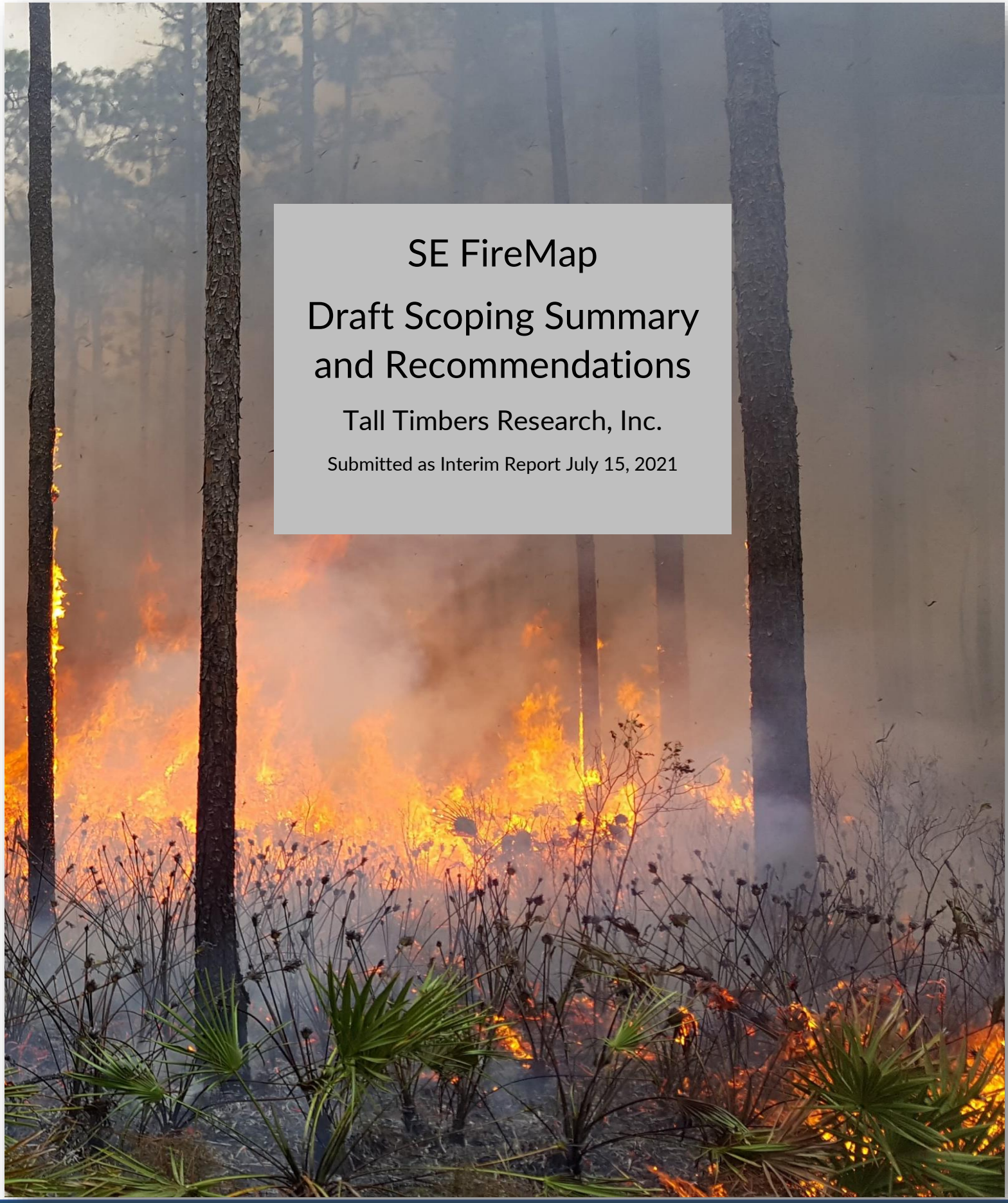

SE FireMap

Draft Scoping Summary and Recommendations

Tall Timbers Research, Inc.

