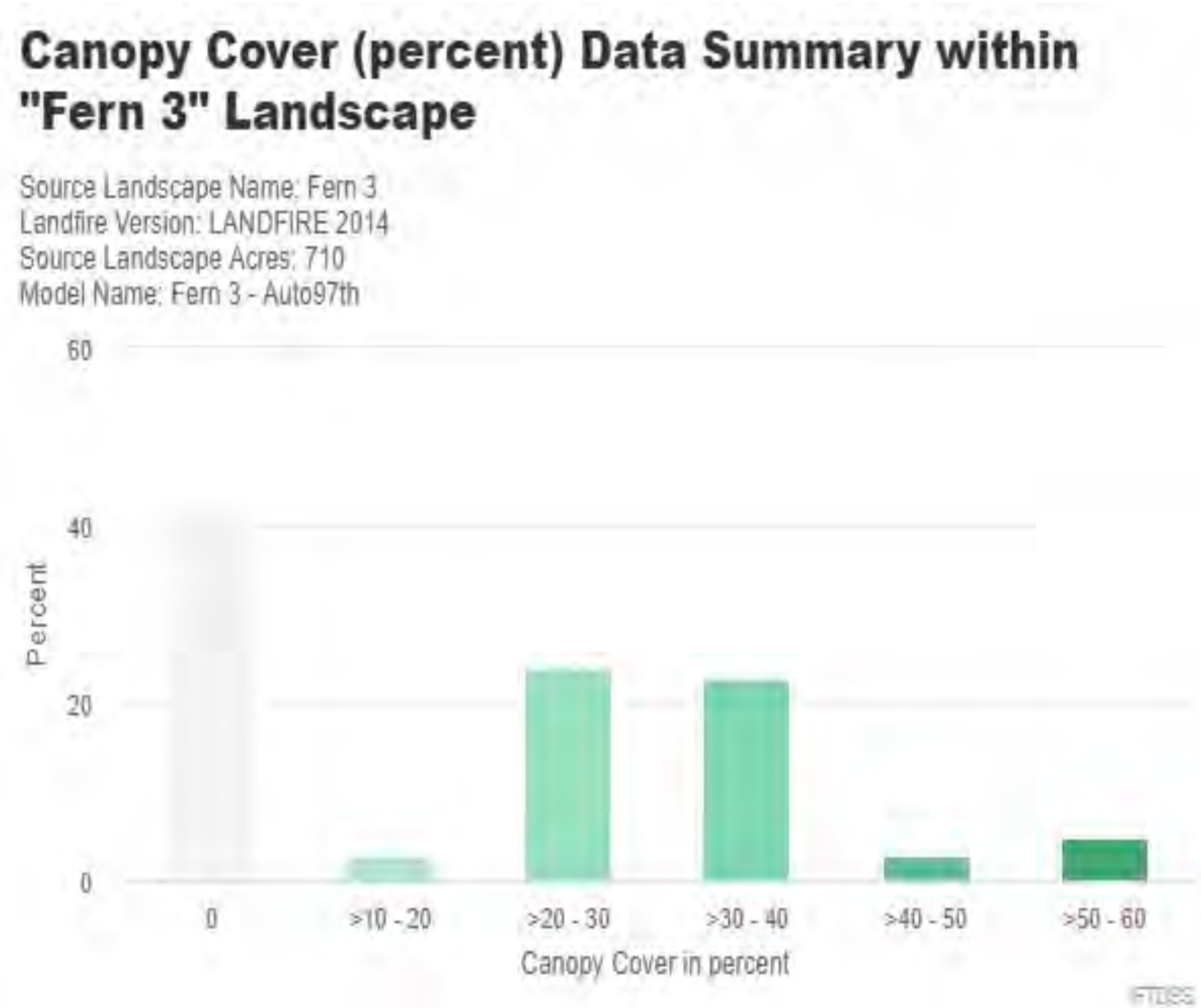
IFTDSS

SH7 (147)	455	101	14
TU5 (165)	8	2	0
TL2 (182)	26	6	1
TL3 (183)	229	51	7
TL4 (184)	2	0	0
TL5 (185)	5	1	0
TL6 (186)	184	41	6

Canopy Cover

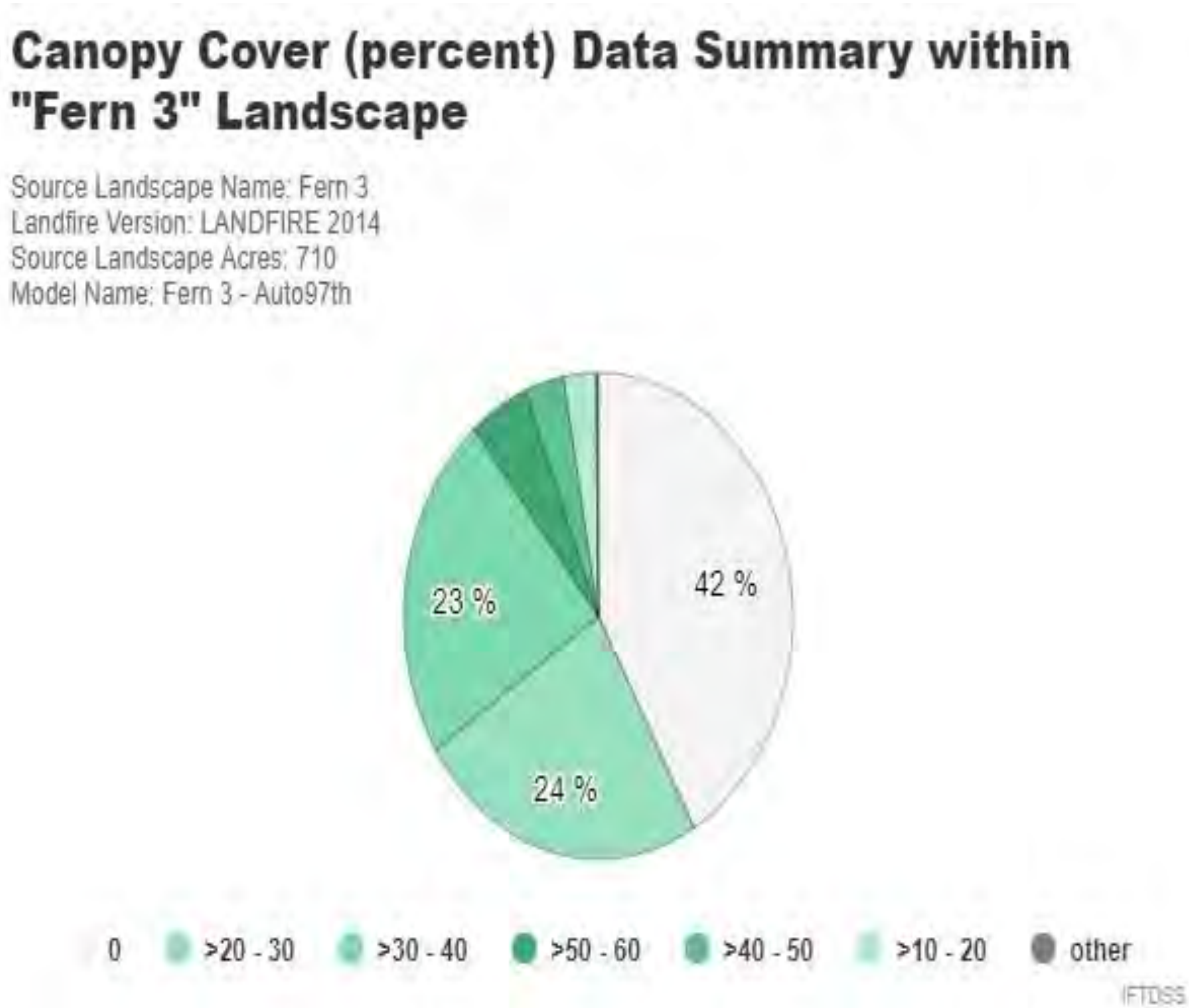


Canopy Cover



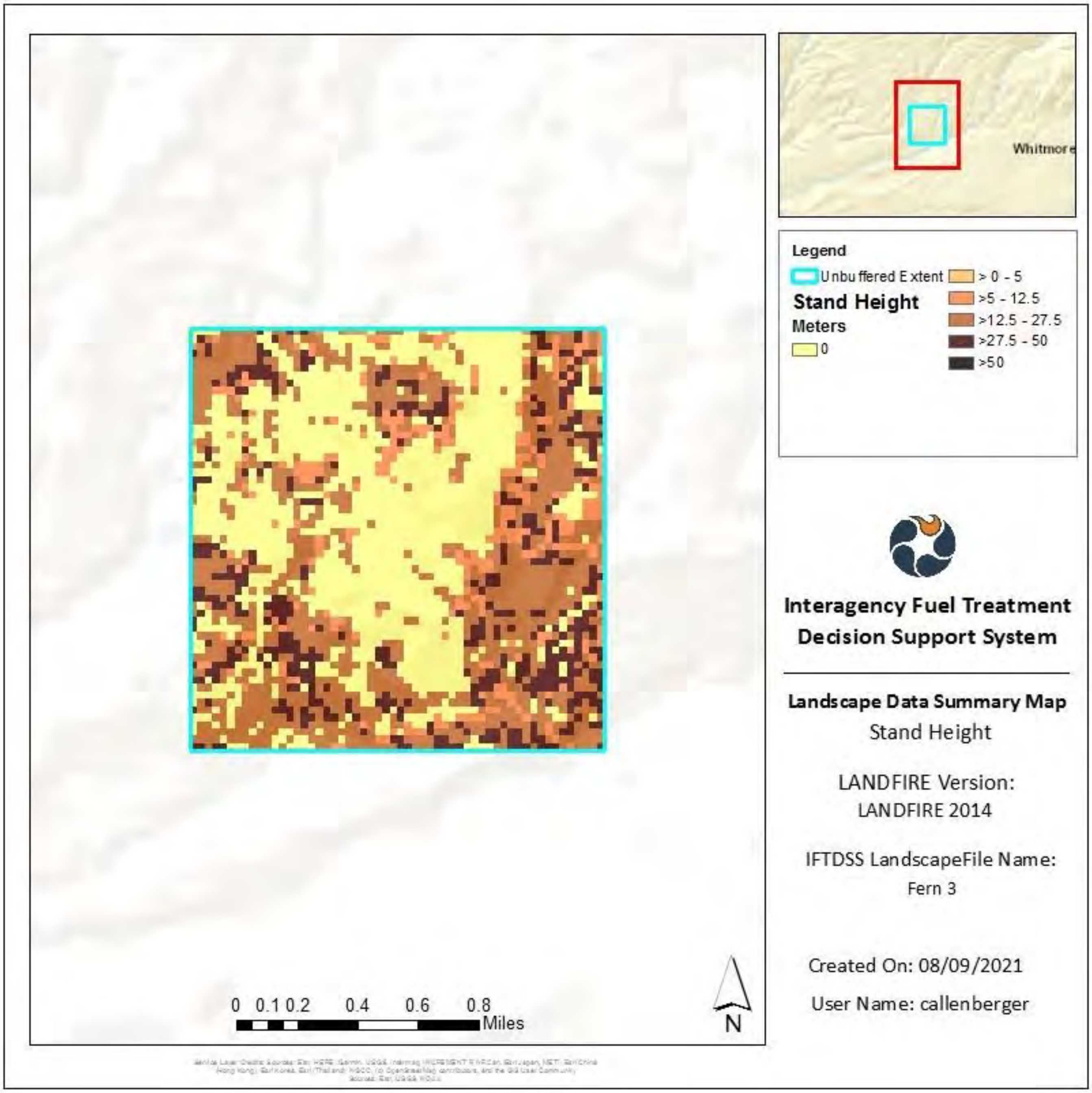
IFTDSS

Canopy Cover

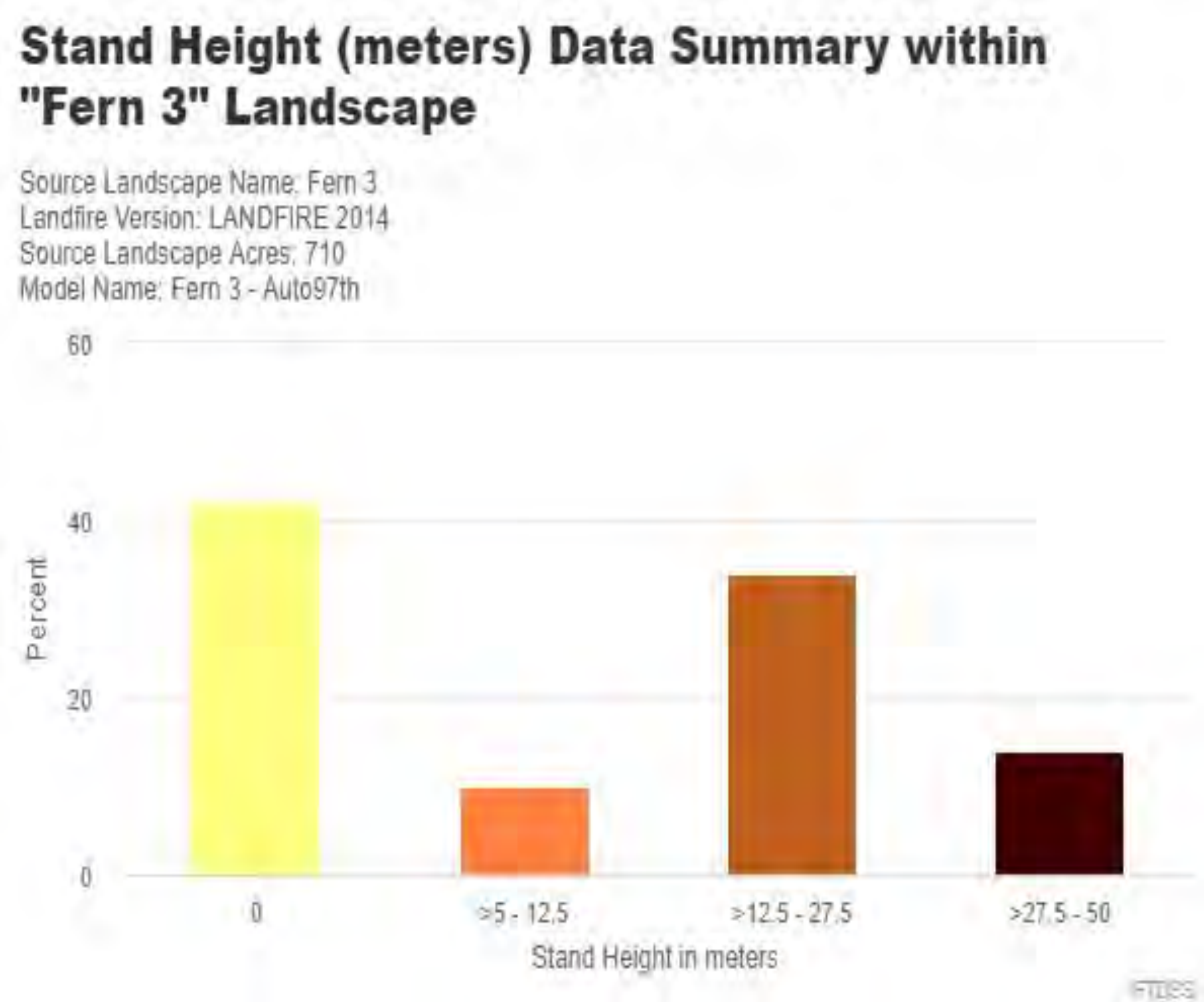


Canopy Cover (percent)	Pixel Count (freq)	Acres In LCP	Percent In LCP
0 (non-forested)	1335	297	42
>10 - 20	85	19	3
>20 - 30	764	170	24
>30 - 40	741	165	23
>40 - 50	105	23	3
>50 - 60	156	35	5
>60 - 70	6	1	0

