Illuminating Botanical Blackholes to Inform Habitat Restoration in the Zaca and Jesusita Fire Scars

Final Report

September 2019

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Summary of Accomplishments

Grant period of performance, with extension: (*June 1, 2017 to June 30, 2019*)

Grant reporting period (*June 1, 2017 to 30 September, 2019*)

The Santa Barbara Botanic Garden (SBBG) received a grant from the National Fish and Wildlife Foundation to conduct comprehensive botanical surveys, particularly for rare and invasive plants, throughout both the Zaca and Jesusita fire scars. We conducted this work on all roads, maintained trails, and firebreaks throughout both fire scars. In the process we identified areas in need of recovery action, and collected seed for both rare plant conservation and habitat restoration. We also used this opportunity to train and mentor local students in botany, and to communicate our findings to diverse audiences through social media. Our trips took the form of day hikes, two and three-day backpacking or car camping trips, three-day horseback trips, and five-day mule pack trips.

Over the course of this project, we covered at least 735 total miles, mapping a net 324 miles at least once, over 307 people days. We mapped 19 rare plant taxa in 237 "populations" (polygon or point features), and 44 weed taxa in 604 "populations" (polygons). We collected 3,628 herbarium specimens, well over our goal of 2,680, which will further the general botanical knowledge for this little-surveyed area (botanical black hole). We also made seven conservation seed collections of rare species, and 24 collections of more common plant taxa for future restoration needs. This project has benefitted from 2,390 hours of service to date from over 60 different volunteers. We have reached 45,315 people and counting with our Facebook posts, and 812 people via five different public and professional presentations, about the value of the Los Padres National Forest, the threat of invasive plants, fire ecology, and much more. The data that we have gathered are helping to guide restoration actions in the Los Padres National Forest.

Project Activities and Timing

<u>Preparation</u>

We received spatial data and Forest Service data collection rules from USFS botanist Lloyd Simpson on September 13, 2017. We then worked to develop a data dictionary that encompassed their required fields, as well as those of the California Natural Diversity Database (**Figure 1**). We received our Forest Service permit to collect herbarium specimens and work with rare plants on January 17, 2018.

We began our equipment research and purchasing in Fall 2017. After consultation with various experts, and consulting those at Trimble about the future of their product lines, we purchased three iPad mini 4s (with Merit waterproof cases and screen protectors) and loaded them with Earth Systems Research Institute (ESRI)'s Collector App, as well as rare plant fact sheets and the Jepson Manual for identification of California plants. The advantage of these units is that they enable polygon delineation by hand directly onto an aerial background image. We used these as our primary mapping devices, together with BadElf GNSS surveyors, which can achieve accuracy of approximately 1 meter. We also purchased Trimble Juno 3B and Garmin E-trex units as a lower-tech backup system in case of primary system failure, as well as laser rangefinders and compasses to use with these units, to estimate the direction and distance of

polygon edges that are off the trail. Because many times we had two trips out at once, we purchased an additional iPad setup by the end of the 2018 field season, for four in total.

To ensure that we would have sufficient energy supply for our longer trips, we purchased several charging devices, including a Sherpa 50 power pack, Sherpa inverter, and Nomad 20 solar panel. For safety and communication, we acquired SPOT devices for evening check-ins and emergency communication, and 2-way radios ($660 in-kind). Field vests with multiple pockets helped us to have all of the gear we needed at the ready: iPad, BadElf, compass, field notebook, camera (phone), and hand lens. We also acquired additional soft herbarium presses for field use, as well as additional clippers and hori-hori soil knives for collecting herbarium specimens.

We held a route planning session at the Garden with Bryan Conant (Los Padres Forest Association) and Graham Goodfield (Los Padres Outfitters) in February 2018, at which we discussed water availability on our trails and the best routes for our 5-day mule trips and set a field schedule. From there, GIS manager Stephanie Calloway worked to plan the specific routes for each trip. She also had several meetings with our volunteer horseman John Parke to plan the trip routes with him and his horses.

Students from Dr. Susan Mazer's Plant Biology and Biodiversity class selected rare plant taxa from a list that we provided, and submitted 34 draft rare plant fact sheets in Winter quarter 2018. Our Rare Plant Technician developed the final fact sheets used in our project, covering 49 rare plant taxa (see **Figure 2** for an example).

Dr. Denise Knapp (Conservation & Research Director) recruited known, field-tested volunteers from a pool of SBBG colleagues, staff, and friends, and developed a field schedule. Stephanie Calloway (Conservation Technician, GIS manager, and project coordinator) prepared safety info and a packing list for them, and gave them route and meeting location information.

We prepared a Biodiversity Apprentice recruitment flyer for Santa Barbara City College students, and Dr. Matt Guilliams (Plant Systematist) and Denise Knapp offered an introduction to the project with pizza provided at the Garden on March 8th. Dr. Matt Kay promoted the project to his students, and interfaced with them to get applications. We made our final selections after consultation with Dr. Kay, and had four apprentices secured by the end of March for help during the summer: Guadalupe Leyva, Jordan Grecco, Serafina Crannel, and Sarah Lane. Sarah dropped out just before summer in favor of paid work.

Field Work

We began field work on February 12, 2018 with several one-day field trips in the Jesusita Fire scar. This enabled the primary field staff to all train together, troubleshoot, and fine-tune protocols. We wrapped up field work for 2018 on August 9th. This was earlier than planned, because the very dry spring and heat spells had made for very poor botanizing. Furthermore, the excessive heat and lack of water made for dangerous conditions on the long, dry, rugged, exposed trails that were remaining. We were able to extend our field work into the 2019 field season, and completed 6 more trips, ending on May 20th, 2019.

Figure 1. Los Padres Botanical Blackholes Project data dictionary

Los Padres National Forest Botanical Black Holes, Attribute Field Descriptions:

Field Name	Attribute Description
Species	Select taxa name from a drop-down menu of the taxa we are contracted to survey for.
Other_Sp	Write in other species of interest that are not included on the "Species" drop-down menu.
Ind_Range	Select from drop-down menu values: <100, 100-500, 500-100, >1000
Ind_Count	If there are less than 20 individuals, record their count.
Phen	Select from drop-down menu values: Mostly Flowering, Mostly Fruiting, Vegetative (Declining), Vegetative (Starting), Senesced, Other
Other_Phen	Write in other data on phenology / phenological observations.
Density	Record the vegetative cover of the documented plant taxa within the mapped polygon.
Area m2	Only necessary to fill out if the locational accuracy is poor and/or you are using the offset feature tool on a Juno device. In square meters.
Hab	Select from the drop-down menu of values.
Other_Hab	Write in other habitat types that are not included on the "Hab" drop-down menu
Slope	Select from drop-down menu values: flat, gentle, moderate, steep
Aspect	Select from drop-down menu values: N, NE, NW, E, W, S, SE, SW
Elevation	Record Elevation in meters
Assoc_sp	Record associated species.
Dom_sp	Record the top X dominant species.
Threats	Select from the drop-down menu of values.
Other_Threats	Write in other threats that are not included on the "Threats" drop-down menu
Voucher_ID	Write in a temporary voucher ID if you collected a specimen.
Surv1	Select surveyor from the drop down menu of values.
Surv2	Select surveyor from the drop down menu of values.
Surv3	Select surveyor from the drop down menu of values.
Other_Surv	Write in other surveyors not included on the "Surv" drop down menus.
Loc_Uncert	An indication of how confident you are in the accuracy of defining the location. When following the accuracy standards as described within this protocol, locational uncertainty should generally be negligible (accurate within 20 feet). The TESP-IS Application will default this field to negligible. Choose from the following value list:
Aerial_Uncert	This field is required only if 'Aerial Estimated' is selected in the 'Locational Uncertainty' field. Select from the drop-down menu values (in meters).
Date	Check the box to auto-populate the survey date.
Notes	Write in any additional notes relevant to the occurrence.

Name	Description
Negligible	The location of the observation is precisely known and mapped within a 20 foot radius (6.25m) of error or less.
Aerial delimited	Uncertainty is greater than 20' (6.25m) in any direction, but located within a larger area with identifiable boundaries.
Linear	Uncertainty is greater than 20' (6.25m) along one axis, but identifiable features that serve as endpoints are mapped.
Aerial estimated	Uncertainty is greater than 20' (6.25m) in any direction, but the extent cannot be delimited by boundaries on a map.