Submitted as Interim Report July 15, 2021

Executive Summary

Tall Timbers Research, Inc. is pleased to present the July 15th 2021 Final Report and recommendations for the scoping agreement of the SE FireMap to the U.S. Endowment for Forestry and Communities and the USDA Natural Resources Conservation Service. The overall purpose of the scoping phase is to develop a cohesive and spatially explicit system to track both prescribed fire and wildfire on public and private lands. The development of a comprehensive spatially explicit map of fire occurrence remains one of the most critical needs for conservation in the Southeastern US. Knowledge of recent fire history is a key consideration for land management decisions supporting fire-dependent ecosystems. As more sophisticated models and tools for prescribed fire planning and fire risk analysis become available, the more important it is that current landscape conditions are accurately portrayed in these models. The SE FireMap will provide baseline information to ensure land management decisions are based on the most current information available. Fire occurrence on public and private lands in the Southeast is currently tracked by approximate location through various permitting systems or burn unit mapping that is done by some federal, state, and limited private land ownerships. In the case of permitting, these systems do not record perimeter data or include assessments regarding which burns are actually completed. Relying solely on these disparate systems results in documented data gaps when estimating the size, location and effectiveness of managed fires on a regional scale. Prescribed fires and wildfires mapped by either permit data or agency burn records underestimate the majority of burned areas on private lands which represent 87% of the land ownership in the Southeastern US.

Tall Timbers Research, Inc., as part of the scoping phase for the SE FireMap is addressing these needs by the assessment of advanced remote sensing techniques in order to make recommendations to track both prescribed fire and wildfire on both public and private lands.

Glossary of Terms and Concepts

Broadcast Burn is an open burn that is done for agricultural, silvicultural, or land clearing purposes and is not a pile.

CONUS The Conterminous United States; this reference excludes Alaska and Hawaii.

Florida Forest Service (FFS) is a division of the Florida Department of Agriculture and Consumer Services (FDACS) whose mission is to protect and manage forest resources in Florida.

Fire Information for Resource Management System (FIRMS) distributes Near Real-Time (NRT) active fire data within 3 hours of satellite observation from both the Moderate Resolution Imaging Spectroradiometer (MODIS) and the Visible Infrared Imaging Radiometer Suite (VIIRS).

Fire Mapping Information System (FMIS) integrated set of applications that handle data input, processing and reporting needs for the Florida Forest Service (FFS).

Global Fire Emissions Database (GFED) Database combining satellite information on fire activity and vegetation productivity to estimate gridded monthly burned area and fire emissions.

GOES-16 previously known as GOES-R, is part of the Geostationary Operational Environmental Satellite (GOES) system operated by the U.S. National Oceanic and Atmospheric Administration and is the first spacecraft in NOAA's next-generation of geostationary satellites. The GOES-R series satellites will provide advanced imaging with

increased spatial resolution and faster coverage, improving the detection of environmental phenomena.

GOES-17 (formerly GOES-S) is the second of the current generation of weather satellites operated by the National Oceanic and Atmospheric Administration (NOAA). The four satellites of the series (GOES-16, -17, -T, and -U) will extend the availability of the GOES (Geostationary Operational Environmental Satellite system) until 2036.

Google Earth Engine (GEE) is a cloud-based platform for planetary-scale environmental data analysis.

Hazard Mapping Systems (HMS) NOAA product suite that provides both fire and smoke analysis products. It is an interactive processing system that allows analysts to manually integrate data from automated fire detection algorithms using GOES and polar (Advanced Very High Resolution Radiometer (AVHRR) and Moderate Resolution Imaging Spectroradiometer (MODIS) images. The result is a quality controlled display of the locations of fires and significant smoke plumes detected by meteorological satellites.

Interagency Fire Occurrence Reporting Modules (InFORM) provides a single, nationwide system of record for both federal and state agencies to report wildfires. InFORM will eliminate redundant data entry, improve the quality and completeness of fire data, and make it easier to access.

Interagency Fuel Treatment Decision Support System (IFTDSS) is a web-based software and data integration framework that organizes fire and fuels software applications to make fuels treatment planning and analysis more efficient. The effort was initiated by the Joint Fire Science Program and the National Wildfire Coordinating Group (NWCG) Fuels Management Committee in 2007.

Integrated Reporting of Wildland-Fire Information (IRWIN) This service is a Wildland Fire Information and Technology (WFIT) affiliated investment intended to provide an "end-to-end" fire reporting capability. IRWIN is tasked with providing data exchange capabilities between existing applications used to manage data related to wildland fire incidents.