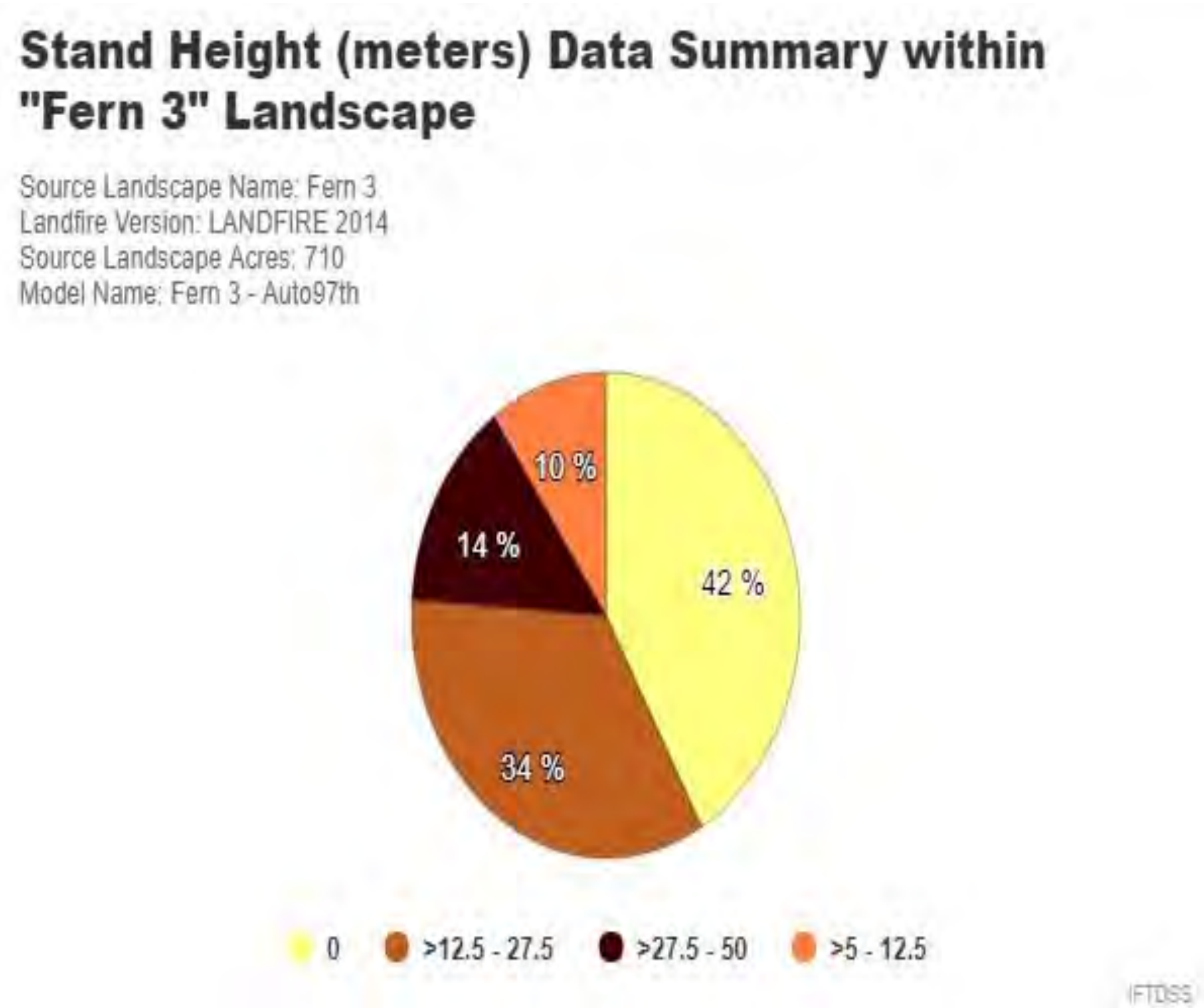
Stand Height



Stand Height

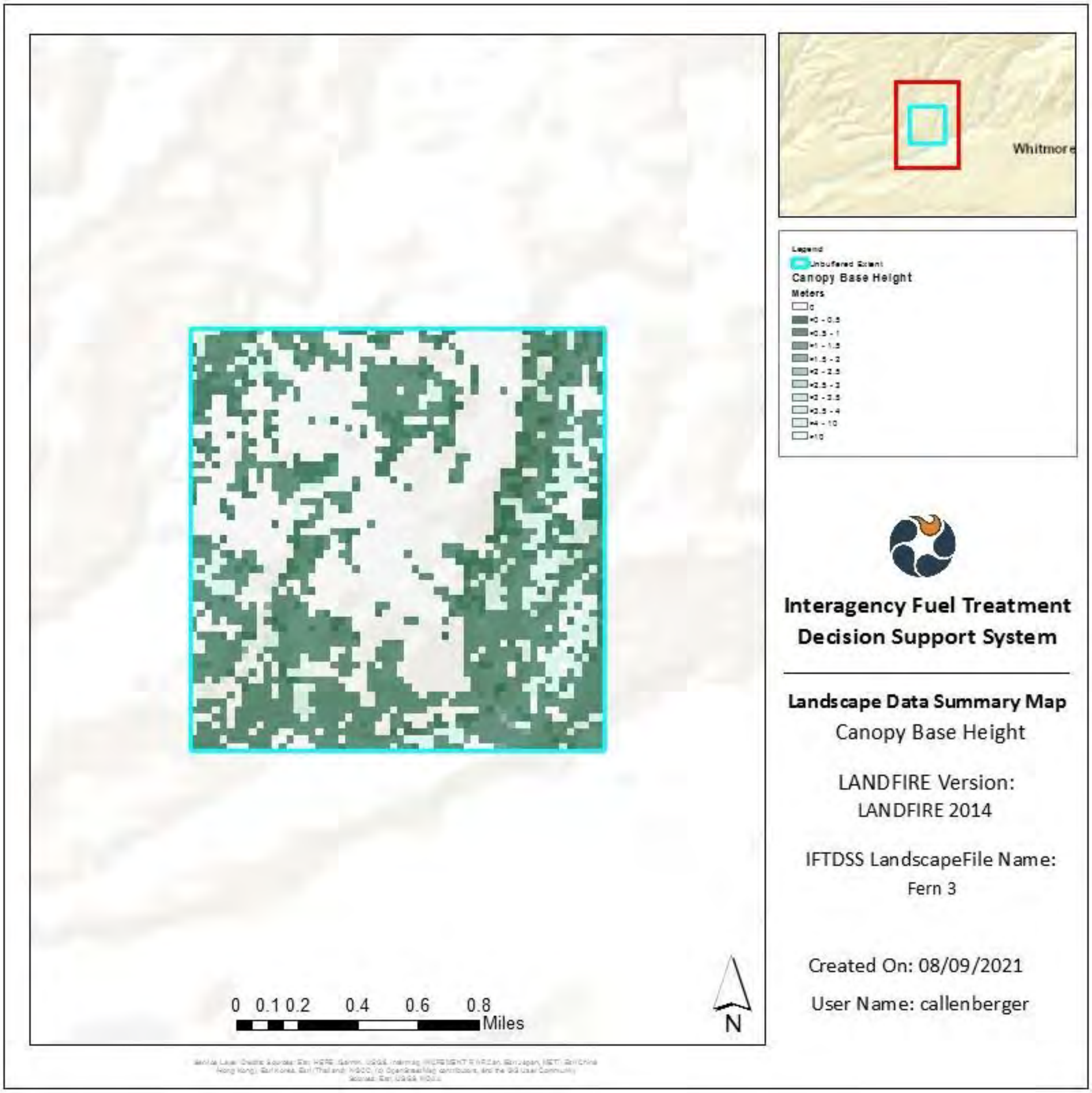


Stand Height

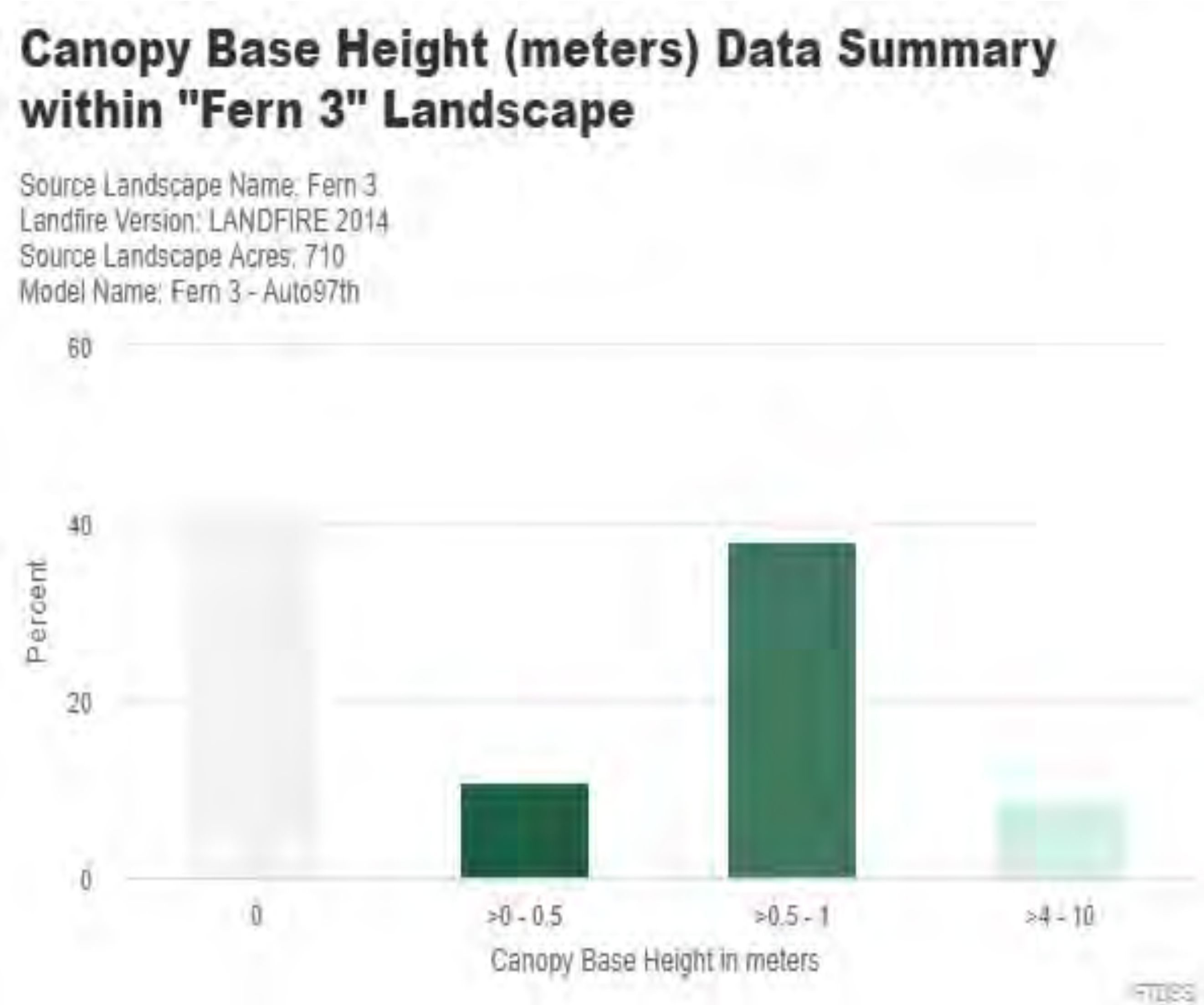


Stand Height (meters)	Pixel Count (freq)	Acres In LCP	Percent In LCP
0 (non-forested)	1335	297	42
>5 - 12.5	311	69	10
>12.5 - 27.5	1092	243	34
>27.5 - 50	454	101	14