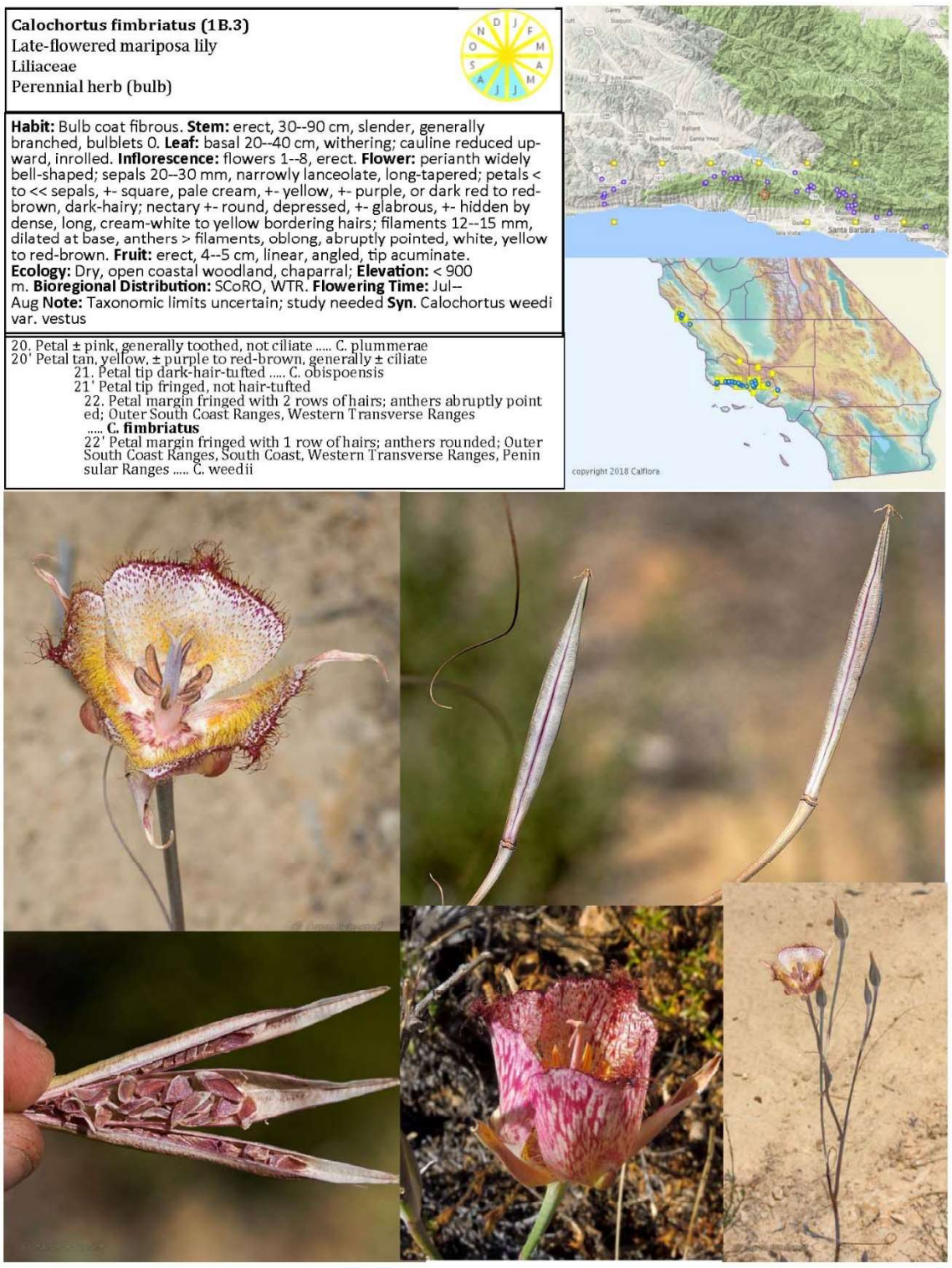
Forest Service Required Field

CNDDB Required Field

Both FS and CNDDB Required

Optional but encouraged

Figure 2. An example Rare Plant Fact Sheet.



Outcomes

Area Coverage

Our aim was to map at least 363 miles, covering each *maintained* trail, road, and firebreak at least once. Over the course of this project, we completed at least 735 total miles when accounting for round trips and other repeated trips, and at least 324 absolute miles of trails, roads, and firebreaks that were found to be maintained. This included over 47 trips and 96 days, including six mule trips, five three-day horse trips, 12 two and three-day backpacking or car camping trips, and 24 day-trips. Accounting for both the number of trips and the number of people on each trip, our work totals **307 people days**.

SBBG staff and consultants leading the mapping efforts included Stephanie Calloway (Conservation Technician), Dr. Denise Knapp (Conservation & Research Director), Dr. Heather Schneider (Rare Plant Biologist), Sarah Termondt (Rare Plant Technician), Dr. Matt Guilliams (Plant Systematist), Dr. Kristen Lehman (Conservation Geneticist), Steve Junak (Botanist emeritus), Adam Searcy (botanical consultant), and Lucie Gimmel (Herbarium Curatorial Assistant).

Rare Plant Mapping

On our surveys we targeted 42 plants identified as rare or sensitive by the Forest Service and found within Santa Barbara and Ventura Counties in habitat likely to be present within the Los Padres. We mapped 19 rare plant taxa over 236 "populations" (polygon and point features), as reported in **Tables 1 and 2**, below. We have submitted data to the California Natural Diversity Database for every rare plant species population encountered. Comprehensive maps of all rare species encountered in the Jesusita and Zaca Fire scars are provided in **Figures 3 and 4**, below. Maps for each rare taxon in the Jesusita and Zaca fire scars are provided in **Appendices A and B**, respectively, at the end of this document, while maps for each invasive taxon in the Jesusita and Zaca fire scars are provided in **Appendices C and D**, respectively. Rare plant maps represent point features of mapped points and/or point features of polygon centroids and occasional polygon features for ease of viewing.

Table 1. Rare Plants mapped in the Jesusita fire scar

Scientific Name	# Points and Polygons	Average Count
Baccharis plummerae ssp. *plummerae*	26	>161
Calochortus fimbriatus	9	149
Lonicera subspicata var. *subspicata*	88	1,659
Monardella hypoleuca ssp. *lanata*	1	1
Quercus dumosa	17	3,835
Thelypteris puberula var. *sonorensis*	2	13
TOTAL	**142**	**5,644**

Table 2. Rare Plants mapped in the Zaca Fire scar

Species	# Points and Polygons	Average Count
Amsinckia douglasiana	6	10,870
Amsinckia vernicosa	1	300
Baccharis plummerae ssp. *plummerae*	5	unkn
Caulanthus lemmonii	14	3,143
Clinopodium mimuloides	1	3,000
Delphinium umbraculorum (potential)	11	333
Diplacus johnstonii	3	128
Eriophyllum lanatum var. *hallii*	1	21
Fritillaria ojaiensis	1	100
Horkelia yadonii	11	666
Layia heterotricha	13	54,114
Malacothrix saxatilis var. *arachnoidea*	7	2,197
Sidalcea hickmanii ssp. *parishii*	10	3,134
Thermopsis californica var. *argentata*	5	247
TOTAL	**94**	**78,300**

Invasive Plant Mapping

On our surveys we targeted eight plant invaders identified by the Forest Service as of concern, as well as any new, noxious, or otherwise noteworthy invaders that we encountered. We found and mapped populations of seven of these eight plants (*Centaurea melitensis*, *Centaurea solstitialis*, *Foeniculum vulgare*, *Nicotiana glauca*, *Ricinus communis*, and *Spartium junceum* - all except *Ailanthus altissima*), along with numerous other suspected invaders (weeds hereafter), for a **total of 44 plant invaders mapped**. The additional taxa can be categorized based on our confidence in how comprehensively we believe different taxa were mapped throughout the fire scars. **Table 3** depicts taxa that were comprehensively mapped across the fire scar in green, while taxa that may need further mapping in order to determine their full extent are depicted in black. In some areas, certain weed taxa were considered so widespread that mapping them would have been unrealistic, while in other places, mappers may have only encountered a handful of individuals of the same taxa. Nevertheless, these data serve as an important occurrence records of weed species and are included in our spatial data along with comprehensively mapped taxa.

In the 8,733-acre Jesusita Fire, we mapped 190 polygons of 28 taxa, covering 74 gross acres (i.e., including other plants found within the polygons). **Table 4** presents data for those species comprehensively mapped and of limited distribution, and **Table 5** presents data for those species comprehensively mapped that were more widespread. In the 240,000-acre Zaca Fire we mapped 414 polygons of 25 taxa, covering 634 gross acres. **Table 6** presents data for those species comprehensively mapped and of limited distribution, with red denoting taxa we will address later in this document as having potential for control. **Table 7** presents data for those species that were comprehensively mapped and more widespread. Looking at weeds that were comprehensively mapped, it is evident that the front country, in the Jesusita fire scar, is much more heavily invaded by a variety of weeds than the back country, in the Zaca Fire scar.

Table 3. List of all weeds mapped in the Zaca and Jesusita fire scars. Those mapped comprehensively are indicated in green.

Taxon	Zaca	Jesusita
Ageratina adenophora		X
Araujia sericifera		X
Brassica nigra	X	X
Bromus tectorum	X	
Carduus pycnocephalus ssp. *pycnocephalus*	X	X
Centaurea melitensis	X	X
Centaurea solstitialis	X	X
Cistus incanus		X
Conium maculatum		X
Delairea odorata		X
Elymus caput-medusae	X	
Euphorbia terracina		X
Ficus carica		X
Foeniculum vulgare	X	X
Genista monspessulana		X
Hirschfeldia incana	X	X
Lactuca serriola	X	
Marrubium vulgare	X	X
Nicotiana glauca		X
Opuntia ficus-indica		X
Oxalis pes-caprae		X
Pennisetum setaceum		X
Plantago lanceolata	X	
Poa bulbosa ssp. *vivipara*	X	
Polygonum arenastrum	X	
Ricinus communis		X
Silybum marianum	X	
Sonchus asper	X	
Sonchus oleraceus	X	
Spartium junceum	X	X
Tamarix sp.	X	X
Tragopogon sp.	X	
Vinca major		X
Needs Further Information (timing issue)		
Asteraceae sp.	X	
Cardaria sp.	X	
Cirsium sp.		X
Dimorphotheca sp.		X
Fabaceae sp.		X
Lotus sp.	X	
Matricaria sp.	X	
Olea sp.		X
Polygonaceae sp.	X	
Rumex sp.	X	
Salsola sp.		X

Table 4. Limited invasive plants mapped in the Jesusita fire scar. Red denotes taxa we will address later in this document as having potential for eradication.