LANDFIRE (LF) Landscape Fire and Resource Management Planning Tools, is a shared program between the wildland fire management programs of the U.S. Department of Agriculture Forest Service and U.S. Department of the Interior, providing landscape-scale geospatial products to support cross-boundary planning, management, and operations.

LANDFIRE Disturbance products are developed to help inform updates to LANDFIRE (LF) data to reflect change on the landscape caused by management activities and natural disturbance, including both vegetation and fuel.

Landsat is a series of Earth-observing satellite missions jointly managed by NASA and the U.S. Geological Survey. Imagery is available since 1972 from six satellites in the LANDSAT series. These satellites have been a major component of NASA's Earth observation program.

LANDSAT Burned Area product is designed to identify burned areas across all ecosystems (e.g. forests, shrublands, and grasslands) for Landsat 4-8 data. The Landsat Burned Area product contains two acquisition-based raster data products that represent burn classification and burn probability. Landsat Burned Area is generated from U.S. Landsat Analysis Ready Data (ARD) Surface Reflectance and Top of Atmosphere Brightness Temperature data. The Landsat Burned Area product is processed to 30-meter spatial resolution in Albers Equal Area (AEA) projection using the World Geodetic System 1984 (WGS84) datum and gridded to a common tiling scheme.

Moderate Resolution Imaging Spectroradiometer (MODIS) is a key instrument aboard the Terra and Aqua satellites. The instruments capture data in 36 spectral bands ranging in wavelength from 0.4 μm to 14.4 μm and at varying spatial resolutions (2 bands at 250 m, 5 bands at 500 m and 29 bands at 1 km). Together the instruments image the entire Earth every 1 to 2 days. They are designed to provide measurements in large-scale global dynamics including changes in Earth's cloud cover, radiation budget and processes occurring in the oceans, on land, and in the lower atmosphere.

MODIS Burned Area Product contains burning and quality information on a per-pixel basis. Produced from both the Terra and Aqua MODIS-derived daily surface reflectance inputs,

the algorithm analyzes the daily surface reflectance dynamics to locate rapid changes, and uses that information to detect the approximate date of burning, mapping the spatial extent of recent fires only. It provides varied quality assessment information and a single summary quality assessment score for each pixel. The algorithm improves on previous methods by using a bi-directional reflectance (BRDF) model-based change detection approach to handle angular variations in the data and uses a statistical measure to identify change probability from a previously observed state.

Monitoring Trends in Burn Severity (MTBS) is an interagency program whose goal is to consistently map the burn severity and extent of large fires across all lands of the United States from 1984 to present. This includes all fires 1,000 acres or greater in the western United States and 500 acres or greater in the eastern Unites States. The extent of coverage includes the continental U.S., Alaska, Hawaii and Puerto Rico.

NatureServe Prescribed Fire Geodatabase developed in partnership with South Atlantic Landscape Conservation cooperative this database contains contributions from over 12 managing agencies totaling more than 1600 records with standard attribute fields.

Risk Management Assistance (RMS) Dashboard provides a series of tabs, linking the user to products to help line officers, agency administrators, fire managers, incident management teams, area commands, geographic area coordination centers, and multi-agency coordination groups make more risk-informed decisions.

Sentinel-2 is the Copernicus Sentinel-2 mission which comprises a constellation of two polar-orbiting satellites placed in the same sun-synchronous orbit, phased at 180° to each other. It aims at monitoring variability in land surface conditions, and its wide swath width (290 km) and high revisit time (10 days at the equator with one satellite, and 5 days with 2 satellites under cloud-free conditions which results in 2-3 days at mid-latitudes) will support monitoring of Earth's surface changes. The coverage limits are from between latitudes 56° south and 84° north.

Sentinel-3 The main objective of the Sentinel-3 mission is to measure sea surface topography, sea and land surface temperature, and ocean and land surface color with high

accuracy and reliability to support ocean forecasting systems, environmental monitoring and climate monitoring. The Sentinel-3 Mission Guide provides a high-level description of the mission objectives, satellite description and ground segment. It also covers an introduction to heritage missions, thematic areas and services, orbit characteristics and coverage, instrument payloads and data products.