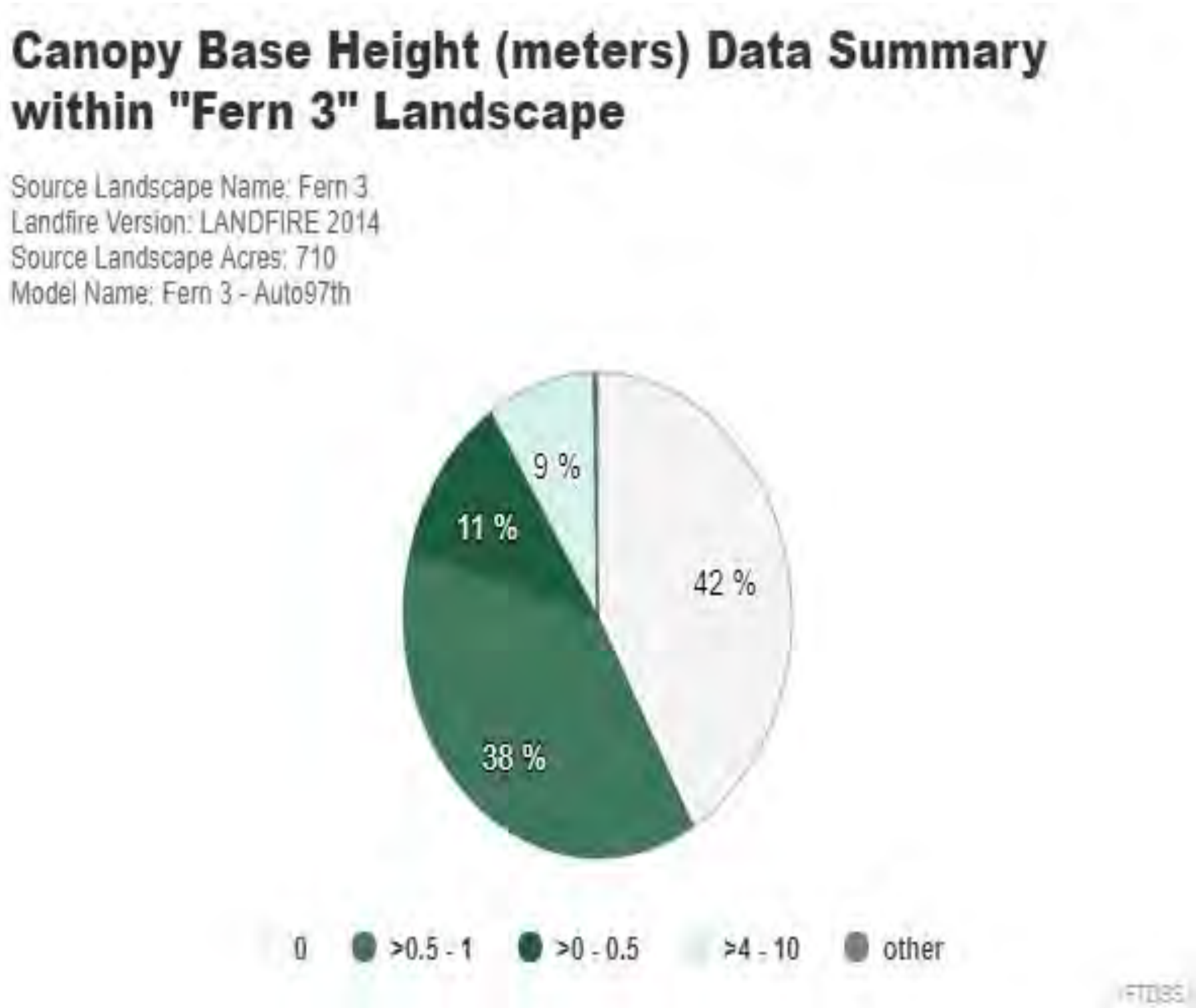
Canopy Base Height



Canopy Base Height

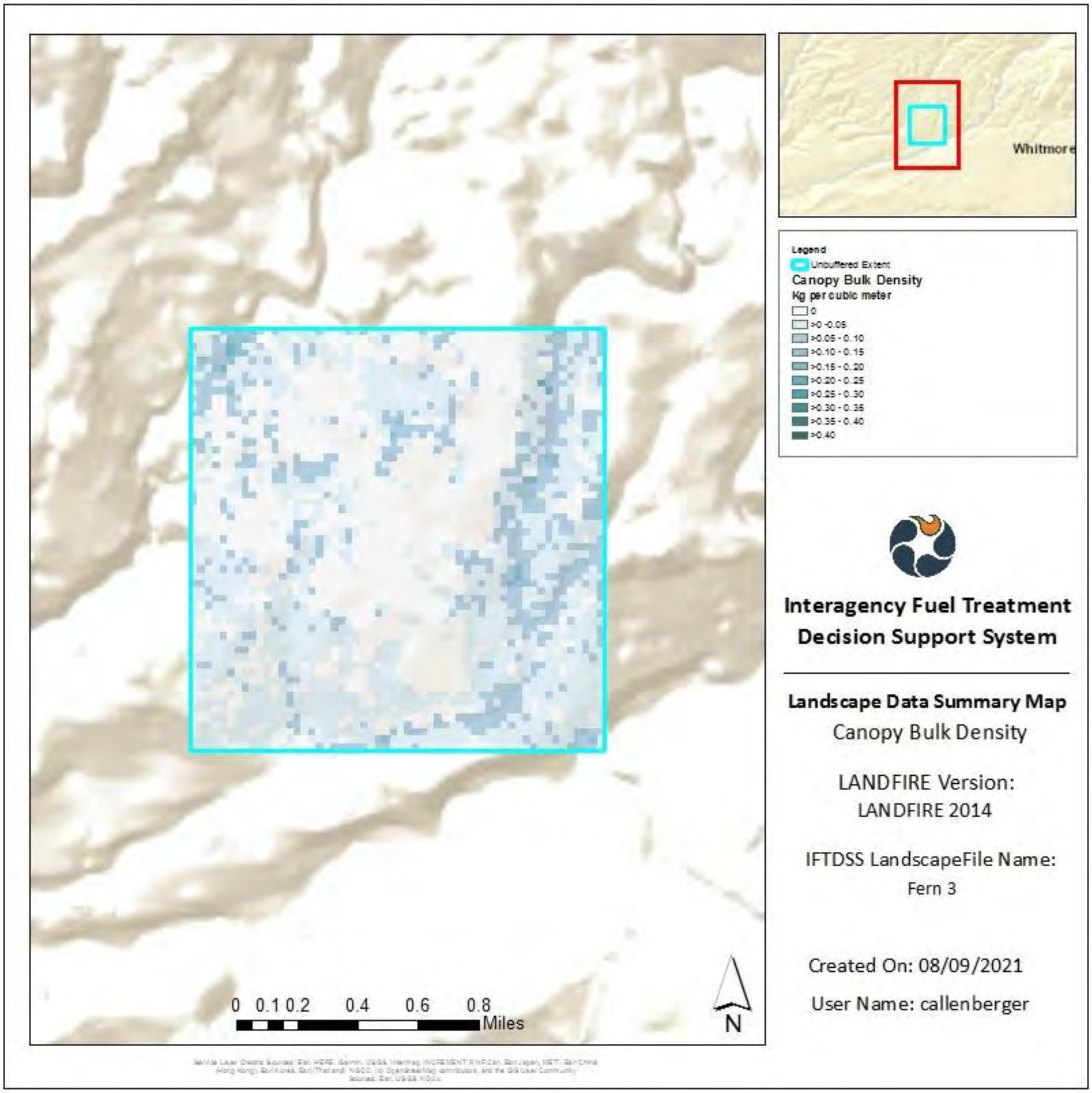


Canopy Base Height

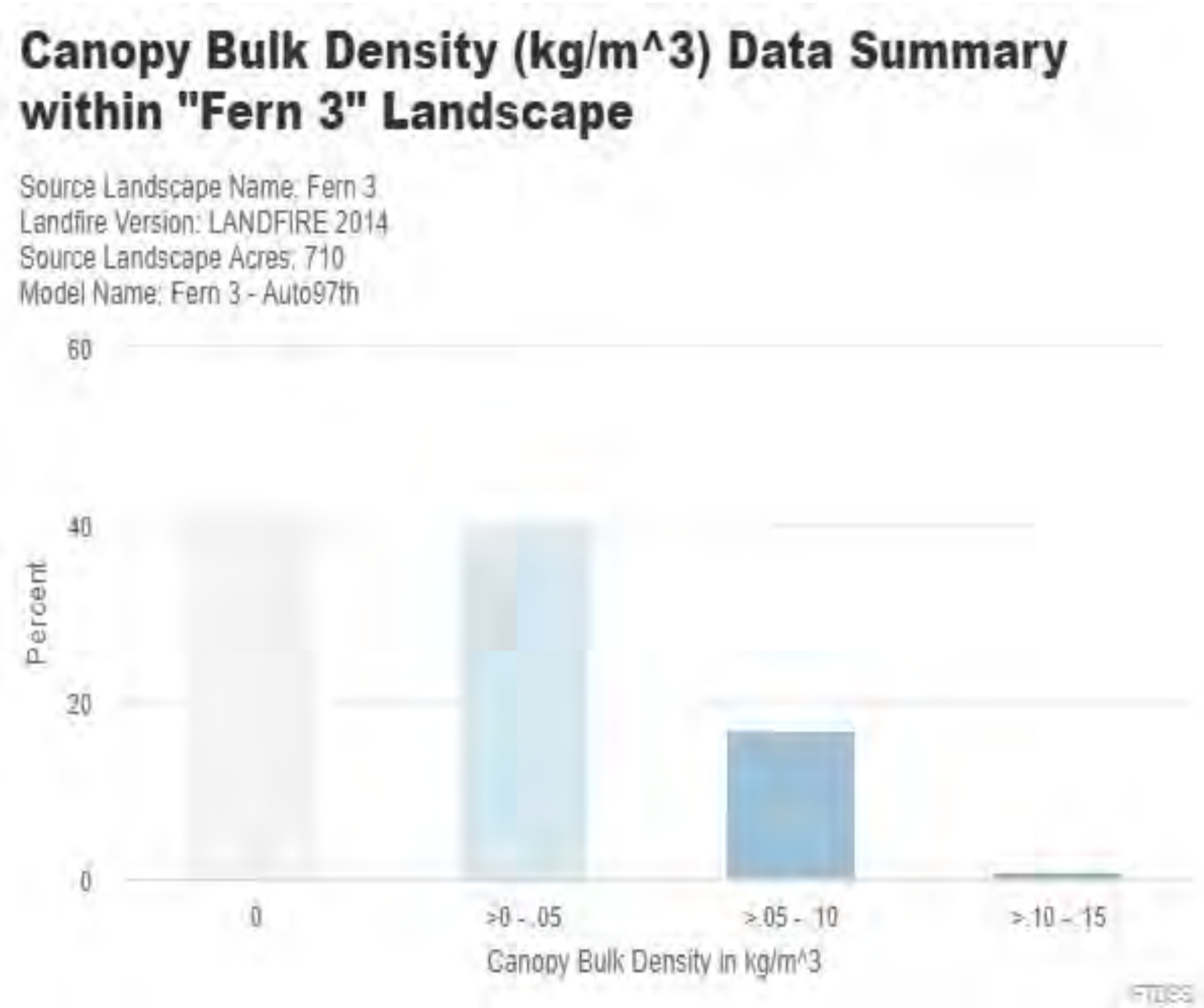


Canopy Base Height (meters)	Pixel Count (freq)	Acres In LCP	Percent In LCP
0 (non-forested)	1335	297	42
>0 - 0.5	361	80	11
>0.5 - 1	1201	267	38
>1 - 1.5	5	1	0
>1.5 - 2	6	1	0
>4 - 10	284	63	9

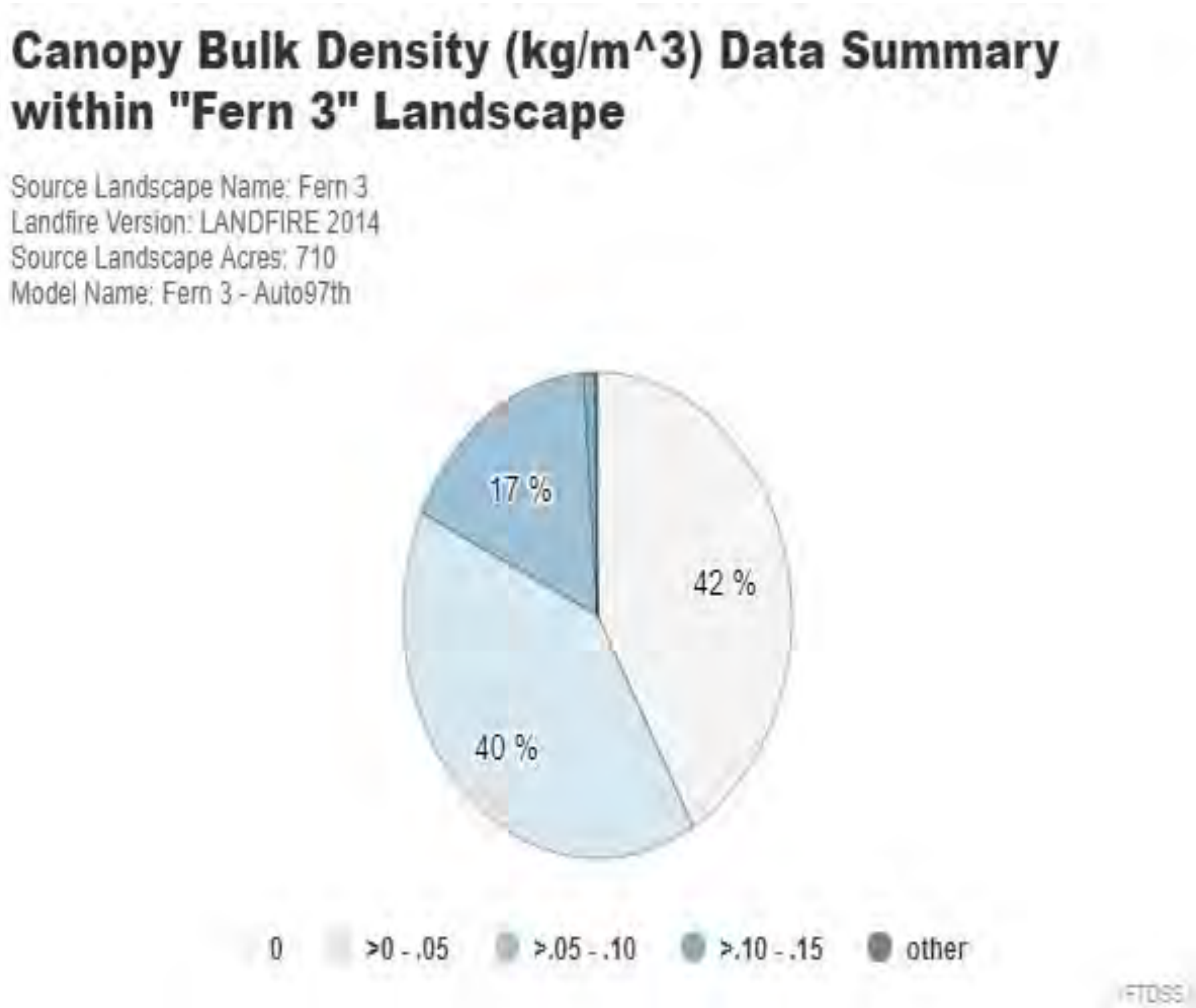
Canopy Bulk Density



Canopy Bulk Density

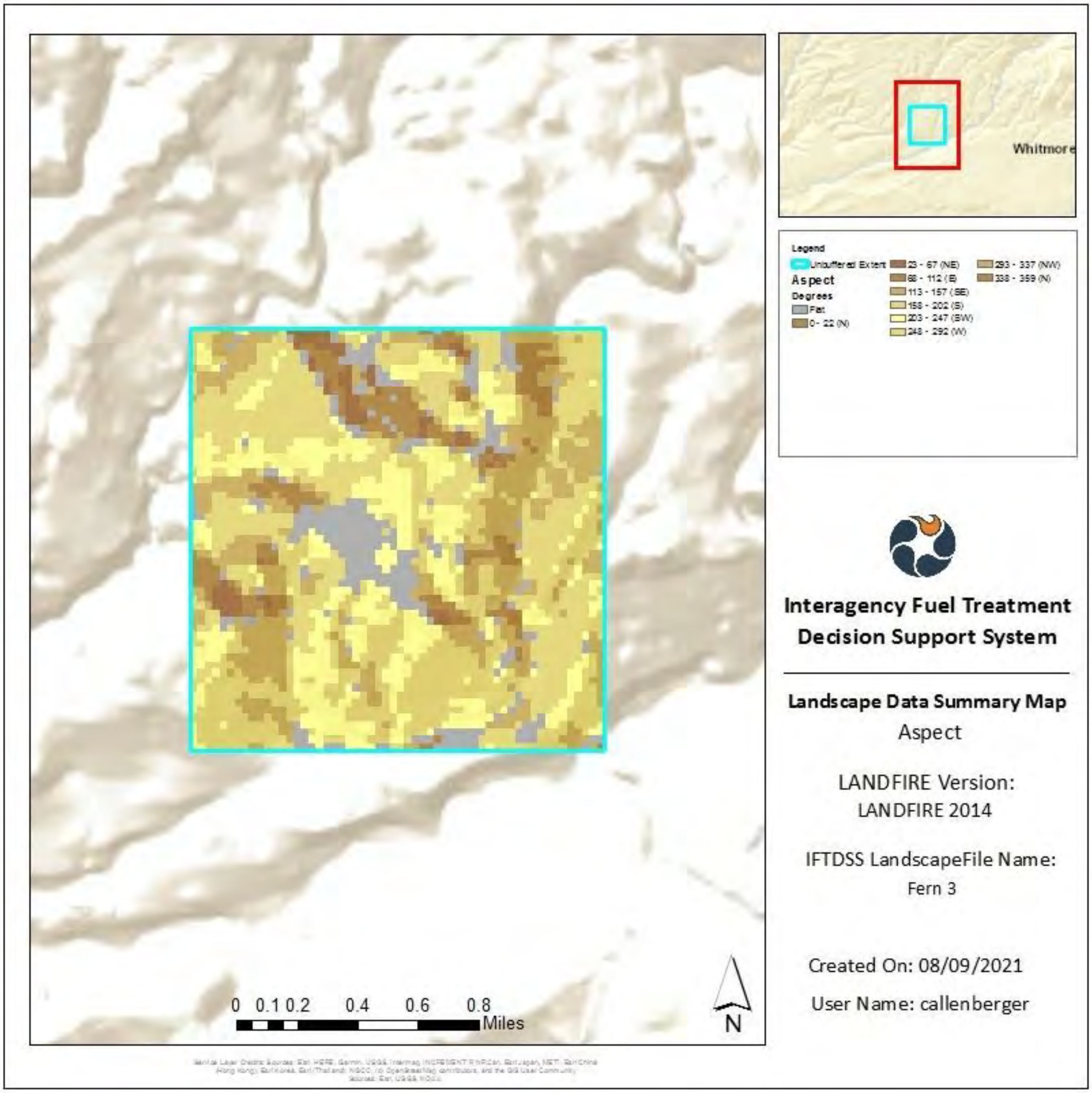


Canopy Bulk Density

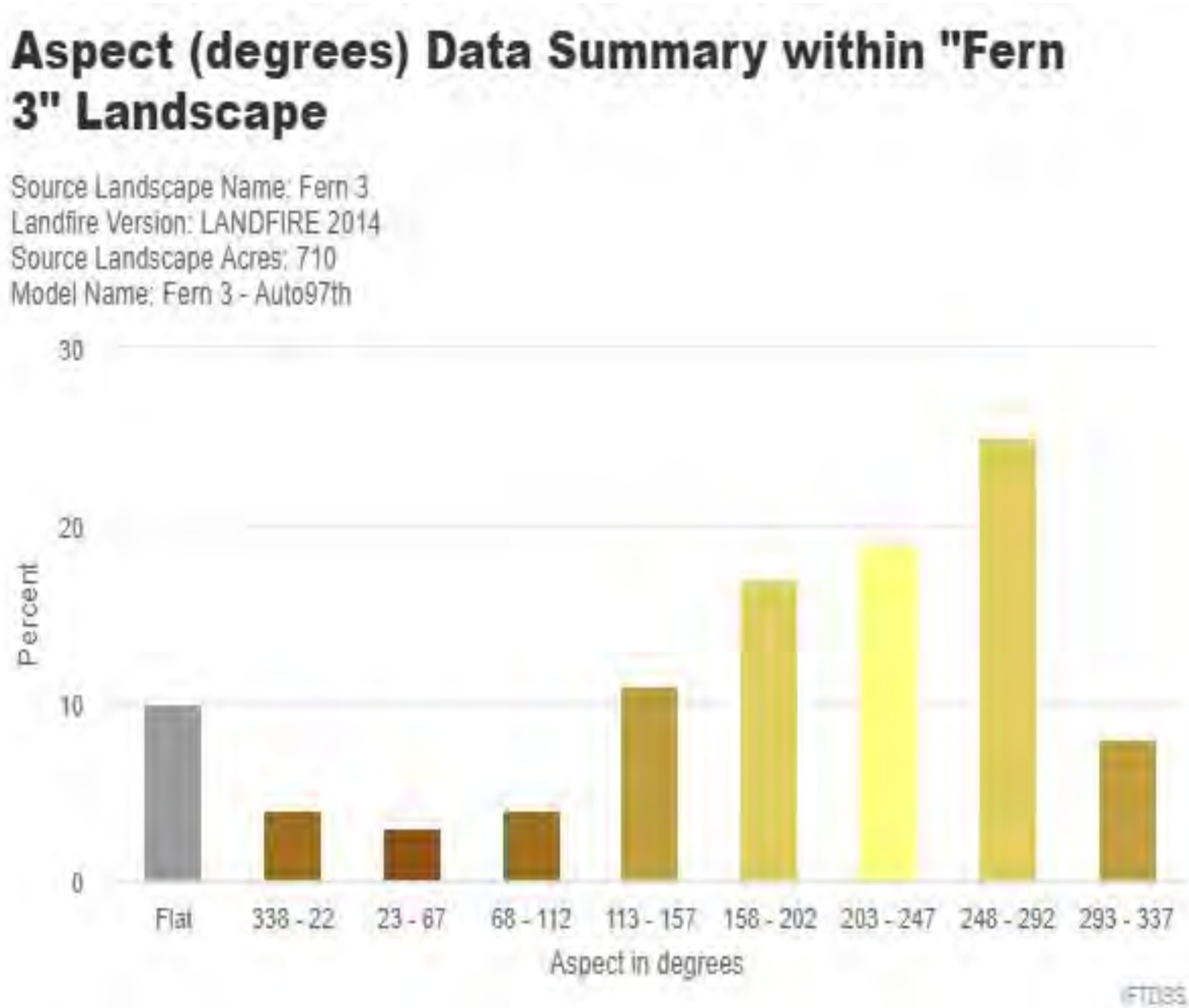


Canopy Bulk Density (kg/m^3)	Pixel Count (freq)	Acres In LCP	Percent In LCP
0 (non-forested)	1335	297	42
>0 - .05	1281	285	40
>.05 - .10	539	120	17
>.10 - .15	30	7	1
>.15 - .20	7	2	0

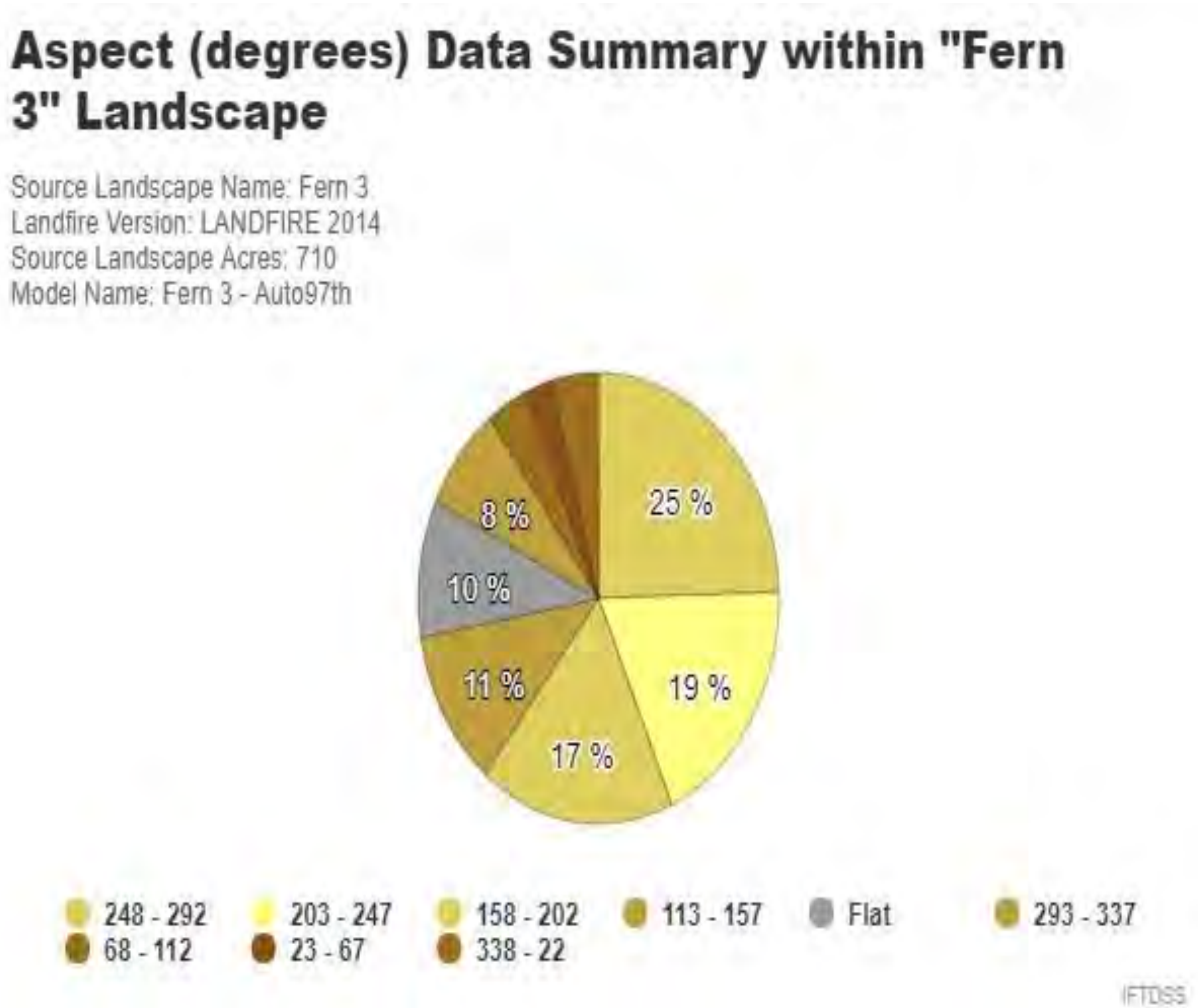
Aspect


Whitmore
Legend
Unbuffered Extent
Aspect
Degrees
Flat
0 - 22 (N)
23 - 67 (NE)
68 - 112 (E)
113 - 157 (SE)
158 - 202 (S)
203 - 247 (SW)
248 - 292 (W)
293 - 337 (NW)
338 - 359 (N)
Interagency Fuel Treatment Decision Support System
Landscape Data Summary Map
Aspect
LANDFIRE Version:
LANDFIRE 2014
IFTDSS LandscapeFile Name:
Fern 3
Created On: 08/09/2021
User Name: callenberger
0 0.1 0.2 0.4 0.6 0.8
Miles
N