Taxon	# Polygons	Gross Acres
Ageratina adenophora	5	0.01
Araujia sericifera	1	0.02
Centaurea solstitialis	3	2.16
Cistus incanus	5	0.02
Delairea odorata	10	0.07
Euphorbia terracina	1	0.01
Genista monspessulana	3	0.01
Nicotiana glauca	10	3.69
Pennisetum setaceum	6	3.71
Ricinus communis	13	5.31
Spartium junceum	1	0.14
Tamarix sp.	1	0.02
Vinca major	1	0.01
Vinca sp.	8	0.06
TOTAL	**73**	**15.24**

Table 5. Widespread invasive plants mapped in the Jesusita fire scar

Taxon	# Polygons	Net Acres	Gross Acres	Average Count
Centaurea melitensis	64	>0.23	28.63	36,776
Foeniculum vulgare	38	>4.34	27.71	5095
TOTAL	**102**	**>4.57**	**56.26**	**41,871**

Table 6. Limited invasive plants mapped in the Zaca fire scar

Taxon	# Polygons	Gross Acres
Elymus caput-medusae	7	0.63
Tamarix sp.	40	3.51
TOTAL	**43**	**4.14**

Table 7. Widespread invasive plants mapped in the Zaca fire scar

Taxon	# Polygons	Net Acres	Gross Acres	Average Count
Centaurea melitensis	264	>16.13	372.73	311,304
Centaurea solstitialis	37	>10.11	201.87	87,025
Foeniculum vulgare	1	.003	.003	1
TOTAL	**301**	**>26.42**	**574.60**	**398,330**

We present maps of all invasive plant taxa mapped in the Jesusita Fire scar in **Figure 5**, and those comprehensively mapped in **Figure 6**. These same maps are presented for the Zaca Fire in **Figures 7 and 8**, respectively. For ease of viewing, all points on these maps represent polygon centroids of weeds mapped along with occasional polygons. All spatial data files will be submitted with this report.

Spatial Data

We collected point, line, and polygon data using ESRI's Collector App loaded on iPad Mini 4s that were protected by rugged, waterproof cases. Data were entered into the data dictionary outlined in the "Preparation" section of this report. The final datasets were curated to meet the USDA National Data Standards as outlined in two protocols provided by the Forest Service: 1) The Threatened, Endangered and Sensitive Plants Element Occurrence Protocol and Field Guide, and 2) The USDA Forest Service National Forest System Data Recording Protocols and Requirements for Invasive Species Survey, Inventory, and Treatment. **Tables 8 and 9** depict this curation in detail. Data should be easily integrated into existing Forest Service formats.

Drafts of all spatial data were submitted to LPNF Botanist, Lloyd Simpson, on March 14th, 2019. Final spatial data in the form of Geodatabase Files, a Map Package, and excel files will be loaded onto a flash drive and submitted to NFWF and the Forest Service. **Final data should supersede draft data** as all records have been further edited. The following is a description of the final datasets and their feature classes:

SBBG_TESP_2018_2019_FINAL (geodatabase/.gdb file)

- SBBG_TESP_Jesusita_Point_FINAL (point feature class) – *all threatened, endangered, and sensitive plant point data collected in the Jesusita Fire scar*
- SBBG_TESP_Jesusita_Poly_FINAL (polygon feature class) – *all threatened, endangered, and sensitive plant polygon data collected in the Jesusita Fire scar*
- SBBG_TESP_Jesusita_Poly_Centroids_FINAL (point feature class) – *centroids of all threatened, endangered, and sensitive plant polygon data collected in the Jesusita Fire scar*
- SBBG_Seed_Collection_Jesusita_FINAL (point feature class) – *Seed collection locations for seeds collected in the Jesusita Fire scar*
- SBBG_TESP_Zaca_Point_FINAL (point feature class) – *all threatened, endangered, and sensitive plant point data collected in the Zaca Fire scar*
- SBBG_TESP_Zaca_Poly_FINAL (polygon feature class) – *all threatened, endangered, and sensitive plant polygon data collected in the Zaca Fire scar*

- SBBG_TESP_Zaca_Poly_Centroids_FINAL (point feature class) – *centroids of all threatened, endangered, and sensitive plant polygon data collected in the Zaca Fire scar*
- SBBG_Seed_Collection_Zaca_FINAL (point feature class) – *Seed collection locations for seeds collected in the Zaca Fire scar.*
- SBBG_Herbarium_Collections_07302019 (point feature class) – *herbarium specimens collected in the Zaca and Jesusita fire scars as of July 30th, 2019. For the most recent and updated data, visit our online portal as described in the "Herbarium Specimens" section of this report. The latest identifications and specimens not yet georeferenced will be there.*

SBBG_Invasives_2018_2019_FINAL (geodatabase/.gdb file)

- SBBG_Invasive_Jesusita_Poly_FINAL (polygon feature class) – *all invasive plant and weed polygon data collected in the Jesusita Fire scar*
- SBBG_Invasive_Jesusita_Poly_Centroids_FINAL (point feature class) – *centroids of all invasive plant and weed polygon data collected in the Jesusita Fire scar*
- SBBG_Invasive_Zaca_Poly_FINAL (polygon feature class) – *all invasive plant and weed polygon data collected in the Zaca Fire scar*
- SBBG_Invasive_Zaca_Poly_Centroids_FINAL (point feature class) – *centroids of all invasive plant and weed polygon data collected in the Zaca Fire scar*

SBBG_Misc_Notes_2018_2019_FINAL

- Jesusita_TESP_Misc_Poly_2018 (polygon feature class) – *miscellaneous polygon notes regarding TES plants and habitats in the Jesusita Fire scar*
- Jesusita_TESP_Misc_Point_2018 (point feature class) – *miscellaneous point notes regarding TES plants and habitats in the Jesusita Fire scar*
- Zaca_Firebreak_Notes_2018 (point feature class) – *notes regarding conditions of fire breaks in the Zaca Fire scar*
- Zaca_Road_Condition_Notes_2019 (point feature class) – *notes regarding conditions on unpaved roads in the Zaca Fire scar*
- Zaca_TESP_Notes_Misc_Poly_2018 (polygon feature class) – *miscellaneous polygon notes regarding TES plants and habitats in the Zaca Fire scar*
- Zaca_TESP_Notes_Misc_Pt_2018 (point feature class) – *miscellaneous point notes regarding TES plants and habitats in the Zaca Fire scar*
- Zaca_TESP_Notes_Misc_Pt_2019 (point feature class) – *miscellaneous point notes regarding TES plants and habitats in the Zaca Fire scar*
- Zaca_Trail_Condition_Notes_2018 (point feature class) – *miscellaneous notes regarding trail conditions within the Zaca Fire scar*