Sea and Land Surface Temperature Radiometer (SLSTR) is a key instrument onboard the Sentinel-3 satellites. The sensor measures in nine spectral channels and two additional bands optimized for fire monitoring. The first six spectral bands cover the visible and near-infrared (VNIR) spectrum as well as the short-wave infrared (SWIR) spectrum; VNIR for bands 1 to 3, and SWIR for bands 4 to 6. These 6 bands have a spatial resolution of 500 m (1,600 ft), while bands 7 to 9 as well as the two additional bands have a spatial resolution of 1 km (0.6 mi).

Visible Infrared Imaging Radiometer Suite (VIIRS) is an instrument onboard the Suomi National Polar-Orbiting Partnership (S-NPP) and NOAA-20 satellites. The VIIRS instrument follows the legacy of, and improves upon, the measurements made by the NOAA AVHRR and the MODIS instruments on Aqua and Terra. VIIRS observes Earth's entire surface twice each day. The VIIRS instrument collects imagery of the land, atmosphere, oceans, and cryosphere across 22 spectral bands, ranging in wavelengths from 0.41 to 12.5 microns, and at two native spatial resolutions: 375m (I-bands) and 750m (M-bands).

Wildland Fire Management Application (WFMAP) is a web-based application that allows users and U.S. Department of Defense (DOD) Military installations to input and analyze fire data.

Background

Cost-effective and efficient management of conservation lands requires up-to-date detailed resource maps. There are numerous sources for detailed land cover, species, and habitat suitability datasets for the Southeast. Many species in the Southeast are dependent on fire for maintenance of appropriate habitat conditions. For these species, managing an appropriate fire return interval is critical. This and other key qualitative attribute have long been identified as a critical data gap pertaining to prescribed fire. For over a decade, resource managers across the Southeast have recognized the importance of tracking and monitoring the use of prescribed fire. For example, differentiating areas that have an appropriate fire return interval from areas without an appropriate fire return interval would allow managers to focus resources on areas most in need of management actions, as well as serve as a means to measure and quantify the success of conservation and restoration efforts. Thus, mapping and providing qualitative attributes based on fire regime characteristics, such as fire return interval, would inform the targeted acquisition of conservation lands, increase the effectiveness of land and fire management, and allow for tracking the success and failure of conservation efforts.

With the release of the SE FireMap 1.0 beta viewer and datasets in April of 2021, a critical gap has been filled with regards to tracking the current and historic fire regime characteristics on both public and private lands in the Southeast.

The following report details the steps taken in the scoping process, the development of the SE FireMap 1.0 beta and the recommendations based on our discovery and feedback during the scoping process.

Scoping Overview

The overall aim of the scoping process for the SE FireMap was to develop a robust understanding of the data sources and reporting capabilities that are available for advanced monitoring of wildfire and prescribed fire on both public and private lands across the Southeastern United States.

Tall Timbers, in partnership with the Southern Fire Exchange, began the scoping effort on April 16th, 2020. The Natural Resources Conservation Service and U.S Endowment for Forestry and Communities established the SE FireMap Technical Oversight Team (TOT) to serve as the advisory body for the proposed SE FireMap initiative. The TOT is comprised of subject area experts from a variety of organizations who expressed an interest in directly supporting the project. TOT meetings were facilitated by the Longleaf Alliance.

Tall Timbers was tasked with the following deliverables:

1) Up to 8 meetings, workshops, webinars or conference calls to convene partners and experts to discuss broadly the current data collection, technologies and/or mapping being conducted in the Southeast and elsewhere, with at least two such events focused outside the Southeast;

2) A summary report from each of the above events due within 1 week of the event;

3) A list with moderate detail describing the existing relevant mapping efforts, data collection and/or technologies reviewed as part of this Scoping Phase, including a brief assessment of their strengths and weaknesses as it pertains to the end-user (scale, coverage, accessibility, format, interface, etc.), and a contact person for each;

4) Clear, detailed recommendations for building a scalable SE FireMap database that depicts fire occurrences in the Southeastern U.S. at various landscape scales through a web interface that supports simple queries, reports and downloads as either Excel spreadsheets, pdf(s) or shapefile(s). Recommendations will include how to expand the SE FireMap to help ensure seamless fire planning at larger geographies of the U.S. (especially Western states, if there is interest in doing so);

5) An approximate cost range for developing the SE FireMap as described above;

6) Participation, as needed but at least bi-monthly, in conference calls or online meetings with the Technical Oversight Team convened to lead this project;

7) One in-person meeting of the Technical Oversight Team at the end of this project to discuss findings and final recommendations;

8) Status briefings, as needed and on request, for the Endowment or the Technical Oversight Team Coordinator to support their need to keep partners updated on status of the Scoping Phase.