Aspect

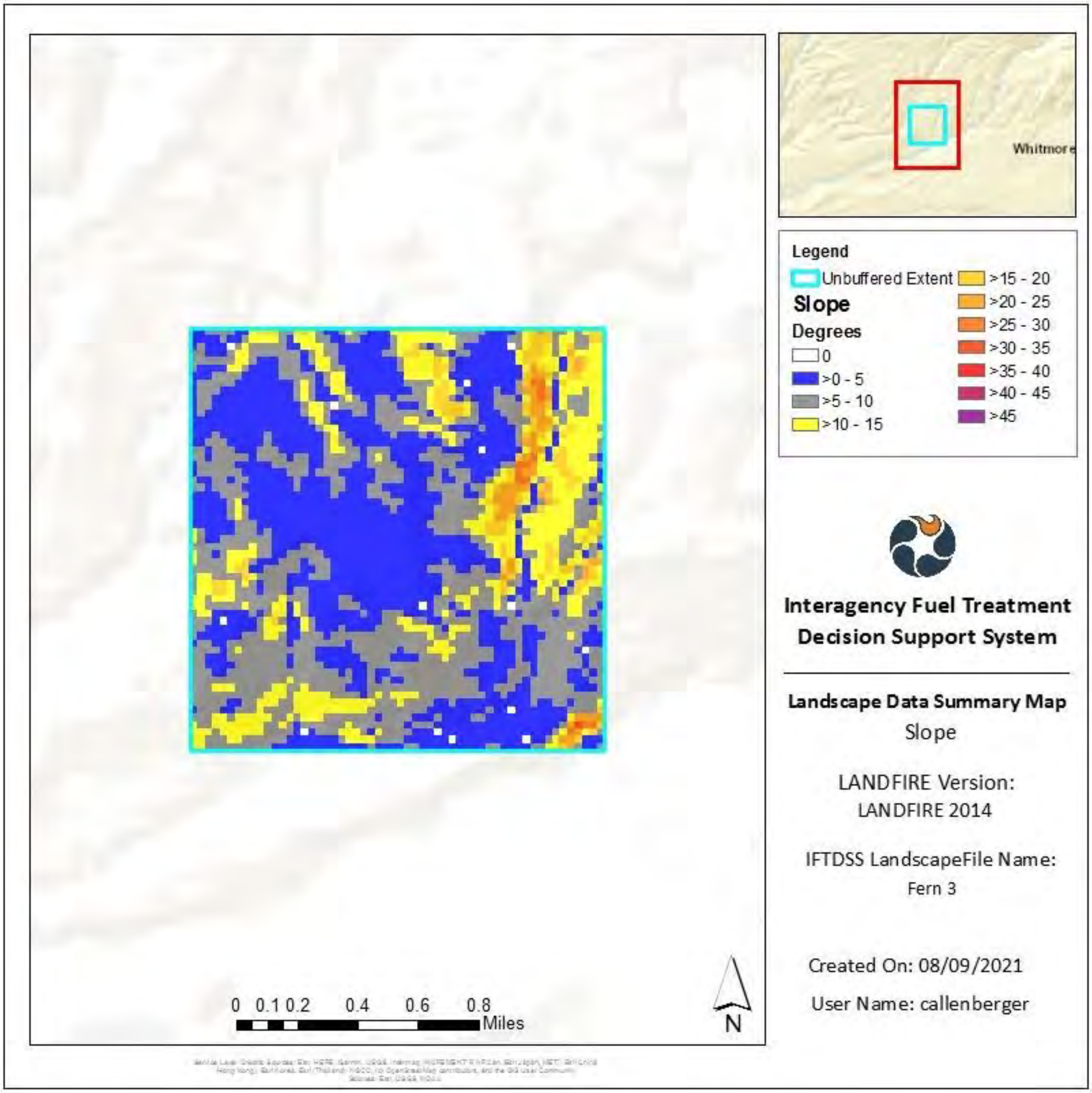

Aspect (degrees) Data Summary within "Fern 3" Landscape
Source Landscape Name: Fern 3
Landfire Version: LANDFIRE 2014
Source Landscape Acres: 710
Model Name: Fern 3 - Auto97th
30
20
10
0
Percent
Flat
338 - 22
23 - 67
68 - 112
113 - 157
158 - 202
203 - 247
248 - 292
293 - 337
Aspect in degrees
IFTDSS

Aspect



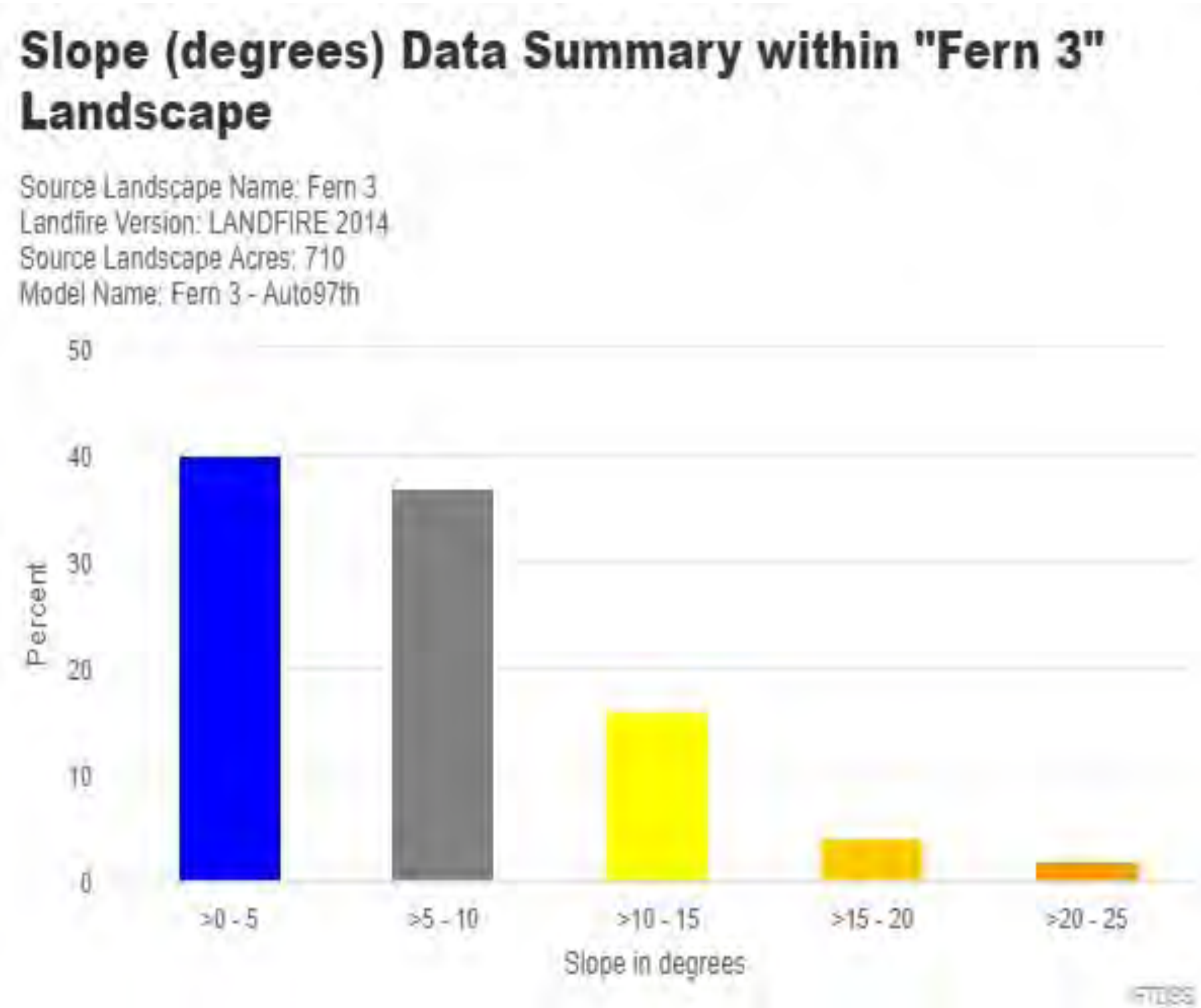
Aspect (degrees)	Pixel Count (freq)	Acres In LCP	Percent In LCP
Flat	315	70	10
338 - 22 (N)	133	30	4
23 - 67 (NE)	81	18	3
68 - 112 (E)	114	25	4
113 - 157 (SE)	364	81	11
158 - 202 (S)	558	124	17
203 - 247 (SW)	600	133	19
248 - 292 (W)	784	174	25
293 - 337 (NW)	243	54	8

Slope

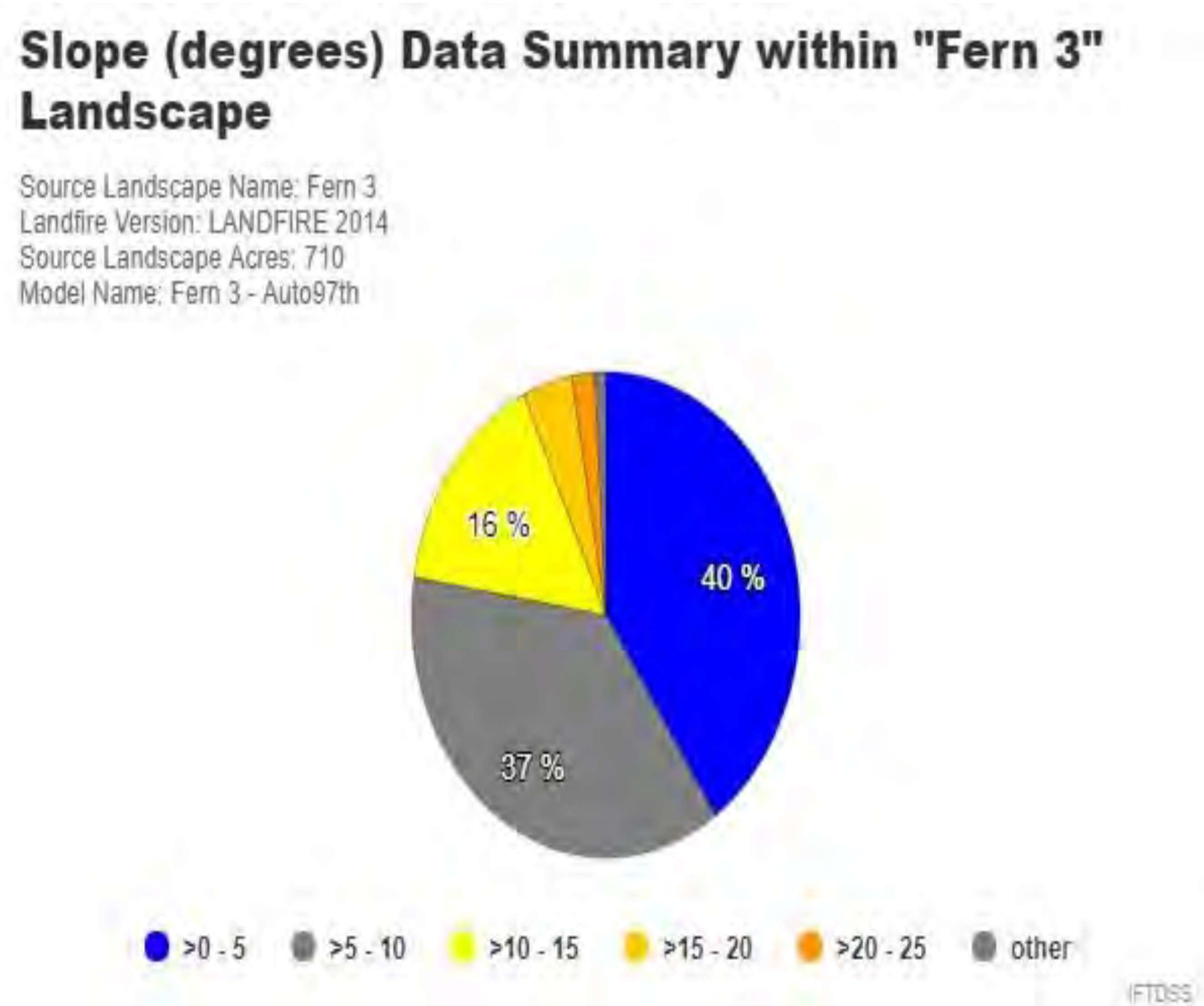


Whitmore
Legend
Unbuffered Extent
Slope
Degrees
0
>0 - 5
>5 - 10
>10 - 15
>15 - 20
>20 - 25
>25 - 30
>30 - 35
>35 - 40
>40 - 45
>45
Interagency Fuel Treatment Decision Support System
Landscape Data Summary Map
Slope
LANDFIRE Version:
LANDFIRE 2014
IFTDSS LandscapeFile Name:
Fern 3
Created On: 08/09/2021
User Name: callenberger
0 0.1 0.2 0.4 0.6 0.8
Miles
N

Slope

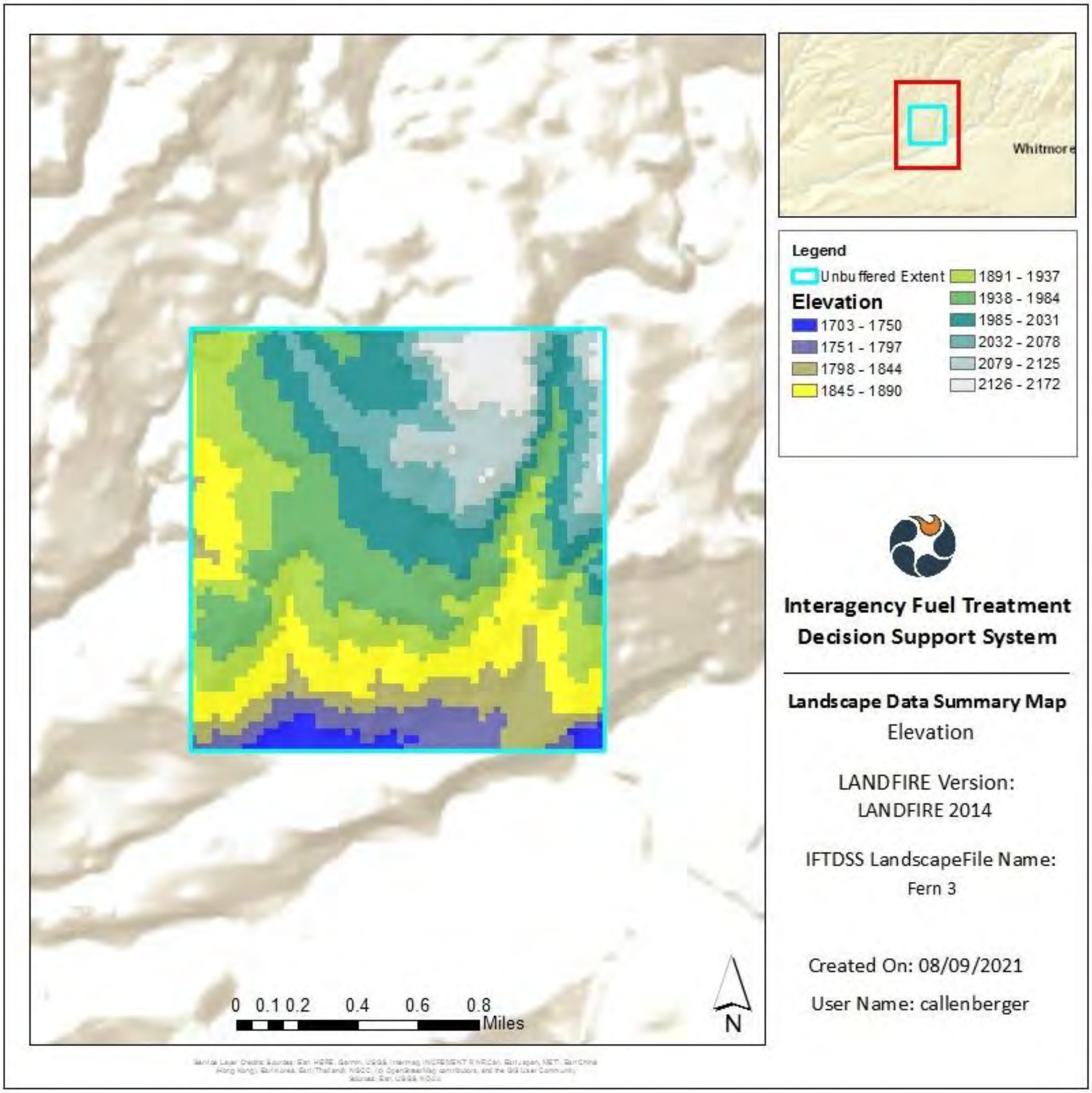

Slope (degrees) Data Summary within "Fern 3" Landscape
Source Landscape Name: Fern 3
Landfire Version: LANDFIRE 2014
Source Landscape Acres: 710
Model Name: Fern 3 - Auto97th
Percent
50
40
30
20
10
0
>0 - 5
>5 - 10
>10 - 15
>15 - 20
>20 - 25
Slope in degrees
IFTDSS