Figure 5. All weed taxa mapped in the Jesusita Fire scar

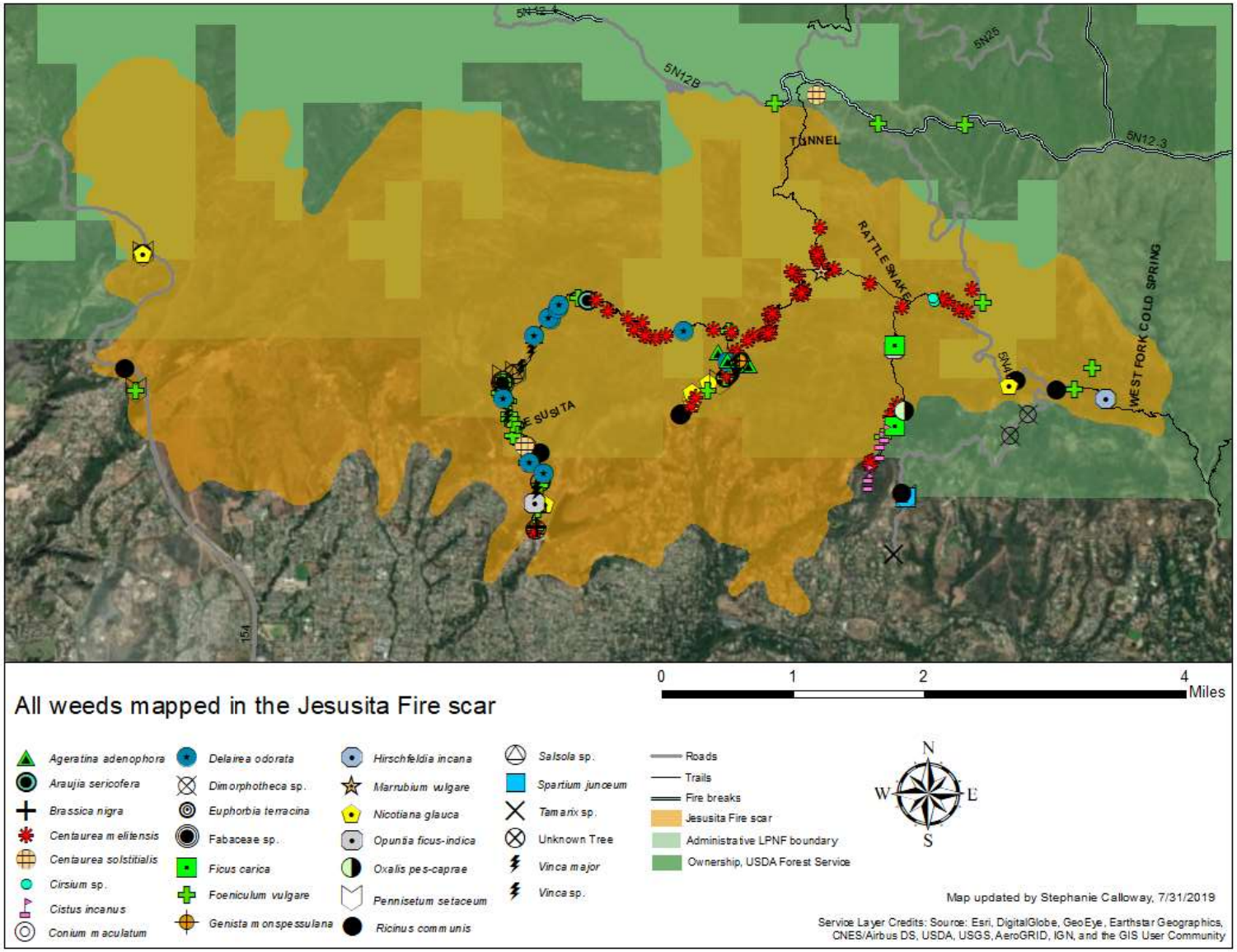


Figure 6. All weed taxa mapped comprehensively in the Jesusita Fire scar

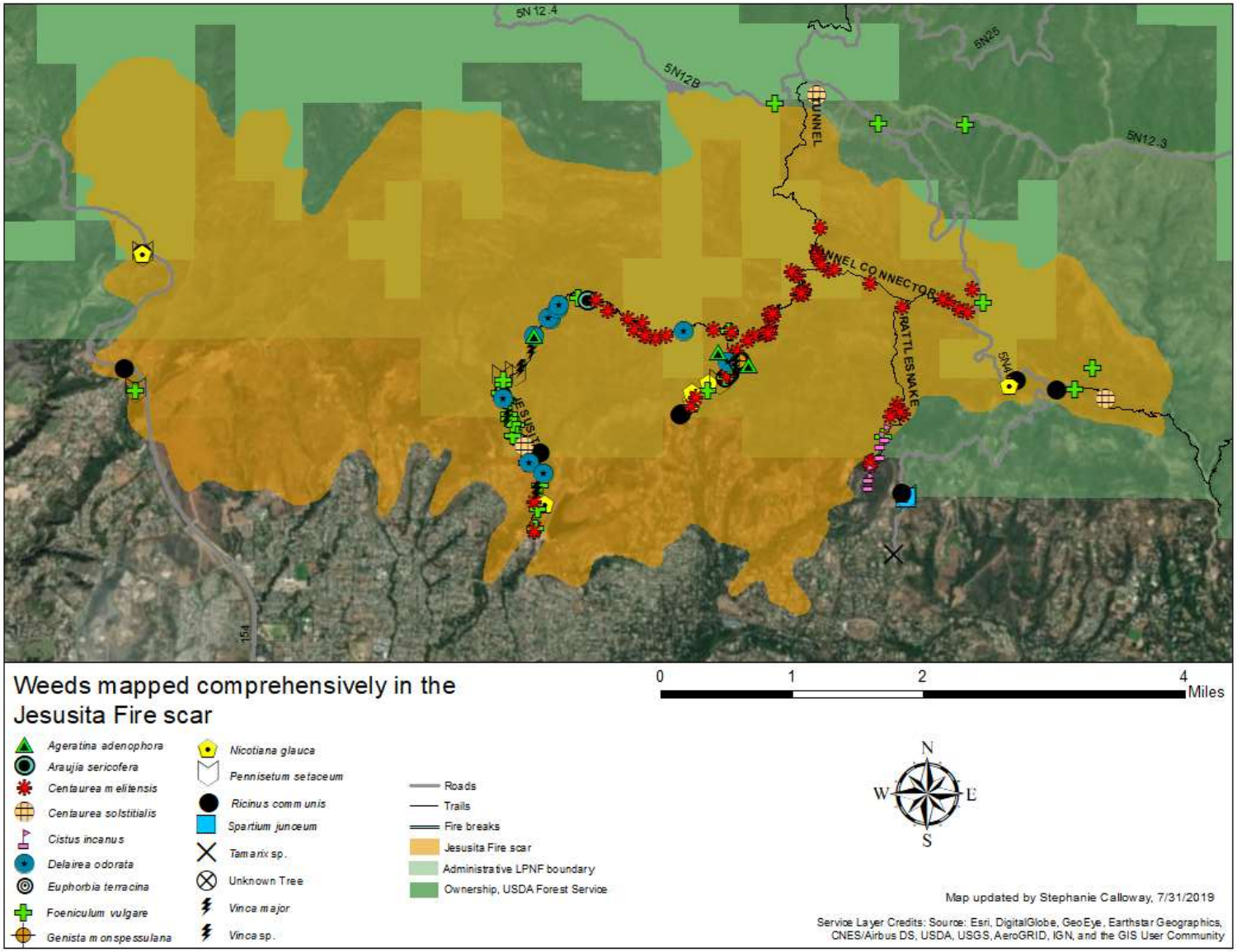


Figure 7. All weed taxa mapped in the Zaca Fire scar

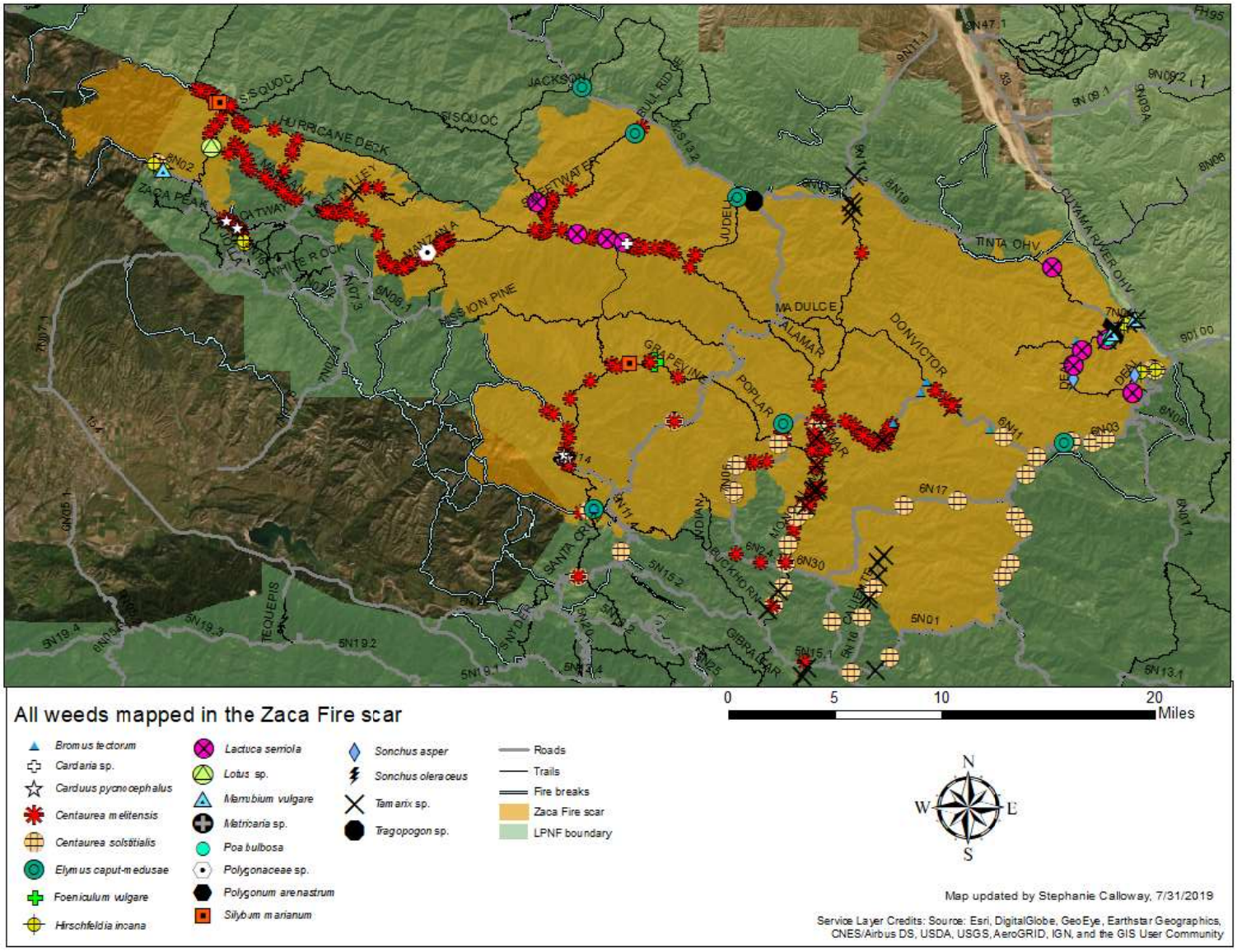


Figure 8. All weed taxa mapped comprehensively in the Zaca Fire scar

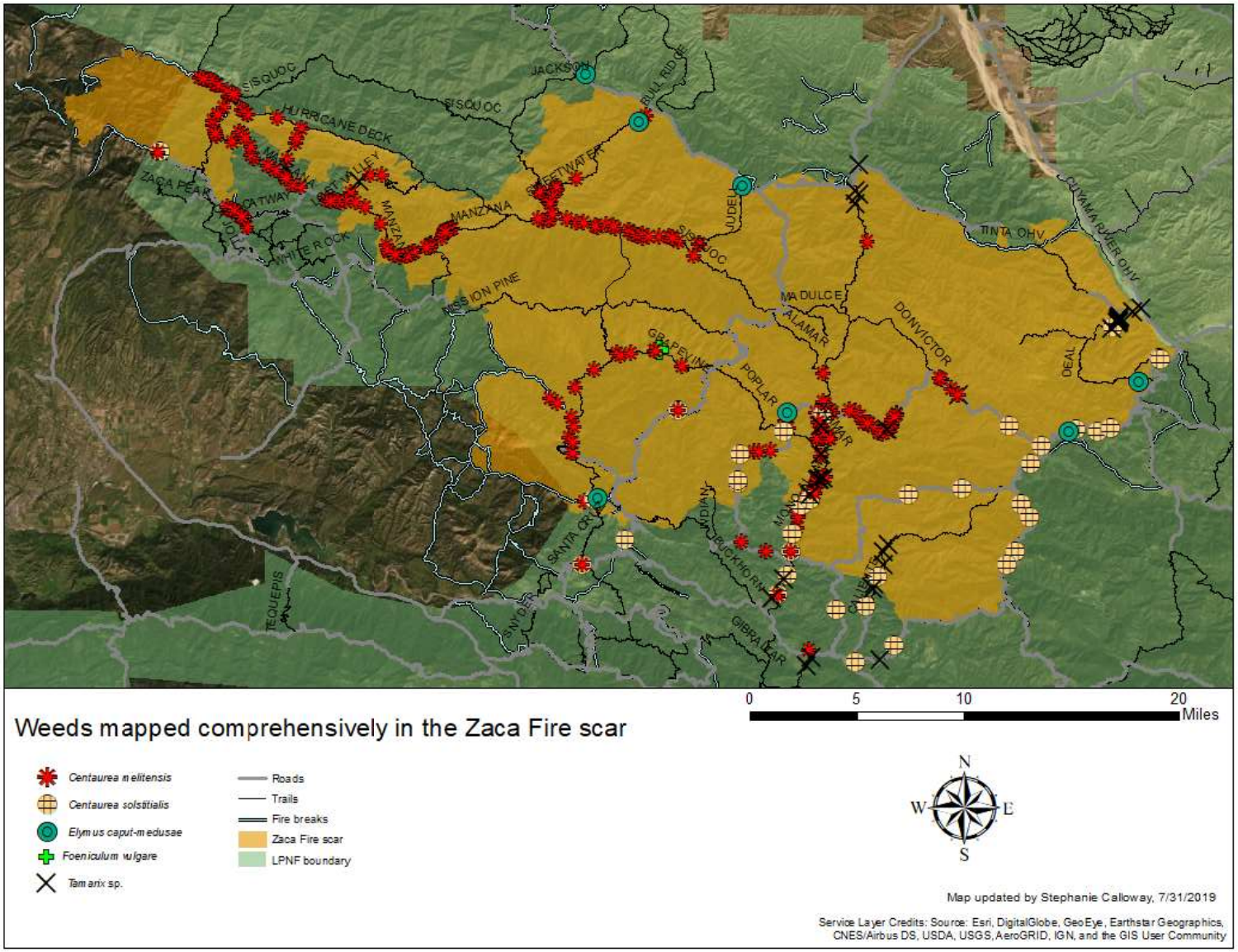


Table 9. Field survey data dictionary vs. curation to final dataset: Invasive Plants and Weeds

SBBG Field Survey Data Dictionary			Final SBBG Data Dictionary Taken from the USDA Forest Service National Forest System Data Recording Protocols and Requirements for Invasive Species Survey, Inventory, and Treatment				
SBBG Fields	**Attribute Description**	**Corresponding Fields**	**Forest Service Fields**	**Description**	**Required**	**Optional**	**Lloyd's Dataset**
Date	The calendar month, day, and year the infestation was found or re-measured. This is the day that the information was collected in the field. The format is MM/DD/YYYY.	**Yes**	**Date**	The calendar month, day, and year the infestation was found or re-measured. This is the day that the information was collected in the field. The format is MM/DD/YYYY.	X		X
		No	**Species Category**	The general taxonomic group of the detected Invasive Species, selected from a LOV. This field allows for the categorization of the target species and is used to reduce the species code list when selecting a species code in the following Species Code field.	X		
		No	**Species_Code**	The accepted Species Code for the target species from the LOV. The Target Species Code is available based on the category selected from Species Category Field. **SBBG created and populated field in final dataset.**	X		X
Species	Scientific name of the documented taxa. Taxa we were contracted to map.	**Yes**	**Scientific_Name**	This refers to the Latin scientific name for the invasive species. The scientific name is generated from the Species Code.		X	X
Other_Sp	Scientific name of rare taxa that we were not contracted to map.						

		No	**Common_name**	This refers to the common or colloquial name, if any, for the target invasive species. This field is generated from the Species Code. **SBBG created and populated field in final dataset.**		X	X
Area	Total area of a polygon estimated if using offset feature tool in Trimble Junos. If area was mapped without estimation, the area was calculated in ArcDesktop in Acres.	**Yes**	**Gross_Area_Acres**	An area, in acres, occupied by an invasive species delineated by a polygon that may represent a general area where the population is found or may represent the spatial extent of the infestation/ population. Total Area is calculated from the area of the spatial feature. Total Area may contain significant areas that are not within the perimeter of the target invasive species infestation in which case "% Infested" would be less than 100%.	X		X