Critical Dates and Activities

4/16/2020 Initial planning web-meeting with project leads and TOT

4/23/2020 Meeting updates to TOT

4/23/2020 Interim Report #1 submitted

4/23/2020 Survey developed by TT and SFE to gain focus for future meetings

5/08/2020 TOT Meeting – Landscape Portal Intro & Scoping Review

5/28/2020 Webinar Meeting #1 (Carl Nordman, NatureServe and Andy Beavers CEMML

6/30/2020 Webinar Meeting #2 (Todd Hawbaker, USGS/Beth Stys, FFWC and Josh Picotte, USGS)

7/15/2020 Interim Report #2 submitted

8/07/2020 Interim Report #2 Q/A presentation to TOT

10/06/2020 Webinar Meeting #3 presentation of InFORM , IFTDSS and Southern Fire Risk Assessment (Kim Ernstrom, USFS/Andrew Kirsch, NPS/Curt Stripling, SouthWRAP

10/15/2020 Interim Report #3 submitted

11/05/2020 Modification approved

12/09/2020 MTBS Postfire Tool Demo – Burn Severity Mapping Meeting (Michael Bogle, USFS, Josh Picotte, USGS

12/09/2020 Fire History/Fire Metrics Discussion (Lou Ballard, Edwin Christopher, Tate Fischer, Jennifer Hincley, Cameron Tongier, Jon Wallace, USFWS; Melanie Vanderhoof, USGS, Todd Hawbaker, USGS)

12/31/2020: SE FireMap Scoping Survey closed

12/27/2020 SE FHM processing completed

01/13/2021 Google Earth Engine SE FHM draft viewer completed

01/15/2021 Interim Report #4 submitted

01/30/2021 QA/QC Draft SE FHM completed and clipped

03/15/2021 Google Earth Engine SE FHM viewer enhancements completed

04/01/2021 User guides, product information guides, metadata and product survey completed for portal upload.

04/05/2021 Data use agreement finalized

04/10/2021 Data distribution site setup with reporting

04/16/2021 SE FireMap SFE Webinar conducted. Link: https://youtu.be/0FitNpo4MW4

05/19/2021 Modification 2 signed, ongoing support of viewer and data delivery

07-15-2021 Final Report and Recommendations submitted

Ongoing – Receive feedback and data distribution. Google Earth Engine viewer support

Scoping Summary

The scoping activities, webinars, analysis and survey results are detailed in each interim report. A brief summary of each report is provided here with referenced appendices.

Interim Report 1 (April 23, 2020) Appendix A:

Initial meeting to introduce TOT members and SE FireMap project, providing goals and vision for the project as well as the proposed timeline. Introduction of the Landscape Partnership Portal and upcoming webinar series. Receive recommendations from TOT on webinar content and survey questions.

Interim Report 2 (July 15, 2020) Appendix B:

1. We address Active Fire detection methods and the feasibility of using these products for prescribed fire tracking. We discuss methods to validate active fire products by comparing active fire locations to prescribed burn authorization records obtained from the Florida Forest Service Fire Management Information System (FMIS).
2. We address Burned Area detection methods and the feasibility of using these products for prescribed fire tracking. We discuss methods to validate burned area products by comparing burned area locations to prescribed burn records obtained from private land owners and public agencies. Furthermore, we examine the various ways these collaborators map prescribed fire and wildfire on their lands and examine some of the challenges of using these data for validation of remotely sensed fires.
3. We explore the feasibility of using novel processing platforms (i.e. Google Earth Engine) to replicate a number of operational fire mapping techniques.
4. First two webinar reports submitted.