Slope

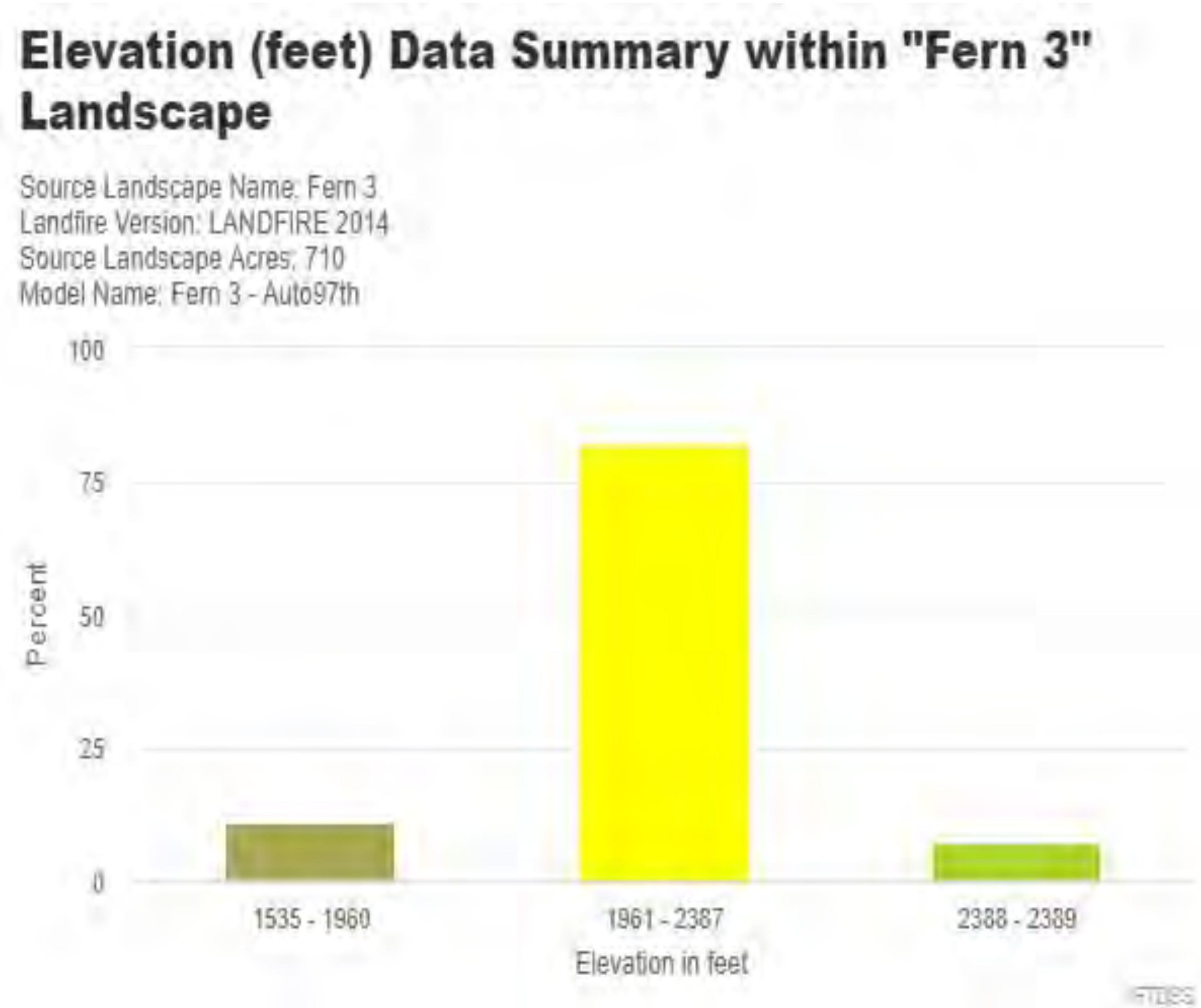


Slope (degrees)	Pixel Count (freq)	Acres In LCP	Percent In LCP
0	14	3	0
>0 - 5	1292	287	40
>5 - 10	1182	263	37
>10 - 15	497	111	16
>15 - 20	132	29	4
>20 - 25	61	14	2
>25 - 30	13	3	0
>30 - 35	1	0	0

Elevation


Whitmore
Legend
Unbuffered Extent
Elevation
1703 - 1750
1751 - 1797
1798 - 1844
1845 - 1890
1891 - 1937
1938 - 1984
1985 - 2031
2032 - 2078
2079 - 2125
2126 - 2172
Interagency Fuel Treatment Decision Support System
Landscape Data Summary Map
Elevation
LANDFIRE Version:
LANDFIRE 2014
IFTDSS LandscapeFile Name:
Fern 3
Created On: 08/09/2021
User Name: callenberger
0 0.1 0.2 0.4 0.6 0.8
Miles
N

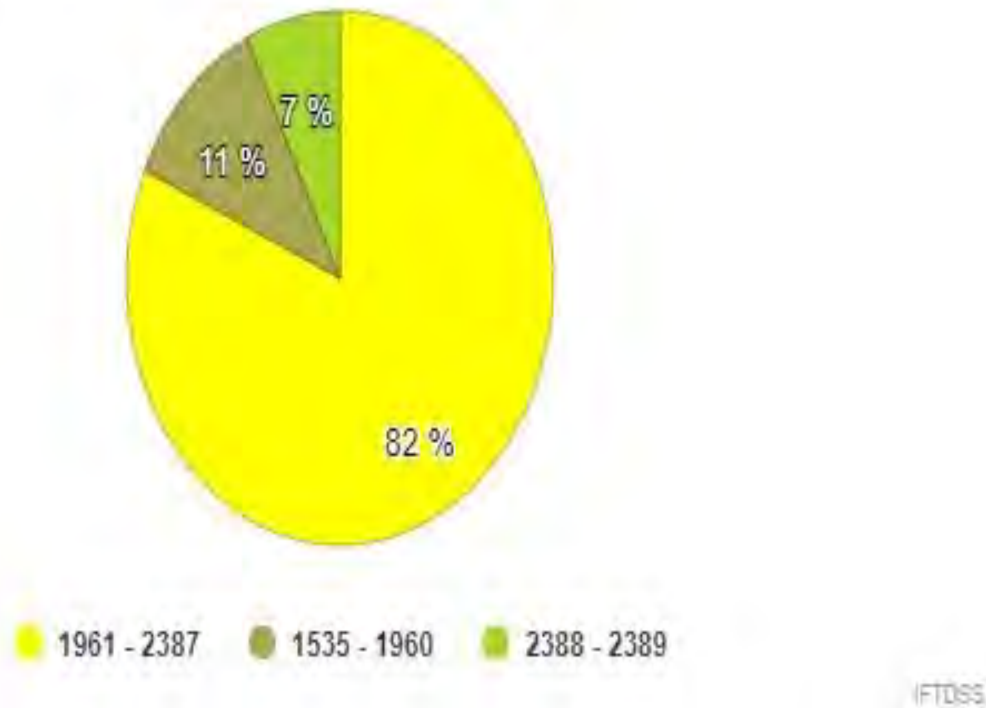
Elevation


Elevation (feet) Data Summary within "Fern 3" Landscape
Source Landscape Name: Fern 3
Landfire Version: LANDFIRE 2014
Source Landscape Acres: 710
Model Name: Fern 3 - Auto97th
100
75
50
25
0
Percent
1535 - 1960
1961 - 2387
2388 - 2389
Elevation in feet
IFTDSS

Elevation

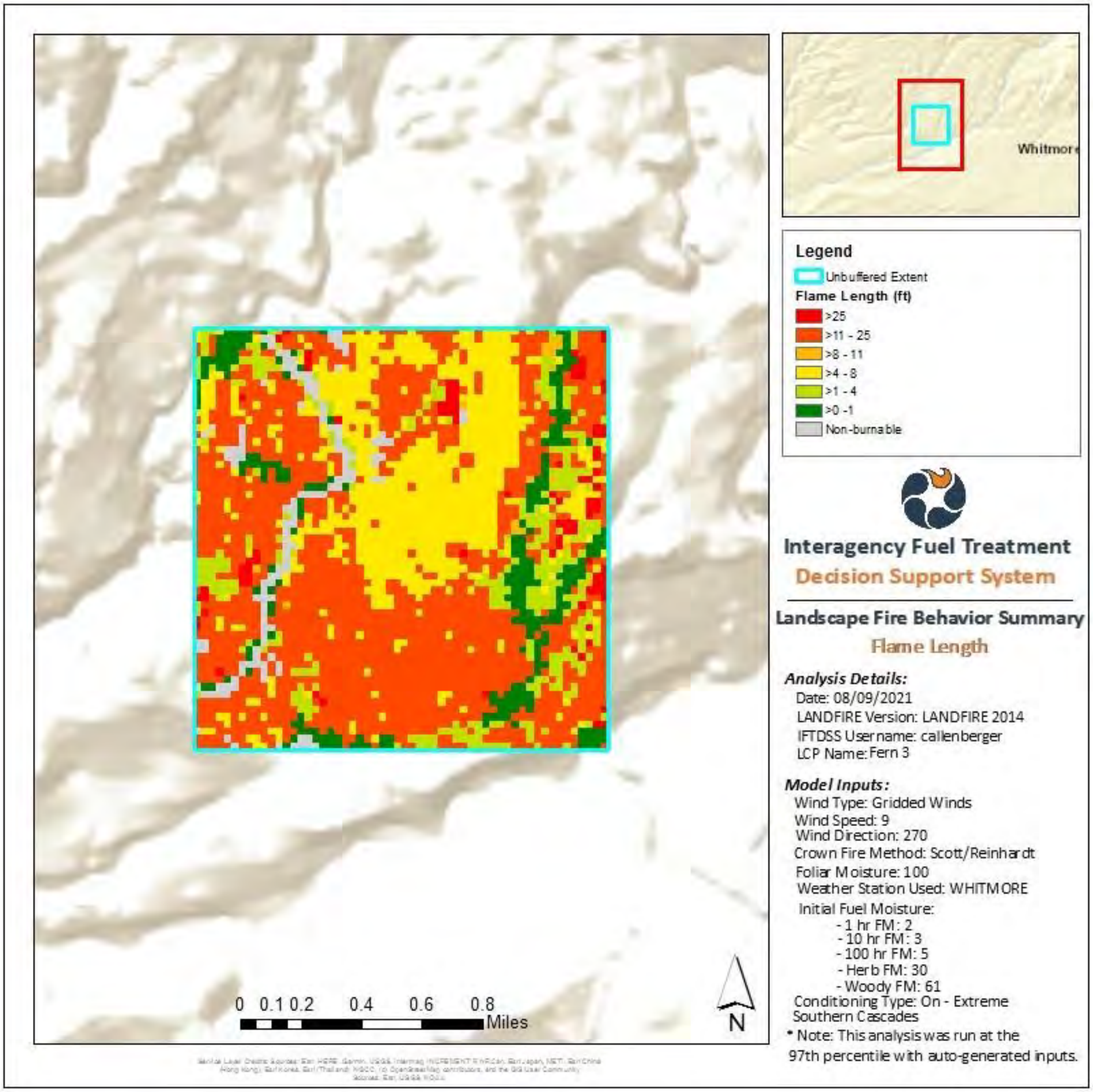
Elevation (feet) Data Summary within "Fern 3" Landscape

Source Landscape Name: Fern 3
Landfire Version: LANDFIRE 2014
Source Landscape Acres: 710
Model Name: Fern 3 - Auto97th

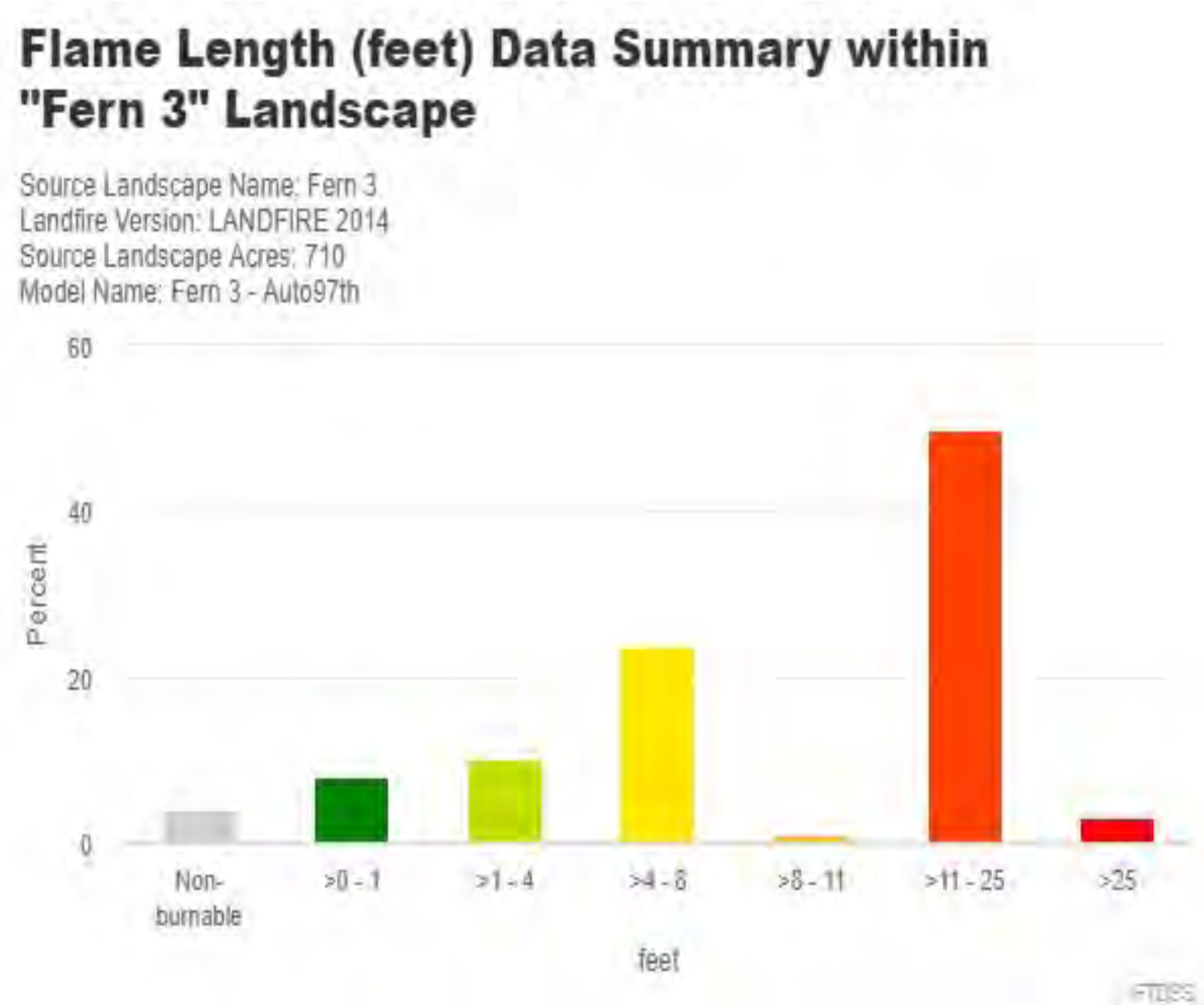


Elevation (feet)	Pixel Count (freq)	Acres In LCP	Percent In LCP
1535 - 1960	356	79	11
1961 - 2387	2606	580	82
2388 - 2389	230	51	7