%Cover	The vegetative cover of the documented invasive plant species within the mapped area, in the following cover classes: 0-1%, 1-5%, 5-15%, 15-25%25-50%, 50-75%, 75-95%, 95-100%. We measured % cover as a general estimate without considering layered vegetation. This more closely matches Infested percent.	**Yes**	**Infested_Percent**	Percent (%) Infested is the proportion of the Total Area that is infested with the target invasive species. The default will be 100% Infested. In other words, the application will assume that the spatial feature that represents the infestation is 100% infested. The cover was calculated as the midpoint rounded to the nearest 0.5% from the following cover classes: 0-1%, 1-5%, 5-15%, 15-25%, 25-50%, 50-75%, 75-95%, 95-100%. **SBBG did not collect this data for various records.**	X		X

		No	**Infested_Area_Acres**	Infested Area is defined as an area of land or water, in acres, containing a single invasive species infestation/ population delineated by the actual perimeter of the infestation or population as defined by the outer edge of the canopy cover of the plants or the visible population (i.e. Home Range or stream reach) of other invasive taxa, excluding adjacent areas not infested and outside the perimeter of the population. Generally, the smallest area of infestation mapped is 1/10,000th (.0001 acre or 4.4 sqft) of an acre. This field is the product of Total Area multiplied by the % Infested. **Generated in ArcDesktop by SBBG.**	X		X
Surv1 **Surv2** **Surv3** **Other_Surv**	First and Last name(s) of the individuals that detected the element occurrence.	**Yes**	**Examiner_1** **Examiner_2** **Examiner_3** **Examiner_4**	First and Last name(s) of the individuals that detected the element occurrence.	X		X
		No	**Ownership**	Land ownership where the occurrence is located. **SBBG created and populated field in final dataset. Ownership was left blank when records were located on Administrative Forest, but not owned by USFS**	X		X
		No	**Parent_Unit_ID**	05 - **SBBG created and populated field in final dataset.**	X		X

		No	**Parent_Unit_Name**	R5, Pacific Southwest Region - **SBBG created and populated field in final dataset.**			X
		No	**FS_Unit_ID**	0507 - **SBBG created and populated field in final dataset.**			X
		No	**FS_Unit_Name**	Los Padres National Forest - **SBBG created and populated field in final dataset.**			X
Notes	This field is available to the user to enter any relevant information on the weed infestation or characteristics of the site not covered by the site and setting fields.	**Yes**	**Comments**	This field is available to the user to enter any relevant information on the weed infestation or characteristics of the site not covered by the site and setting fields. SBBG also noted information about locational certainty into this field since we collected this data, but there is no corresponding field in the Invasive Species Inventory Protocol.		X	X
Phenology	The dominant phenology of the mapped occurrence: Mostly Flowering, Mostly Fruiting, Mostly Vegetative-Senescing, Mostly Vegetative-Starting. Mostly Vegetative, Completely Senesced, Mostly Senesced, Other	**No Equivalent in IS Protocol**	**Phenology**	No Equivalent in FS protocol	n/a	n/a	n/a
Other_Phen	Any value that did not match the above.						