Interim Report 3 (October 15, 2020) Appendix C:

1. Complete review of data aggregation and analysis
2. End user interface review, Google Earth Engine and ArcGIS
3. Explore burn severity mapping and integration with SE FireMap via Google Earth Engine
4. Modification to agreement: Tall Timbers will add processing infrastructure and produce fire history metrics based on Landsat Burned Area (BA) USGS products. Fire history metrics (FHM) will include Fire Frequency (FFQ), Longest Fire Free Interval (LFFI), Time Since Previous Fire (TSPF), and Year Last Burned (YLB). Processing extent will be 49 ARD tiles.

Interim Report 4 (January 15, 2021) Appendix D:

1. SE FireMap v1.0 Beta completed and submitted to portal
2. Google Earth Engine burn severity mapping application
3. Public survey responses

Interim Report 5 (April 30, 2021) Appendix E:

1. Process updates
2. Data Use Agreement completed and posted on portal
3. Product Information Guide and User guide completed and posted to portal
4. Product feedback survey posted to portal
5. Google Drive distribution and tracking site completed

Recommendations

Recommendations for continued development and enhancement of the SE FireMap are based on the expert opinion of Tall Timbers scientists, analysts and collaborators. Additionally, feedback from webinars and surveys was taken into consideration throughout the scoping process.

Recommendation for a SE FireMap application will be broken down into the logical components of primary mapping product (primary product dataset) and update schedule; supporting datasets and products to support the SE FireMap; web interface to include

analysis, reporting, query, and download capabilities; training and implementation. Several mapping products may be used to create the best spatial representation of fire on both public and private lands with the goal of using standardized methods. Recommendations will be made based on those data aggregation and analysis products examined during the scoping process. Emphasis will be given to recommendations from the TOT as to what type of query and reporting needs will be required to meet the needs of the SE FireMap. It is expected that as the SE FireMap moves from the scoping phase into the product development phase that specific recommendations based on end user needs will be required for continued success. It is recommended that a technical advisory team be established to answer specific questions of functionality, query and reporting.

Recommended Project Components for Scoping Process:

1. Primary Mapping Products
2. Supporting Datasets and Products
3. Web User Interface
4. Training and Implementation

Primary Mapping Products:

Background:

Federal, state, and limited private land managers that apply annual prescribed fire plans typically have a method for documenting and tracking acres of prescribed fires each year. While these methods provide a historical record of fire occurrence, there are inconsistencies in how prescribed fire is tracked across agencies and private lands managers. There is no cross-dataset standardization in any manner: projections, tracking, and reporting methods vary among ownerships; fields and attributes differ; various time periods area covered; and data types differ. For example, some landowners may record an entire burn unit for a prescribed fire as having burned even if the burn is patchy or incomplete; other landowners may subset the burnable area within the unit. This makes it

challenging to accurately quantify the acreage of prescribed fire occurring at state-wide to national scales.

Burned Area (BA) products generated from satellite remote sensing techniques provide a historical record of fire occurrence both spatially and temporally and are collected using a standardized methodology, independent of prescribed fire records. One benefit to using satellite derived burned areas, is that the spatial extent of past fires can often be delineated to a higher degree of detail than other ancillary data such as burn units and burnable vegetation. On the other hand, some fires are more difficult to delineate by remote sensing. Common impediments to burned area detection/mapping include rapid green-up following a burn; cloud cover and shadows obscuring burn signatures; difficulty detecting or differentiating a low intensity burn signature beneath tree canopies; and the satellite product resolution often being too coarse to capture fine-scale differences or small burns (Hawbaker et al. 2008, 2017).

We examined BA products including MCD64A1 (MODIS), Fire CCI51 (MODIS), Landsat BA, and Sentinel-2 BA. The USGS Landsat BA (Hawbaker et al., 2020) product which was used to create the SE FireMap v1.0 beta is currently the finest resolution burned area product operationally produced and has the longest time span of data; 1984-2021 across the United States. (See Appendix B)

We also explored Suomi-NPP (VIIRS), MODIS, Sentinel-3A/B (SLSTR) and GOES-16/17 (ABI) Active Fire (AF) products. Active Fire (AF) products generated from satellite remote sensing techniques provide natural resource managers with near real-time detection and characterization of wildland fire conditions in a geospatial context across the globe.

AF products are delivered in a point based format and characterize daily fire detection data based on thermal anomalies. AF points represent the centroid of a fire detection pixel (i.e. the footprint) that signifies an active fire detection location at the time of the satellite overpass.