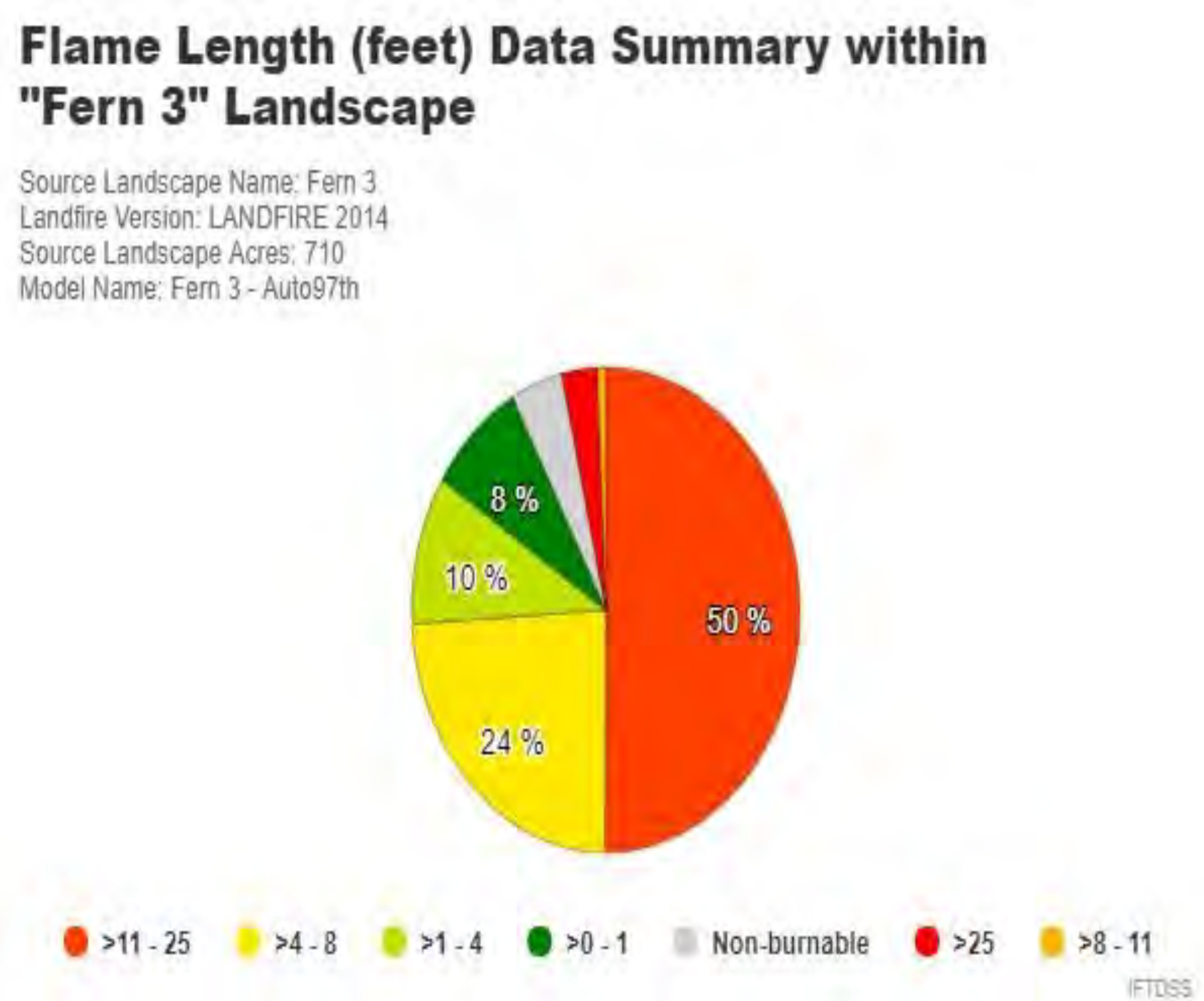
Flame Length



Flame Length

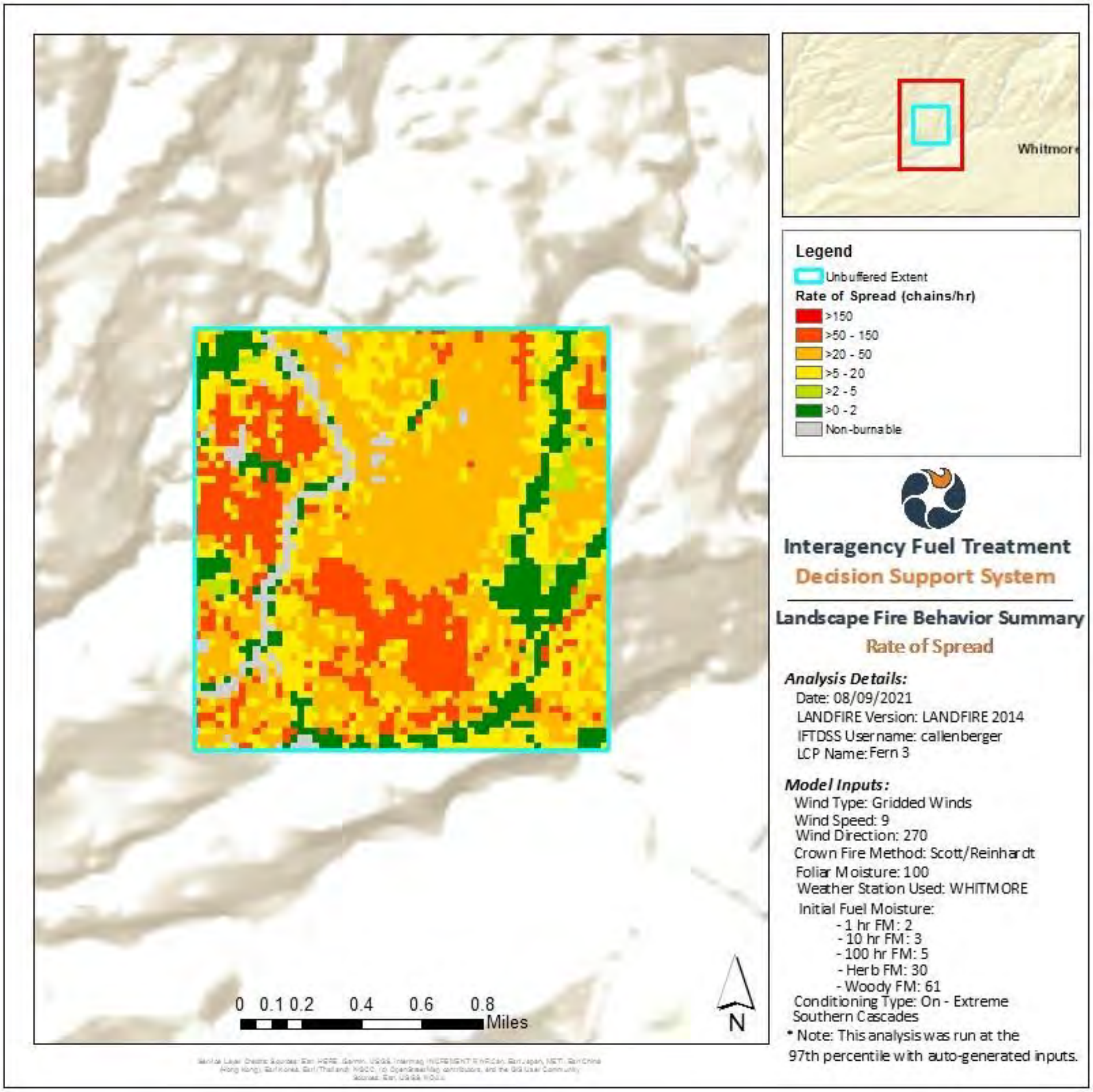


Flame Length

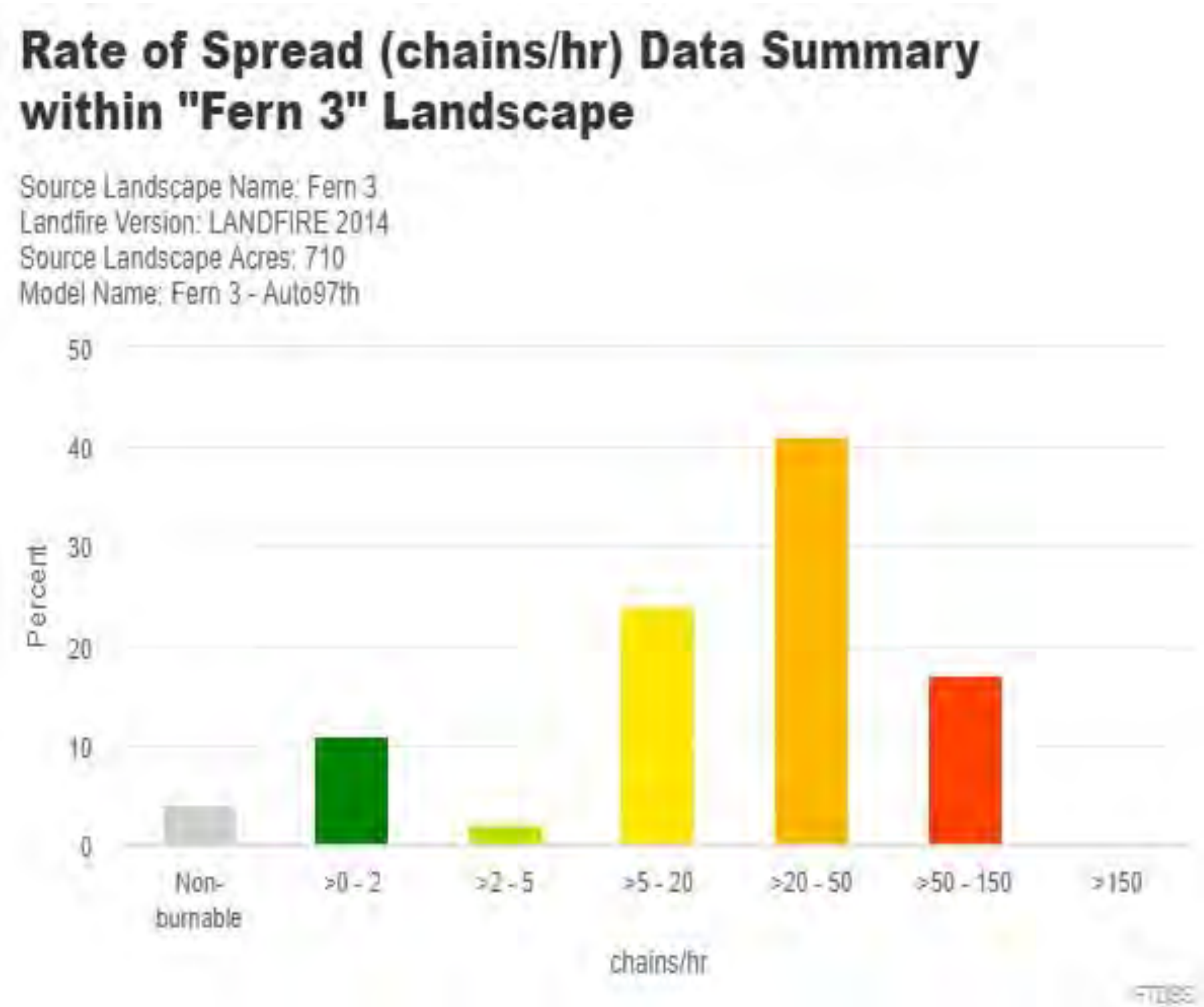


Flame Length (feet)	Pixel Count (freq)	Acres In LCP	Percent In LCP
Non-burnable	137	30	4
>0 - 1	255	57	8
>1 - 4	318	71	10
>4 - 8	766	170	24
>8 - 11	22	5	1
>11 - 25	1599	356	50
>25	95	21	3

Spread Rate

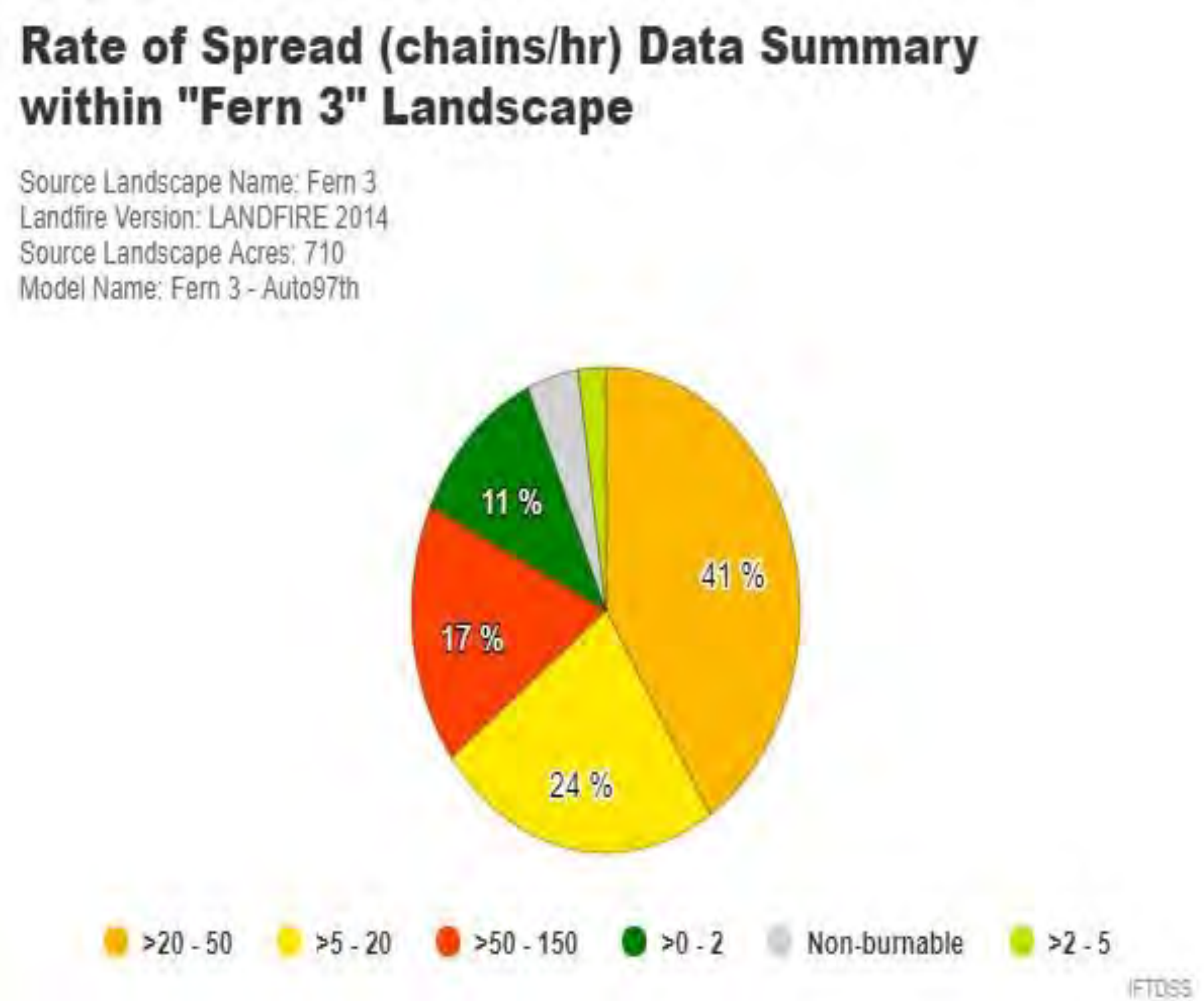

Whitmore
Legend
Unbuffered Extent
Rate of Spread (chains/hr)
>150
>50 - 150
>20 - 50
>5 - 20
>2 - 5
>0 - 2
Non-burnable
Interagency Fuel Treatment
Decision Support System
Landscape Fire Behavior Summary
Rate of Spread
Analysis Details:
Date: 08/09/2021
LANDFIRE Version: LANDFIRE 2014
IFTDSS Username: callenberger
LCP Name: Fern 3
Model Inputs:
Wind Type: Gridded Winds
Wind Speed: 9
Wind Direction: 270
Crown Fire Method: Scott/Reinhardt
Foliar Moisture: 100
Weather Station Used: WHITMORE
Initial Fuel Moisture:
- 1 hr FM: 2
- 10 hr FM: 3
- 100 hr FM: 5
- Herb FM: 30
- Woody FM: 61
Conditioning Type: On - Extreme
Southern Cascades
* Note: This analysis was run at the 97th percentile with auto-generated inputs.
0 0.1 0.2 0.4 0.6 0.8
Miles
N

Spread Rate



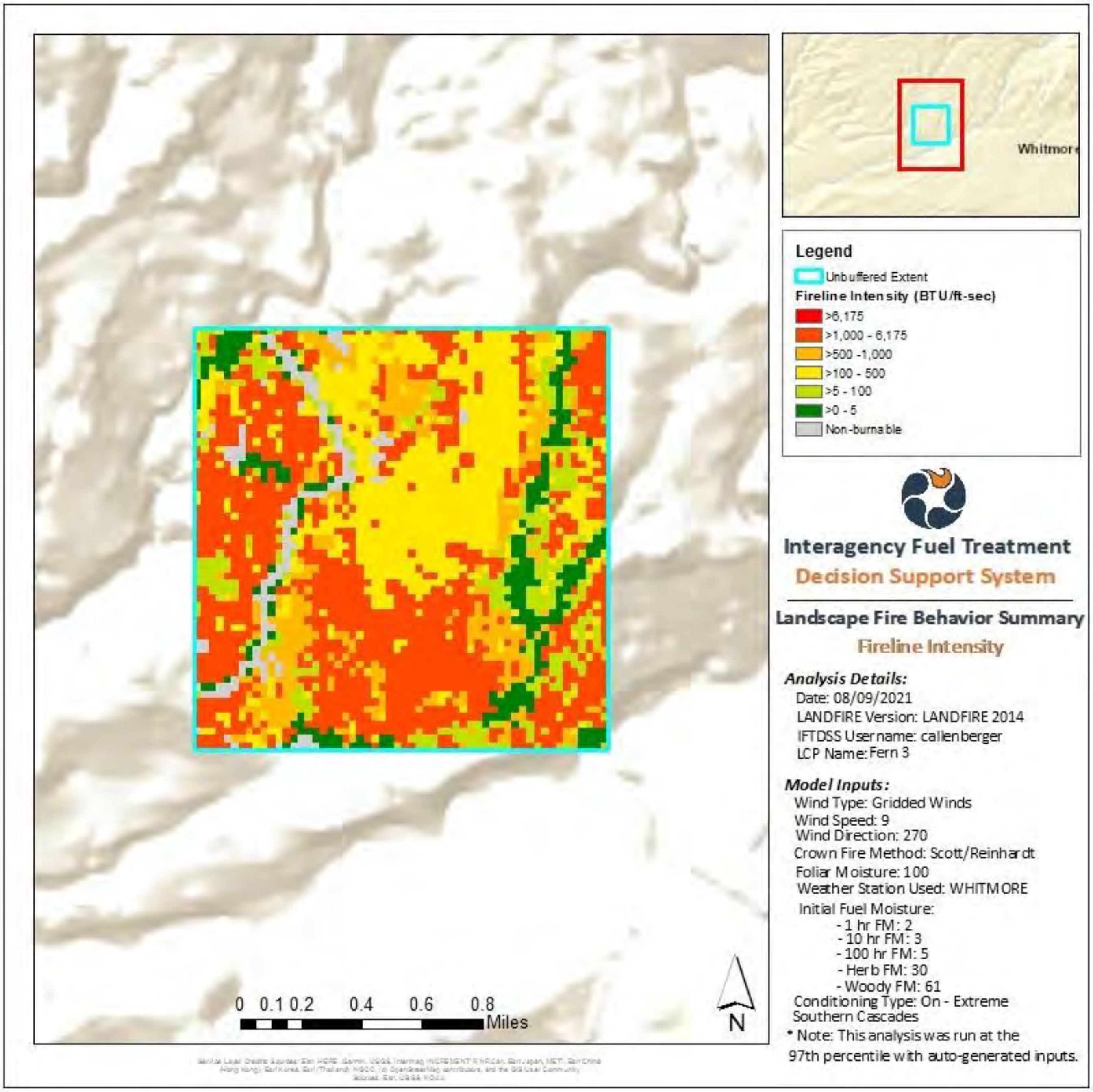
Rate of Spread (chains/hr) Data Summary within "Fern 3" Landscape
Source Landscape Name: Fern 3
Landfire Version: LANDFIRE 2014
Source Landscape Acres: 710
Model Name: Fern 3 - Auto97th
50
40
30
20
10
0
Percent
Non-burnable
>0 - 2
>2 - 5
>5 - 20
>20 - 50
>50 - 150
>150
chains/hr