Elevation	Recorded elevation of mapped area in meters	**Yes**	**Elevation**	For the spatial extent of the infestation, record the Average (or a "predominant") elevation of the land surface occupied by the species as measured feet from the average of the mean high and mean low tide. Minimum and Maximum elevation may be recorded if it is determined that the elevation range is significant for that particular infestation (e.g., on a steep slope or a large occurrence on an undulating landscape). **Feet will be the default units of measure (UOM). SBBG measured in Meters, and converted to feet.**		X	
Aspect	The generalized cardinal direction that the landscape predominantly faces at a defined position, such as the center point of the infestation. (Accuracy Standard: ± 11.25 degrees). See Appendix A for a List of Values.	**Yes**	**Cardinal_D**	The generalized cardinal direction that the landscape predominantly faces at a defined position, such as the center point of the infestation. (Accuracy Standard: ± 11.25 degrees). See Appendix A for a List of Values.		X	
Slope	The average slope that is characteristic of the EO polygon or site, expressed as a percentage as measured in the field. **Included, but measured differently than in TESP EO Protocol as: flat, gentle, moderate, steep.**	**Included but different**	**Slope**	The average slope that is characteristic of the EO polygon or site, expressed as a percentage as measured in the field. **Included, but measured differently than in TESP EO Protocol as: flat, gentle, moderate, steep.**		X	
Hab1	Dominant habitat where mapped occurrence is located.	**Included but different**	**Habitat**	The Forest Service may choose to place this in		X*	

Hab2 **Hab3** **Other_Hab**				Plant Community, potential Vegetation, or Ecological Type.			
Count<20	If there were less than 20 individuals, we recorded the exact count.	**Yes**	**Count**	Count is the total number of individuals (i.e. number of animals, stems, or plants, etc.) across the population or infestation. This is an optional field and may be useful for small infestations or populations with a limited number of individuals occupying an area. SBBG calculated the midpoint of the following value classes: <100; 100-500; 500-1,000; 1,000-5,000; 5,000-10,000; >10,000		X	
Count>20	Estimated number of individuals counted if greater than 20 in mapped area within the following classes: <100; 100-500; 500-1,000; 1,000-5,000; 5,000-10,000; >10,000						
		No	**Count_UOM**	The unit of measure of the total count: Stem, Plant, Individuals. **SBBG always counted # Individuals. SBBG created field and populated.**		X	

Assoc_sp	An Associated Species is defined as any plant (or other) species that occurs, is associated with or commonly found growing or living on the site with the target invasive species. Associated species are those found in the same habitat and same location and should not include species that are not directly within or related to the polygon or site.	**Yes**	**Associated_Species**	An Associated Species is defined as any plant (or other) species that occurs, is associated with or commonly found growing or living on the site with the target invasive species. Associated species are those found in the same habitat and same location and should not include species that are not directly within or related to the polygon or site. **SBBG listed and did not enter as separate fields.**		X	
		No	**Latitude_Centroid**	Latitude in a degree value to at least 6 decimal places. **SBBG created field and populated.**	X		X
		No	**Longitude_Centroid**	Longitude in a degree value at least 6 decimal places. **SBBG created field and populated.**	X		X
		No	**Datum**	Datum of Latitude/Longitude. **Not in IS protocol, but in Lloyd's dataset.**			X

Outreach

This project offered a unique opportunity for public outreach about the value of wilderness areas like LPNF and the biodiversity they support; the beauty and threats to rare plant taxa; the impacts that invasive plants are having on these systems; and the value and process of restoration efforts. Our outreach efforts have built awareness and support for the Forest Service and its stewardship efforts.

Our goal was to reach thousands of people, and we have easily met that goal, with **45,315 people reached through our Facebook posts alone.** Our partners with the Los Padres National Forest, California Native Plant Society, Los Padres Forest Association, Santa Ynez Chumash Environmental Office, and Los Padres Outfitters agreed to help by sharing our posts. We developed a blog to track all of our adventures in one place, but limitations in our web platform led us to transfer this to a Facebook photo album.

Our video posts reached the most people, with 7,573 people reached by our video about invasive plants, 6,903 people reached by our video about botanical exploration and herbarium specimen collection, 6,157 people reached by our video about not spreading seeds after wildfires, 5,014 people reached by our video about native plants that flower after fire and their pollinators, and 3,345 reached by our video about fire ecology. These videos have had 2,552, 2,605, 2,721, 1,774, and 1,338 views respectively, with a total of 61 comments, 188 shares, and 912 positive reactions (Likes, Loves, etc.). These videos are also available to view on our website at https://www.sbbg.org/conservation-research/black-holes-blog.

We posted 206 photos to our Facebook photo album. These have received a total of 2,090 engagements, including 762 cumulative likes. The most successful photo posts included the introduction to this project, photos of flowers and nice views, and photos of the Los Padres Outfitters trail hands and mules.

We interacted with 140 recreationists over the course of this project, particularly in the front county (such as the Jesusita Trail) where hikers were most abundant. During these interactions, we conveyed where possible the reason for our project and the value of the plants and habitats found in the Los Padres National Forest. People were very enthused about the work that we are doing; our favorite comment was that we are "saving the world." One interaction was more serious: helping with a medical evacuation on Hurricane Deck by providing location information and water.

Our project has been featured by the Santa Barbara News Press (June 30) and Pacific Coast Business Times (May 25), and we were interviewed in the field by Pulitzer Prize winning L.A. Times journalist Bettina Boxall on April 22. In addition, we have given the following eight public presentations (of which two, Cal-IPC and SERCal, were professional), for a total of approximately 812 people reached:

1. Santa Barbara Botanic Garden Board of Directors 5/22/18 (speaker: Peter Schuyler) ~12 attendees
2. Santa Barbara Horticultural Society 6/6/18 (speaker: Denise Knapp) ~70 attendees
3. Santa Barbara Botanic Garden 8/8/18 (speaker: Denise Knapp) ~50 attendees
4. California Invasive Plant Council (Cal-IPC) 11/8/18 (speaker: Stephanie Calloway) ~200 attendees
5. UCSB Conservation & Restoration Ecology Seminar Series 11/26/18 (speaker: Denise Knapp) ~40 attendees
6. Wilderness Hiking Speaker Series, 1/17/19 (speaker: Denise Knapp) ~70 attendees

7. U.S. Forest Service (Goleta office) employees, 3/21/19 (speaker: Denise Knapp) ~20 attendees
8. Society for Ecological Restoration, California (SERCAL), 4/10/2019 (speaker: Denise Knapp) ~300 attendees
9. NFWF grant recipient meeting, 5/8/19 (speaker: Denise Knapp) ~50 attendees

Botanical Mentoring

In March, we worked with Dr. Matt Kay of Santa Barbara City College to recruit three Biodiversity Apprentices. We chose four, and three were able to meet their commitment: Guadalupe (Lupe) Leyva, Jordan Greco, and Serafina Crannell. They each experienced both the field and lab components of this project, and really enjoyed the experience. Lupe had never been camping before, and was full of wonder at the backcountry. Lupe and Serafina were not used to the kind of rigorous field work that is required on a project of this nature, and we adjusted the trips to accommodate this, including devising special one-day hikes for them in the front country to increase the opportunities for more field work without introducing them to excessive risk of heat stroke and injury.

The Santa Ynez Chumash Environmental Office were excellent partners. Interns and staff participated in both the field and lab components of this project, and greatly increased their exposure to botany. One intern was so taken by botany that he talked of pursuing graduate studies in the field. Many of them already knew many ethnobotanical plants important to their tribe, but learned many more plant taxa through this experience. The field work was more intense than any of them had experienced before, which was difficult, but they were persistent and good natured, and ultimately glad for the challenge.

Dr. Susan Mazer's Plant Biology and Biodiversity students at UCSB were enlisted to help in producing rare plant fact sheets. They compiled plant descriptions, maps, illustrations, photographs, and statistics, and through this experience increased their knowledge of and comfort with botany.

Through a private donation of $50,000, we were able to hire three part-time Herbarium Assistants (Lucie Gimmel, Kristen Klitgaard, and Calvin Davison) to help database, mount, and label all of the botanical specimens. Kristen and Calvin were students from Matt Guilliams' botany class at UCSB, and were invaluable for entering all of the field note data into our label database. Through this process all three greatly increased their knowledge of the area's flora. Our staff contributed many in-kind hours to identify these specimens, although a few of the more difficult specimens still need attention.

Challenges/Setbacks

We had hoped to begin work on the project in Fall of 2017, but it took longer than anticipated to receive collection permits from the Forest Service. This put us a bit behind, and we had to obtain an extension to finish the field work in Spring 2019. In addition, there were several climate-related challenges outside of our control. The late and sparse rains in 2018 delayed the bloom, and few plants were collectable on our early (February, March) trips. Heavy rain for a straight week in March led us to postpone our first mule pack trip to July, due to poor road conditions with precluded trailer access. Lastly, given the overall dryness of the year, and the anticipated difficulty of accessing water, we had to cancel a trip scheduled with Los Padres Outfitters in August 2018.

There were a few trails and fuel breaks that did not turn out to be maintained enough to send volunteers, pack animals, and staff on, and thus were dropped from the project. In our proposal, we promised to map all "maintained trails" including those identified as "easy to follow and in good shape" (colored yellow) on Bryan Conant's maps of the Dick Smith and San Rafael Wilderness areas. It also included some that received maintenance since the time that the map was produced, per Mr. Conant. What we have learned, however, is that a lot can change in a few seasons, and opinions differ in what is consider "maintained." In addition, heavy rains in January 2018 washed out a few trails. Generally, we have still been able to survey many of the trails that are in poor condition, but in a few cases, the trail does not meet the definition of "maintained", and we were not able to complete our surveys in these areas. In addition, some of the trails we proposed turned out to be outside of the fire boundary or on private property, when viewed with better fire scar layers. As reported to NFWF in fall 2018, we decided to drop the trails and firebreaks listed in **Table 12**. On the other hand, we were able to add a few trails within the fire boundary, including the western stretch of Hurricane Deck, the Happy Hollow Road, the Zaca Ridge OHV road, and the Pie Canyon Trail, totaling 10.5 miles (Table 13).