While the VIIRS sensor represents a step forward in the ability to detect prescribed fires in near real time, there are still severe spatial limitations that exist with the active fire data

that make it challenging to accurately represent a burned area mosaic across the landscape (See Appendix B).

Additionally, we did an extensive literature review of high spatial resolution commercial imagery as it relates to burned area mapping and burn severity mapping. We were limited in our ability to test due to the high cost of the imagery and found that most studies were focused on individual fires or a small spatial extent as a result of the high cost. While some commercial satellites provide suitable spectral band wavelength to map burned areas, at the current time it would be cost prohibitive to consider commercial high resolution imagery for regional or national mapping efforts.

Recommendations:

Tall Timbers supports continued collaboration with USGS and the use of Landsat BA products as the primary dataset for the SE FireMap. Currently, the Landsat BA products provide the finest resolution burned area product operationally produced across the United States and the USGS continues to support improvements to the product. The Landsat BA products also provide the longest fire history record with a catalog beginning in 1984. Expected improvements to the Landsat BA products include either a complementary Sentinel-2 product or a harmonized Landsat BA/Sentinel-2 product that will increase both spatial and temporal resolution of future BA mapping products. USGS is currently working on methods to map wetland burned area with Sentinel-2 in the Southeast with methods currently in review for publication. These methods are expected to expand to other ecosystems in the future.

Additionally, the USGS has received internal support and funding to provide the Landsat BA fire history metrics developed by Tall Timbers, and used in the SE FireMap v1.0 beta,

through the USGS Science Catalog and Google Earth Engine for the extent of CONUS beginning in the near future.

We further recommend that NRCS develop a memorandum of understanding (MOU) or interagency agreement with USGS that will formalize a partnership to ensure ongoing support and collaboration for future development of the SE FireMap.

Supporting Products and Datasets:

Background

Secondary datasets and products are defined as those datasets that add value and context to the primary fire mapping product. Most of these datasets already exist or are being developed specifically to interface with the SE FireMap.

Cost effective and efficient management of conservation lands requires up-to-date detailed resource maps. In order to answer questions related to conservation planning and prioritization, it is critical that other indicators of ecosystem health be included in any comprehensive mapping effort.

Recommendations:

It is critical to include these secondary datasets in the decision support tools used with the SE FireMap. Datasets of specific fire dependent habitats and species critical to conservation planning and prioritization modeling are needed to complement the fire history metrics and answer specific questions of importance to NRCS and partners. Furthermore, supporting fire related datasets can provide additional insights into the distributions of wildfire vs. prescribed fire within the SE FireMap. Incorporating these secondary datasets will also enhance query and reporting capabilities in the SE FireMap, allowing resource managers to answer complexe questions based on multiple inputs.

Specific Datasets Recommended(nonexclusive):

1. National Land Cover Database (NLCD) 2019
2. Range-wide habitat suitability maps for at-risk species in the longleaf system (Crawford et al. 2020)
3. The Southeast Longleaf Occurrences (LEO) Geodatabase
4. Combined wildfire datasets for the United States and certain territories, 1878-2019 (Welty & Jeffries, 2020)
5. The Southeast Burn Permit Database (Tall Timbers Geospatial 2021, in development)

Web User Interface

Background:

The web user interface generally refers to the operation, look and feel of how the end user interacts with the system through a variety of input and output tools. The web user interface can be developed in a variety of software platforms. It is expected that as the SE FireMap moves from the scoping phase into the product development phase that specific recommendations based on end user needs will be required for continued success. It is recommended that a development team be established to answer specific questions of functionality, query and reporting which will determine the eventual development platform.

As part of the SE FireMap scoping effort, two web user interfaces were developed using two separate software platforms. Initial development for proof of concept was done for the Longleaf Legacy Landscape Viewer (LLLV2) in a map viewer app configured using ESRI's ArcGIS Web AppBuilder, a component within its ArcGIS Enterprise software (v10.7.1). The map viewer provides fire history, species habitat and land cover data

generalized to a 10-acre hexgrid covering the tri-state Longleaf Legacy Landscape area. The data is best used at large scales for display and query purposes. The LLLV2 includes updated fire history data and fire history metrics for years between 1994-2019 (see Appendix C).