Spread Rate

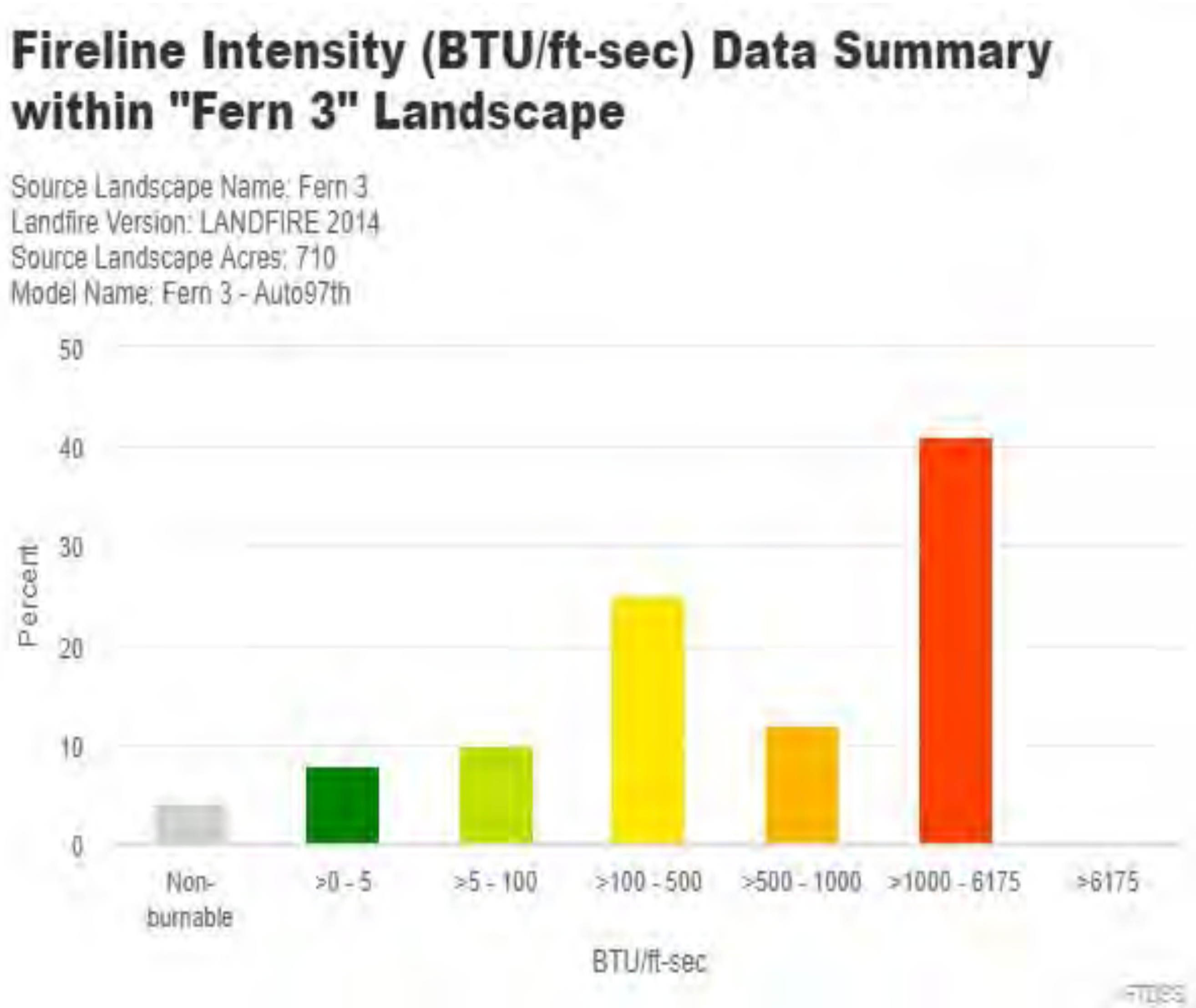


Rate of Spread (chains/hr)	Pixel Count (freq)	Acres In LCP	Percent In LCP
Non-burnable	137	30	4
>0 - 2	362	81	11
>2 - 5	73	16	2
>5 - 20	756	168	24
>20 - 50	1308	291	41
>50 - 150	556	124	17
>150	0	0	0

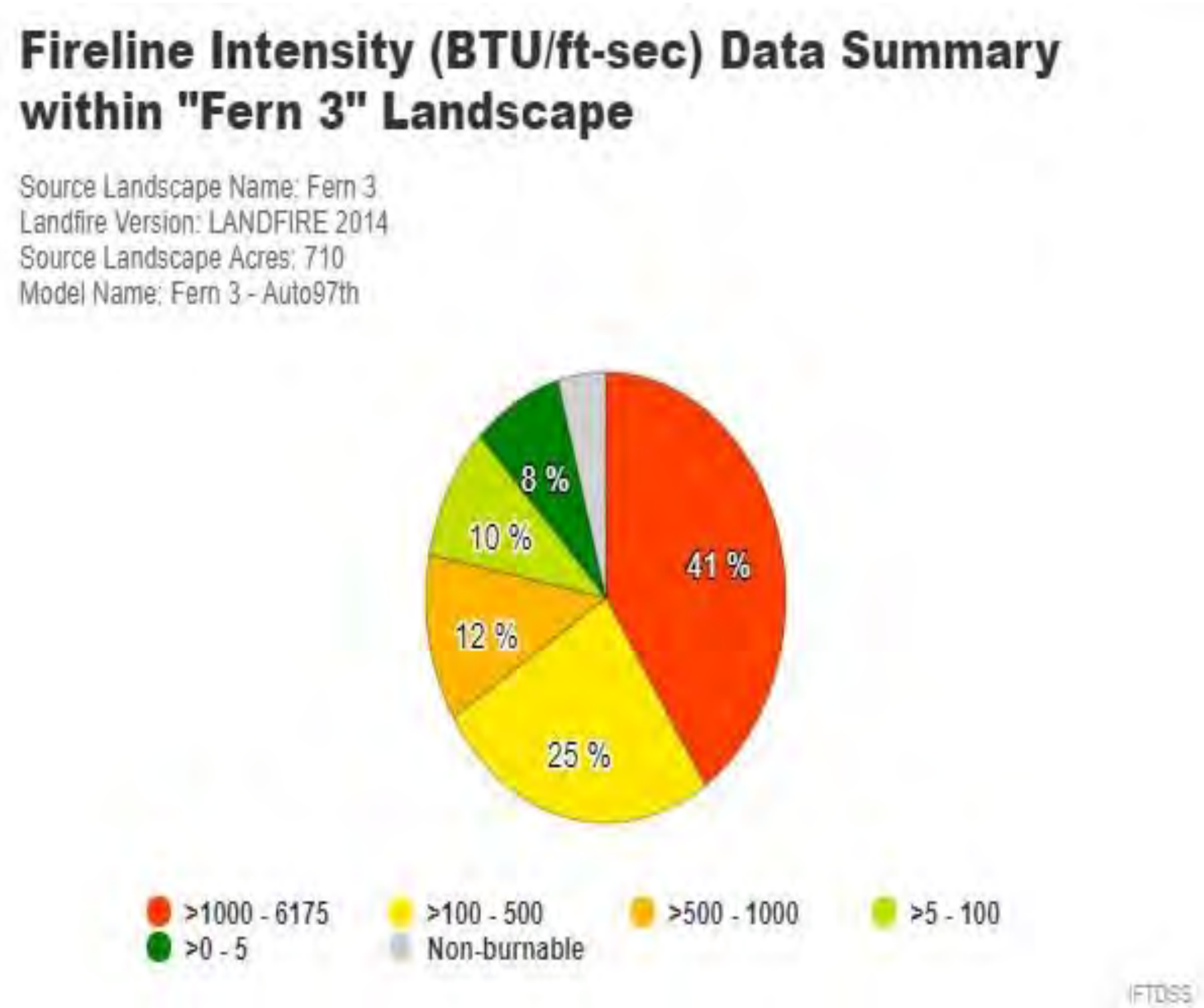
Intensity


Whitmore
Legend
Unbuffered Extent
Fireline Intensity (BTU/ft-sec)
>6,175
>1,000 - 6,175
>500 -1,000
>100 - 500
>5 - 100
>0 - 5
Non-burnable
Interagency Fuel Treatment
Decision Support System
Landscape Fire Behavior Summary
Fireline Intensity
Analysis Details:
Date: 08/09/2021
LANDFIRE Version: LANDFIRE 2014
IFTDSS Username: callenberger
LCP Name: Fern 3
Model Inputs:
Wind Type: Gridded Winds
Wind Speed: 9
Wind Direction: 270
Crown Fire Method: Scott/Reinhardt
Foliar Moisture: 100
Weather Station Used: WHITMORE
Initial Fuel Moisture:
- 1 hr FM: 2
- 10 hr FM: 3
- 100 hr FM: 5
- Herb FM: 30
- Woody FM: 61
Conditioning Type: On - Extreme
Southern Cascades
* Note: This analysis was run at the
97th percentile with auto-generated inputs.
0 0.1 0.2 0.4 0.6 0.8
Miles
N

Intensity

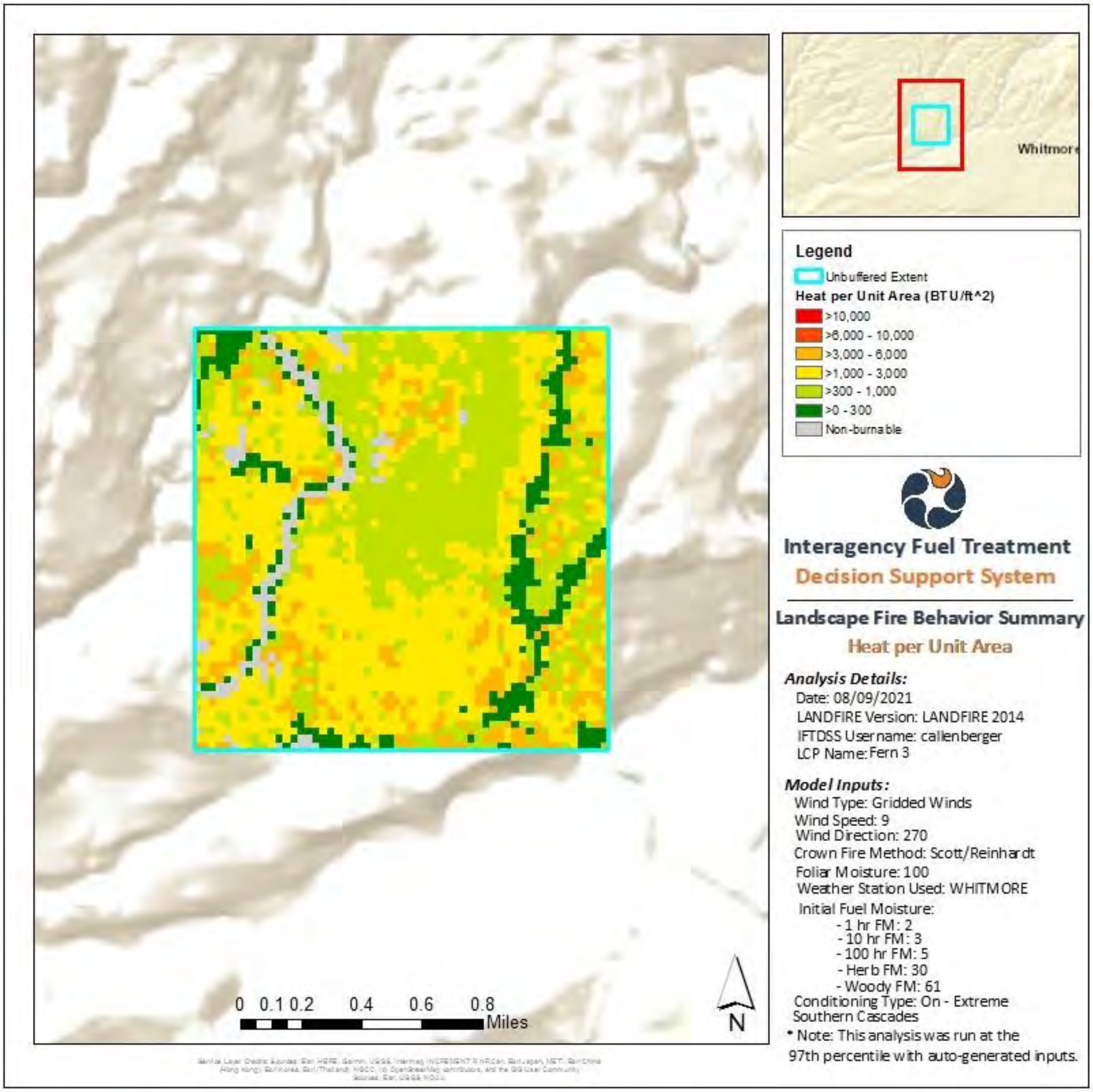

Fireline Intensity (BTU/ft-sec) Data Summary within "Fern 3" Landscape
Source Landscape Name: Fern 3
Landfire Version: LANDFIRE 2014
Source Landscape Acres: 710
Model Name: Fern 3 - Auto97th
50
40
30
20
10
0
Percent
Non-burnable
>0 - 5
>5 - 100
>100 - 500
>500 - 1000
>1000 - 6175
>6175
BTU/ft-sec

Intensity



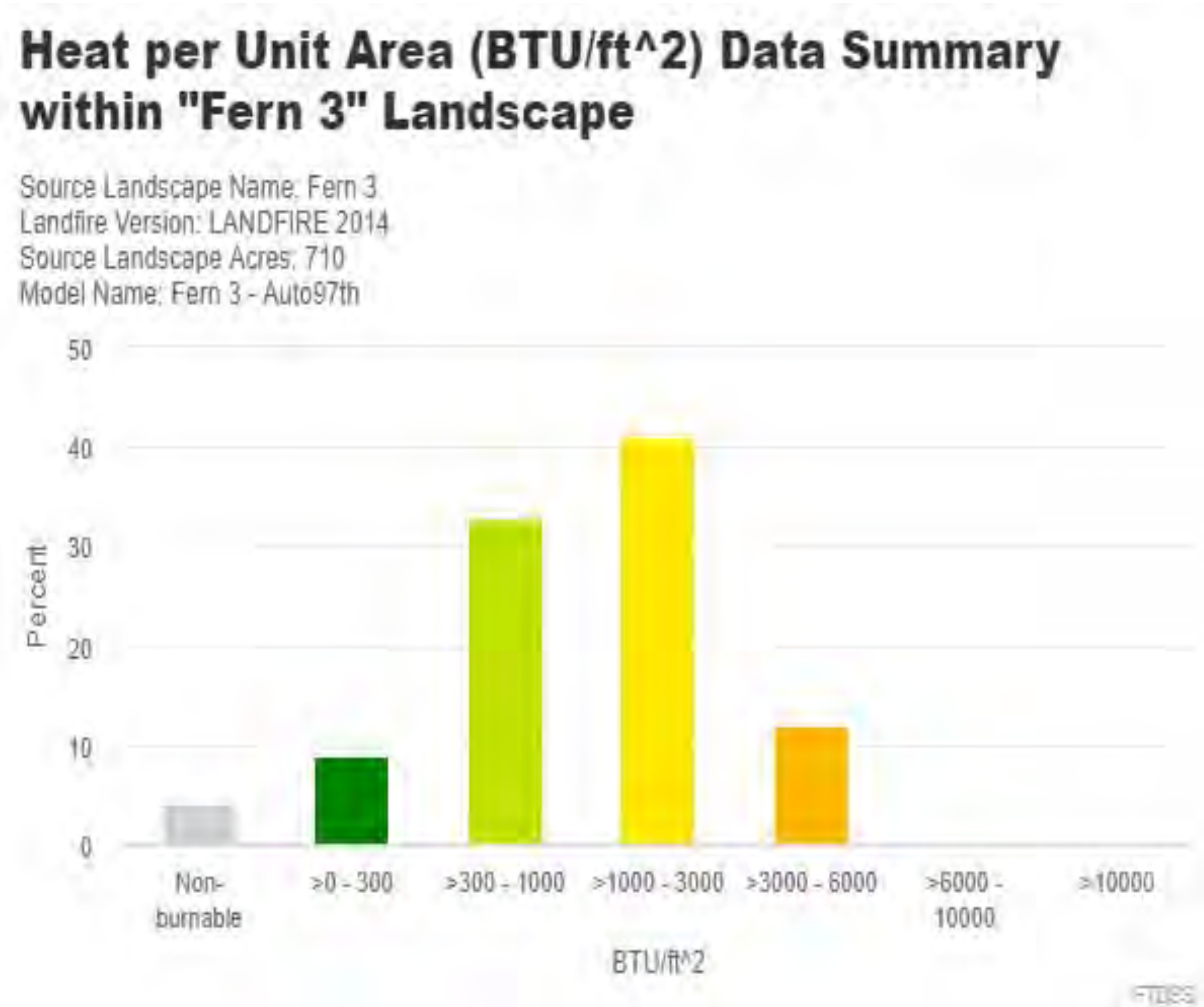
Fireline Intensity (BTU/ft-sec)	Pixel Count (freq)	Acres In LCP	Percent In LCP
Non-burnable	137	30	4
>0 - 5	255	57	8
>5 - 100	307	68	10
>100 - 500	810	180	25
>500 - 1,000	384	85	12
>1,000 - 6,175	1299	289	41
>6,175	0	0	0