Table 12. Trails, jeepways, and firebreaks that were dropped from the Botanical Blackholes project

Name	Miles	Reason
Hildreth Peak Jeepway (inner 10 miles)	10	Not maintained; long, steep, exposed, dry for both humans and pack animals
Pendola Jeepway (northern 5.8 miles)	5.8	Not maintained; long, steep, exposed, dry for both humans and beasts
Alamar Trail	9.1	Not maintained; overgrown
Poplar Trail	3.2	Not maintained; overgrown
Santa Cruz Trail from Mission Pine Basin to Kellogg	3.7	Not maintained; very steep
Santa Cruz Trail from Upper Oso to Santa Cruz Station	10	Not maintained, only partly open, and outside the Zaca Fire scar
Small firebreak on Sisquoc (ID 33)	0.53	Not maintained, on private property
Firebreak 1.5 miles west of Manzana Camp	2.44	Private property
Firebreak on the Sisquoc	1.44	Not maintained, very remote
Firebreak near Bee Rock Canyon	0.9	Not maintained and too remote
Firebreak briefly following Zaca Ridge Rd	1.5	On private property
Firebreaks between SCPFR and Happy Hollow Camp	8.86	Not maintained; on private property
Above Big Pine Road	0.18	Outside of fire scar

Table 13. Trails, jeepways, and firebreaks that were added to the Botanical Blackholes project

Name	Miles
Western stretch of Hurricane Deck	3.2
Happy Hollow Road	1.3
Zaca Ridge OHV Road	3.2
Pie Canyon Trail	2.8

Access to roads has been a major challenge, especially given the many road closures following the Thomas Fire. This made access to some of our promised trails much more difficult, since it would have added on ten miles one way in some cases. Furthermore, we were not able to drive the Buckhorn Road, a major access route, until mid-summer 2018. Permission to access other roads has been variable as well. This lack of access made it very difficult for us to meet our project goals, but we planned strategically and did the best we could.

We did not anticipate the fee charged at some of the trailheads/camps managed by the Parks Management Company, even for day use. We were able to negotiate a reduced rate, as collaborators of the Forest Service, for the specific days that we had planned.

We had one staffing challenge. Chris True had agreed to be one of our primary (temporary) field staff for this project, but just after starting the field work, he got a desirable permanent, full-time job, and left the project. We retained two excellent consulting botanists to take his place: Steve Junak and Adam Searcy.

We had a few technical challenges. With the large number of photos and videos that we took for this project, we quickly found ourselves out of disk space. We purchased a 1TB external hard drive for this purpose (an in-kind donation). We also found that GoPro camera batteries did not last long when continuously recording, and were difficult to position with a hat on (which was essential for sun protection and horse-riding safety). We hand-held the cameras instead, and recorded only when we encountered something interesting.

Management Recommendations

Our findings have allowed us to formulate management recommendations for the Forest Service. We outline our recommendations separately for areas and taxa within the Jesusita and Zaca fire scars:

Jesusita Fire eradications

Within the Jesusita Fire scar, there are a few taxa that are of limited enough abundance that they could and should be eradicated. We discuss each of these species below and recommend that their populations be targeted for eradication:

Araujia sericifera

Araujia sericifera (bladderflower) is a perennial vine in the Asclepiadaceae (milkweed) family that is native to South America. It is currently mostly confined to Southern California in the central and south coast ranges and transverse ranges and can be found in woodlands, grasslands, and scrub

and chaparral habitat. It produces pods with copious amounts of seeds that can be spread by wind. It is considered a noxious weed because of it can grow very fast and cover the canopies of citrus groves. However, not much is known about its impact in natural areas (DiTomaso et al. 2007). Cal-IPC has given it a high risk of invasiveness based on its biological characteristics and the climate where it is from. We found only one occurrence of this plant during our surveys in the Jesusita Fire scar (**Appendix C**). Additionally, there are relatively few known records in California, with only three occurrences known from Santa Barbara County according the Consortium of California Herbaria. Since it is fairly limited in the Jesusita Fire scar, we recommend removing this invasive plant before it spreads more. Unfortunately, while this occurrence is located within Administrative National Forest, it is on privately owned land. It is ranked as a species to watch by Cal-IPC.

Cistus incanus

Cistus incanus (hairy rockrose) is a perennial shrub in the Cistaceae (rockrose) family native to the southern Europe. It is now naturalized in California, particularly in coastal regions of southern California. It has been naturalized along the Rattlesnake Trail in the Jesusita Fire scar since the 1970s (Smith 1998). Anecdotal evidence from Garden botanist Steve Junak suggests that it has continued to spread along the Rattlesnake Trail since the 1970s where it frequently co-occurs with the rare *Quercus dumosa*. According to the CCH, there are eleven known records in Santa Barbara County, with a high concentration along the Rattlesnake Trail. Given its infrequent occurrence and co-occurrence with rare plants, it would be favorable to eradicate from the Jesusita Fire scar. Unfortunately, much of the *Cistus* located in the Jesusita Fire scar is located on private property within the Administrative Forest Boundary (**Appendix C**). It is not ranked by Cal-IPC.

Euphorbia terracina

Euphorbia terracina (carnation spurge) is a perennial or biennial herb in the in the Euphorbiaceae (spurge) family that is native to Europe. Observational data from Cal-IPC suggests that this species is expanding along the California coast where it occupies disturbed places, grasslands, coastal bluffs, dunes, salt marsh, riparian areas and oak woodlands. It is frequently found in waste places and other disturbed sites, but can move into undisturbed sites. It can form dense patches and its allelopathic, dense roots can outcompete other plants and reduce the germination of native plants (DiTomaso and Healy, 2006). It is not yet widely distributed in California and Santa Barbara County according to herbarium records, but it has the potential to spread rapidly. We found only one occurrence of this plant during our surveys (**Appendix C**). Garden staff revisited this occurrence in 2019 and noted that its population numbers had increased dramatically from a few individuals to dozens of individuals. Other colleagues note that it is expanding in our region. Unfortunately, while this occurrence is located within Administrative National Forest, it is on privately owned land. It is ranked limited by Cal-IPC.

Genista monspessulana

Genista monspessulana (French broom) is a perennial shrub in the Fabaceae (pea) family native to the Mediterranean region. Introduced as a landscape ornamental, French broom is now widely spread throughout California (Alexander & D'Antonio 2003). It is an aggressive, nitrogen-fixing

invader, and forms dense stands that exclude native plants (Haubensak et al. 2004). It produces a copious amount of seed, and resprouts from the root crown if cut. We found only one occurrence of this plant during our surveys (**Appendix C**). Additionally, according to CCH, there are few known occurrences in Santa Barbara County. Since it is fairly limited in the Jesusita Fire scar, we recommend removing this invasive plant before it spreads more. Unfortunately, while this occurrence is located within Administrative National Forest, it is on privately owned land. It is ranked as high by Cal-IPC.

Spartium junceum

Spartium junceum (Spanish broom) is a perennial shrub in the Fabaceae (pea) family native to the Mediterranean region. Introduced as a landscape ornamental and as a roadside revegetation species, Spanish broom is now widespread throughout California. It favors disturbed areas, such as post-burn sites (Nilsen 2000). Furthermore, it is highly flammable, and can lead to changes in fire intensity of ecosystems (Nilsen & Semones 1997). While this species is abundant throughout California, there are relatively few records in Santa Barbara country according to CCH. We found one occurrence within the Jesusita Fire scar (**Appendix C**). Since this species has the ability to spread rapidly under suitable conditions like fire (personal observation, Carla Bossard), it would be favorable to eradicate it. Unfortunately, while the occurrence we mapped is located within Administrative National Forest, it is on privately owned land.