The second web user interface was developed in Google Earth Engine (GEE), a powerful web-platform for cloud-based processing of remote sensing data on large scales. Layers included Year Last Burned, Time Since Previous Fire, Longest Fire Free Interval, Fire Frequency, Annual Burned Area (1994-2019), National Land Cover Database (2016) as well as public lands, LIT areas and conservation lands (see Appendix D).

At the request of the TOT, several other GEE applications were created or modified and evaluated including a rapid burn severity mapping and a Landsat and Sentinel-2 reference imagery viewer.

Recommendations:

The web user interface is a critical component of the SE FireMap. The user interface, regardless of the platform used, should be easy to navigate and directly address tasks as they relate to NRCS workflow.

It is recommended that a dedicated development team assess the specific needs of NRCS with regards to query and reporting needs as it will dictate database/end user application design. The web user interface can be viewed as somewhat separate than the products that it is consuming. The web user interface should remain somewhat constant over time regardless of the remotely sensed fire datasets and traditional fire polygon records it may consume. It is expected that data inputs will change and improve as new technology becomes available but the database/end user application design should be designed in a manner to accommodate those changes.

As stated above, the web user interface should specifically address tasks in the NRCS workflow. The temptation to create a “one stop shopping” web mapping application that tries to combine functionality such as burn severity mapping and active fire detection that exists in other existing and supported applications should be avoided.

Based on feedback from the TOT and public surveys, the minimum functions of the web user interface should contain the following:

1. Navigation tools: zoom, zoom to target, pan
2. Layer tools; draw, change symbology, change base layer, adjust opacity
3. Query tools: identify, select by attribute, ability to perform dynamic queries as well as user defined queries.
4. Download datasets
5. Export map

Training and Implementation

Background:

It is imperative to understand how the underlying data of the SE FireMap were produced, along with their strengths and weaknesses. This enables decision makers at all levels to determine if these products can be used to address specific objectives related to resource management. Furthermore, demonstrating how these data can be incorporated into technical analyses can provide a proof of concept for resource managers that are looking for ways to incorporate this novel product into their workflows.

As part of the data use agreement, we provided a detailed description of the underlying SE FireMap products and their limitations. As these data are remotely sensed products, it is important to highlight their differences from traditional prescribed fire records (i.e. burn permits, GPS delineations, etc.).

We also developed a workflow to integrate the Fire History Metrics into a regional prioritization model that highlights high quality longleaf pine habitats by combining and weighting datasets including but not limited to: land cover, rare species habitat, and fire frequency. We are currently working with the Tall Timbers Land Conservancy to make an operational prioritization model that will help assist their resource allocation for land

protection in the Red Hills Region. Documentation of this workflow and its implementation has subsequently been developed.

Recommendations:

Training workshops can be an effective way to inform and focus end users about these products, obtain critical feedback that will be used for product enhancements, as well as track user engagement with these products. Therefore, it is recommended that focus groups be created, with a set agenda and focus on obtaining feedback from end users regarding how they hope to use the data, how the products can be improved, and what additional datasets/tools may be able to enhance their experience with these data. Furthermore, additional or extended workshops can be tailored around the implementation of these products which can provide specific training and examples for the management community. The ability to incorporate the datasets present in the SE FireMap into prioritization modeling and focused reporting can streamline existing workflows and bring new insight into management practices.

Cost Estimate:

Estimating costs for developing the SE FireMap as described above and based on the recommendations from the scoping phase is challenging since individual requests for proposals (RFPs) would need to be solicited in order to compare and estimate costs. The request for proposal process would require that detailed specifications for both the burned area product and decisions support tools would need to be communicated to potential vendors.

The scoping effort was successful in examining the current fire mapping efforts and providing examples of decision support tools. However, the TOT was not tasked with delivering detailed product recommendations and specifications.

Based on the specific recommendations in this report, we estimate the cost for developing the SE FireMap with non-commercial imagery and datasets and using industry available software for building the decision support tools would be between 1 and 1.5 million dollars and would require a 3-5 year effort to complete. This estimate is based on a

contract with from either a university, government agency or non-governmental organization. If a commercial vendor and commercial imagery were specified, the cost would be much higher.