Heat/Area

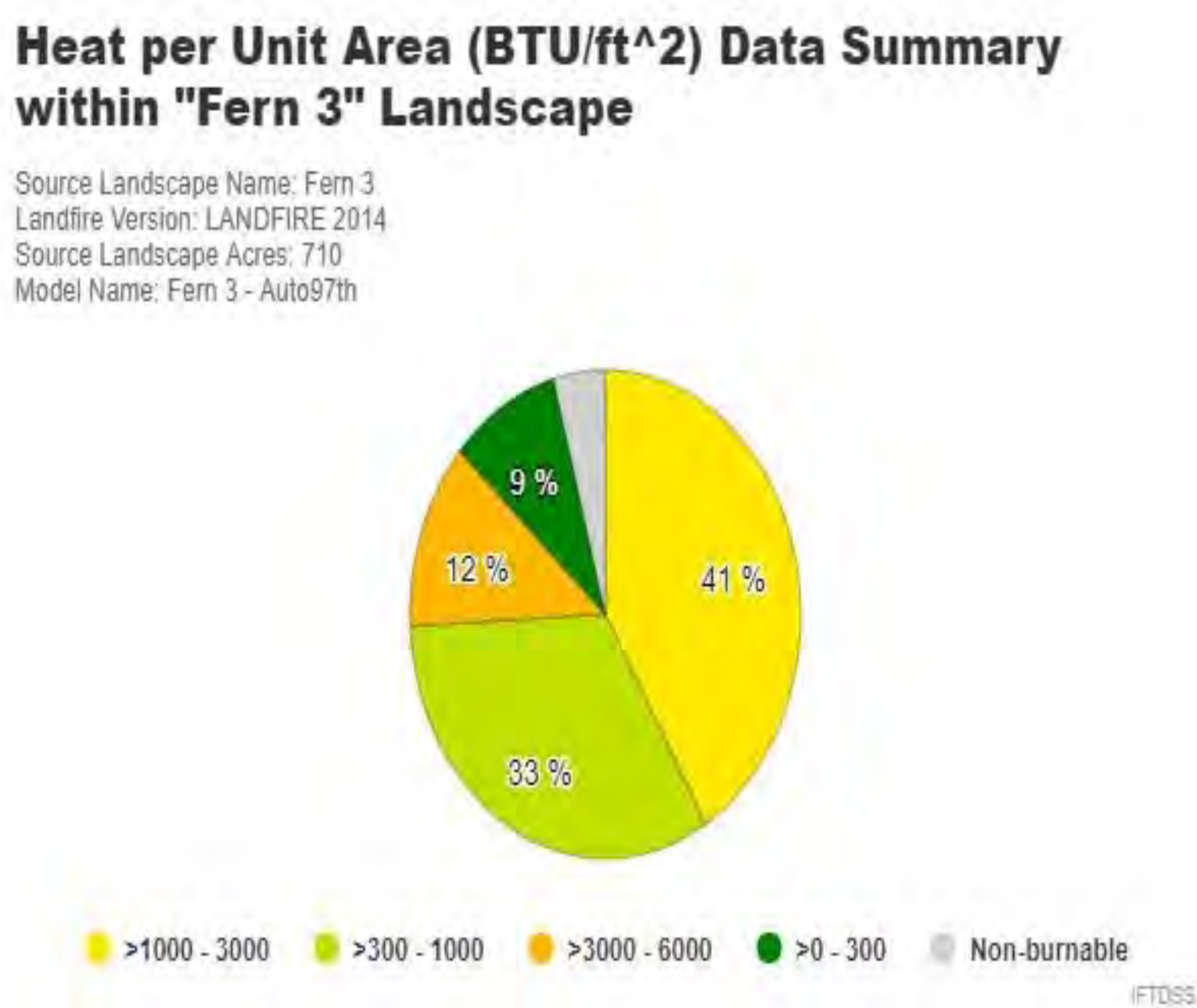


Whitmore
Legend
Unbuffered Extent
Heat per Unit Area (BTU/ft^2)
>10,000
>6,000 - 10,000
>3,000 - 6,000
>1,000 - 3,000
>300 - 1,000
>0 - 300
Non-burnable
Interagency Fuel Treatment
Decision Support System
Landscape Fire Behavior Summary
Heat per Unit Area
Analysis Details:
Date: 08/09/2021
LANDFIRE Version: LANDFIRE 2014
IFTDSS Username: callenberger
LCP Name: Fern 3
Model Inputs:
Wind Type: Gridded Winds
Wind Speed: 9
Wind Direction: 270
Crown Fire Method: Scott/Reinhardt
Foliar Moisture: 100
Weather Station Used: WHITMORE
Initial Fuel Moisture:
- 1 hr FM: 2
- 10 hr FM: 3
- 100 hr FM: 5
- Herb FM: 30
- Woody FM: 61
Conditioning Type: On - Extreme Southern Cascades
* Note: This analysis was run at the 97th percentile with auto-generated inputs.
0 0.1 0.2 0.4 0.6 0.8
Miles
N

Heat/Area

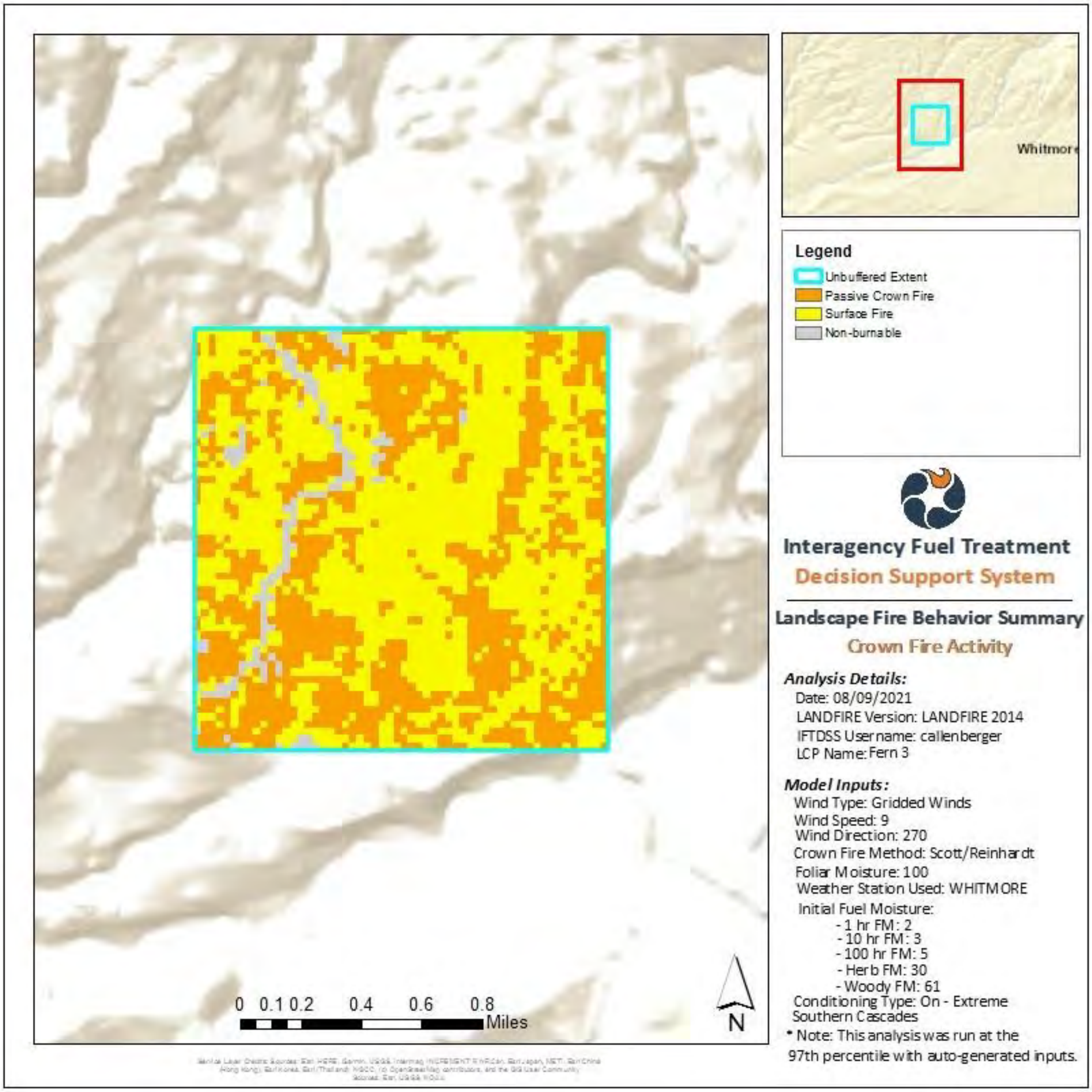

Heat per Unit Area (BTU/ft^2) Data Summary within "Fern 3" Landscape
Source Landscape Name: Fern 3
Landfire Version: LANDFIRE 2014
Source Landscape Acres: 710
Model Name: Fern 3 - Auto97th
Percent
50
40
30
20
10
0
Non-burnable
>0 - 300
>300 - 1000
>1000 - 3000
>3000 - 6000
>6000 - 10000
>10000
BTU/ft^2

Heat/Area

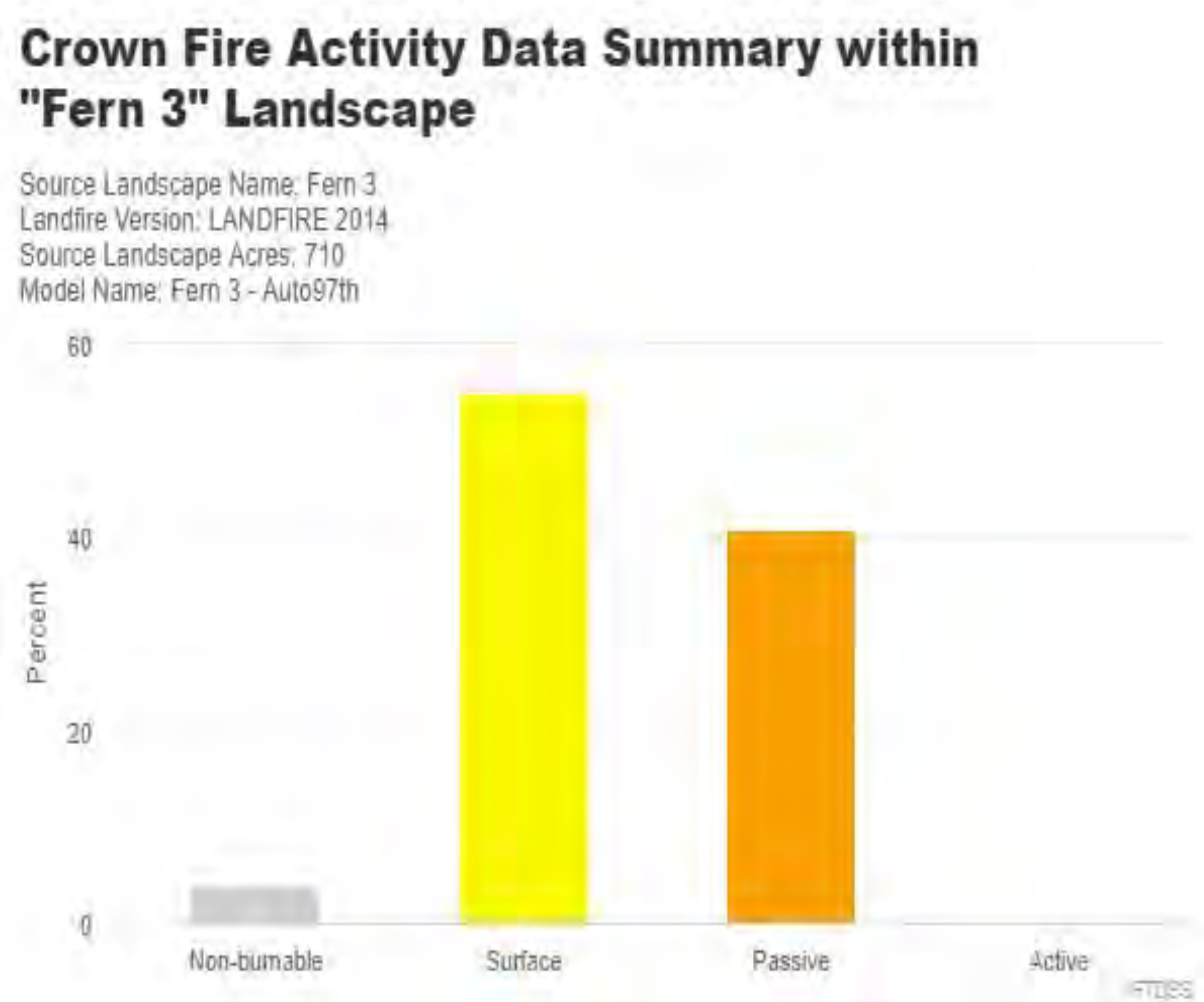


Heat per Unit Area (BTU/ft^2)	Pixel Count (freq)	Acres In LCP	Percent In LCP
Non-burnable	137	30	4
>0 - 300	289	64	9
>300 - 1,000	1047	233	33
>1,000 - 3,000	1323	294	41
>3,000 - 6,000	396	88	12
>6,000 - 10,000	0	0	0
>10,000	0	0	0

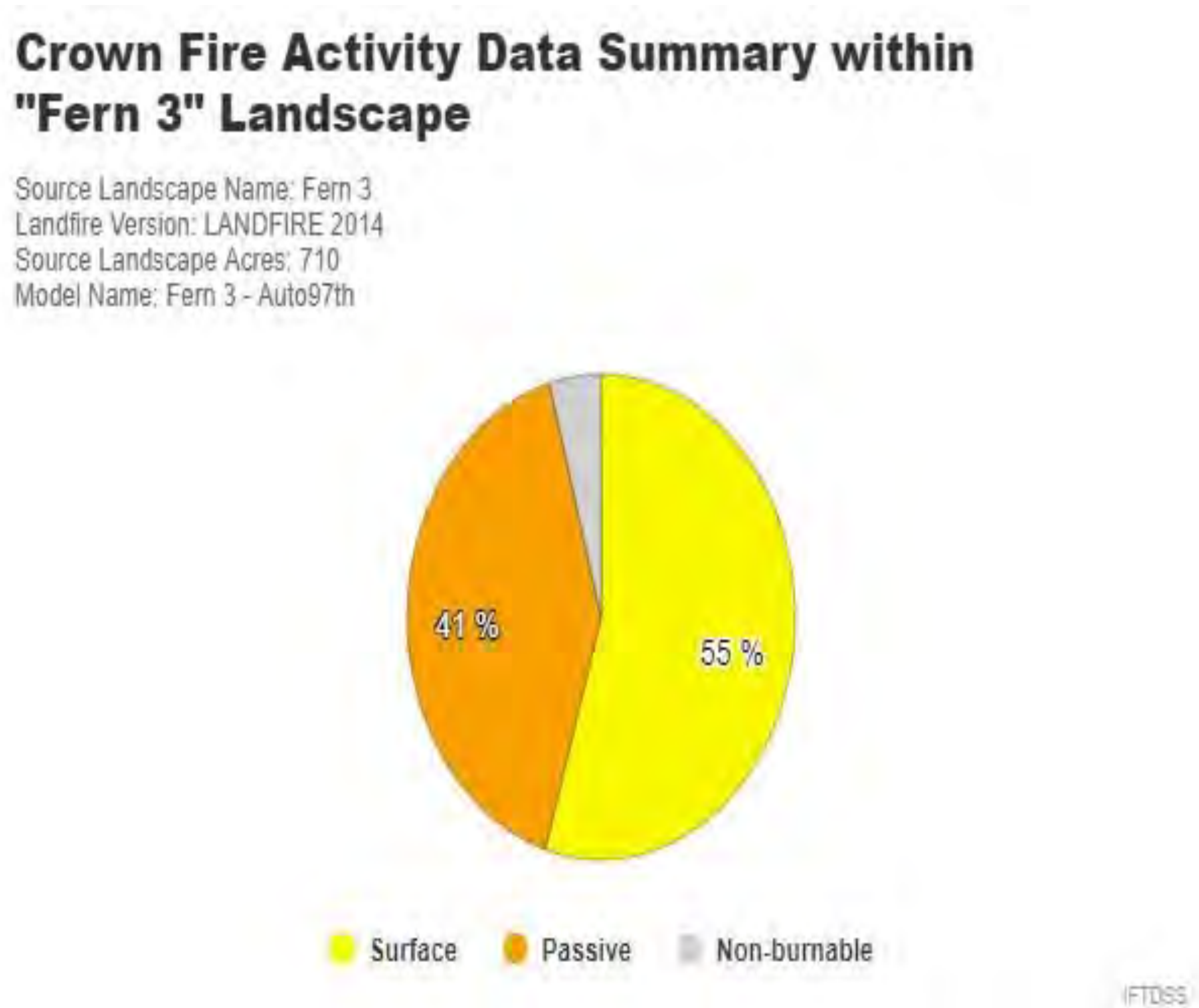
Heat/Area


Whitmore
Legend
Unbuffered Extent
Passive Crown Fire
Surface Fire
Non-burnable
Interagency Fuel Treatment
Decision Support System
Landscape Fire Behavior Summary
Crown Fire Activity
Analysis Details:
Date: 08/09/2021
LANDFIRE Version: LANDFIRE 2014
IFTDSS Username: callenberger
LCP Name: Fern 3
Model Inputs:
Wind Type: Gridded Winds
Wind Speed: 9
Wind Direction: 270
Crown Fire Method: Scott/Reinhardt
Foliar Moisture: 100
Weather Station Used: WHITMORE
Initial Fuel Moisture:
- 1 hr FM: 2
- 10 hr FM: 3
- 100 hr FM: 5
- Herb FM: 30
- Woody FM: 61
Conditioning Type: On - Extreme
Southern Cascades
* Note: This analysis was run at the 97th percentile with auto-generated inputs.
0 0.1 0.2 0.4 0.6 0.8
Miles
N

Heat/Area


Crown Fire Activity Data Summary within "Fern 3" Landscape
Source Landscape Name: Fern 3
Landfire Version: LANDFIRE 2014
Source Landscape Acres: 710
Model Name: Fern 3 - Auto97th
60
40
20
0
Percent
Non-burnable
Surface
Passive
Active
IFTDSS

Heat/Area



Crown Fire Activity	Pixel Count (freq)	Acres In LCP	Percent In LCP
Non-burnable	137	30	4
Surface Fire	1745	388	55
Passive Fire	1310	291	41
Active Fire	0	0	0