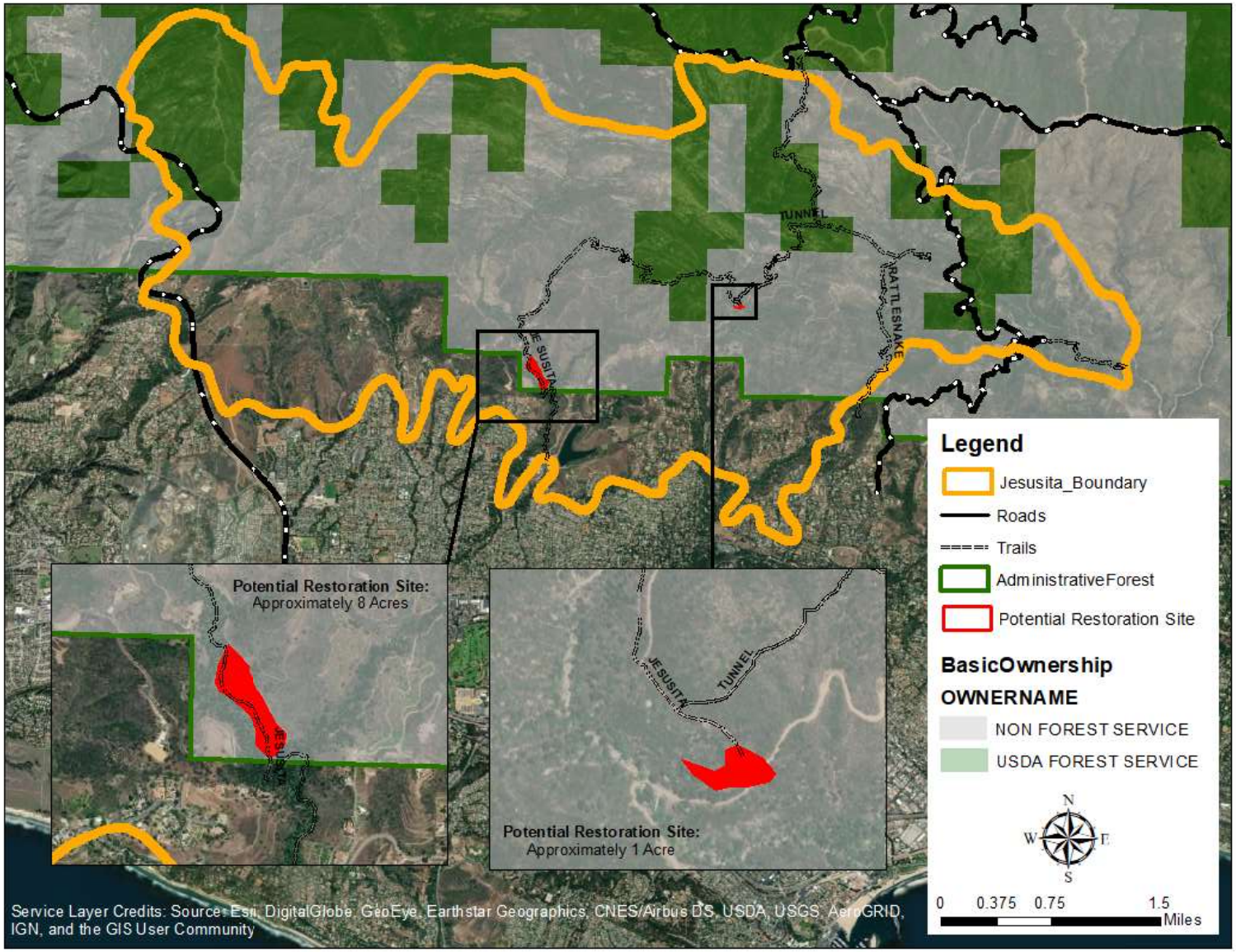
Tamarix sp.

While we did not identify *Tamarix* sp. to species, one of the most widely distributed taxa of *Tamarix* in the Los Padres National Forest is *Tamarix ramosissima* (tamarisk). Tamarisk can form dense stands in riparian areas (Neill 1985), where it can lower the water table and redistribute salts to the soil surface, inhibiting the germination of native species (DiTomaso 1998). Garden staff mapped one occurrence of tamarisk along Gibraltar road (**Appendix C**). However, this was just outside of the fire boundary and outside of the Los Padres National Forest boundary. Further surveys of waterways in the Jesusita Fire scar may yield more tamarisk occurrences. It is ranked as high by Cal-IPC.

Jesusita Fire restoration

The front country in the Jesusita Fire scar is more heavily invaded than the back country in the Zaca Fire scar, with a high diversity of weeds. While it is unrealistic to target all of these weeds for eradication, there is a great opportunity to restore heavily invaded areas and waste places along the Jesusita Trail. There are many users of this trail, who could be recruited to help with such an effort. Furthermore, the act would be an immense outreach opportunity, helping trail users to understand the rare plants in the area, the threat of invasive plants, and the value of habitat restoration. We identified two potential areas (**Figure 15**), infested primarily with mustard, annual grasses, and fennel, and attempted to pursue these recomm-

Figure 15. Potential future restoration sites in the Jesusita Fire scar



-endations with a future NFWF grant proposal. That is when we became aware that, although within the "Administrative Forest Boundary," many Forest Service trails within the Jesusita Fire scar run through privately owned land. We did not proceed with our proposal given these newly discovered constraints.

Zaca Fire eradications

There are a few taxa that have a limited abundance in the Zaca Fire scar, like *Tamarix* spp. and *Elymus caput-medusae*. Further investigation would be needed, but it may be worthwhile to attempt eradication. We discuss each of these species below:

Elymus caput-medusae

Elymus caput-medusae (medusahead) is a winter annual in the Poaceae (grass) family. It invades disturbed sites, grasslands, openings in chaparral, and oak woodlands. It outcompetes native grasses and forbs in addition to forming a dense litter layer that prevents germination and survival of native species (Rodney et al. 1961). It can also contribute to fire danger (Nafus & Davies, 2014). This is all worrisome, as it occupies diverse and unique potrero habitat in the Sierra Madre Mountains. There are very few records known in southern California according to CCH, and the Sierra Madre Road is one of its southernmost known distribution points. We mapped 7 occurrences in the Zaca Fire scar, three of which are located along the Sierra Madre Road (**Appendix D**). We recommend further surveys in the Sierra Madre area to learn its full extent and begin to understand how it may impact the multiple rare plant taxa in the area. It is ranked as high by Cal-IPC.

Tamarix spp.

While we did not identify *Tamarix* sp. to species, one of the most widely distributed taxa of *Tamarix* in the Los Padres National Forest is *Tamarix ramosissima* (tamarisk). Tamarisk can form dense stands in riparian areas (Neill 1985), where it can lower the water table and redistribute salts to the soil surface, inhibiting the germination of native species (DiTomaso 1998). We were able to map tamarisk where it was present at stream crossings on our survey routes (**Appendix D**). It is undoubtedly much more extensive within these waterways, and further surveys would need to be conducted in order to know the full extent of the invasion. Because it is found within dense riparian vegetation, however, it would be a difficult task to find and control all individuals. Channel Islands Restoration has been conducting *Tamarix* control on the Sisquoc River, and it would be desirable to control it in the Santa Ynez River watershed as well. It is ranked as high by Cal-IPC.

Zaca Fire: a note about *Foeniculum vulgare*

Foeniculum vulgare (sweet fennel) is a perennial herb in the Apiaceae (carrot) family. Fennel invades grassland, riparian areas, and other natural areas (Beatty and Licari 1992) and has been naturalized in California since the 1880s (Greene 1887). Once firmly established in an area, fennel can exclude almost all other vegetation (Di Tomaso and Healy 2006). The upper limit of fennel's range is 1,600 m according to the Jepson Manual, and we found one individual at 1,120 m along

the grapevine trail in the Los Padres Backcountry. This was the only individual mapped within the Zaca Fire scar (**Appendix D**), although we know that there are extensive infestations just outside those boundaries on the Gibraltar and East Camino Cielo roads. Staff were able to pull this individual from the middle of the trail. A further survey in the riparian areas in the vicinity of the Grapevine Trail may potentially yield more fennel. It is ranked as a moderate risk by Cal-IPC.

Zaca Fire rare plant refugium

Our surveys reinforced what has long been well known, that increased human use and disturbance bring more plant invasions. Two very widespread weeds, *Centaurea melitensis* and *Centaurea solstitialis*, become less abundant in the more remote areas. The center of the Zaca Fire scar is a rare plant refugium (**Figure 16**), and should be protected from invasion by continuing to restrict access and actively surveying for, then controlling, new infestations.

Conclusions

Through our surveys, we were able to fill in many "botanical blackholes" in the Zaca and Jesusita fire scars. In addition to filling in gaps where georeferenced specimens were largely absent, the 3,628 specimens collected during this project will remain invaluable into the future as they form the basis for ongoing scientific research in ecology, floristics, taxonomy, and conservation biology.

We mapped 236 rare plant features in the Zaca and Jesusita fire scars, some of which had not been mapped in more than a decade. In the Jesusita Fire scar some taxa, like *Lonicera subspicata* var. *subspicata* and *Quercus dumosa,* are fairly widespread and appear to have robust, healthy populations. However, the high diversity of weeds in the Jesusita Fire scar occur in close proximity to many of these rare plants. This, combined with heavy recreation use and close proximity to roads creates high potential for the sustained spread of established and newly introduced weeds. It will be important to remain diligent regarding the potential impact on rare plants and habitats given the high density of rare plants in this area and the diversity of land use. The Zaca Fire scar yielded a high richness of rare plants, particularly in the Mission Pine area of the San Rafael Mountains (**Figure 16**). This area is markedly devoid of many widespread weeds, and should be protected from further invasion. Additionally, there are some taxa that we can more actively conserve, like *Eriophyllum lanatum* var. *hallii* along the Sierra Madre Road, which would benefit from the re-establishment of a livestock exclosure.

We have learned that there are a few invasive taxa that are of limited enough abundance, like *Euphorbia terracina*, *Genista monspessulana*, and *Araujia sericifera* that they could and should be eradicated in these fire scars. For a few taxa, like *Tamarix* spp. and *Elymus caput-medusae*, further investigation would be needed, but it may be worthwhile to attempt eradication. For *Tamarix*, Channel Islands Restoration has been conducting *Tamarix* control on the Sisquoc River, and it would be desirable to control it in the Santa Ynez River watershed as well. Because it is found within dense riparian vegetation, however, it would be a difficult task to find and control all individuals. For *Elymus caput-medusae*, there is very little in southern California, and the Sierra Madre Road is one of its southernmost distribution points. It occupies diverse and unique potrero habitat.

On the other side of the spectrum, the front country in the Jesusita Fire is far more heavily invaded, but there is a great opportunity to restore heavily invaded areas such as along the Jesusita Trail. There are many users of this trail, who could be recruited to help with such an effort. Furthermore, the act would

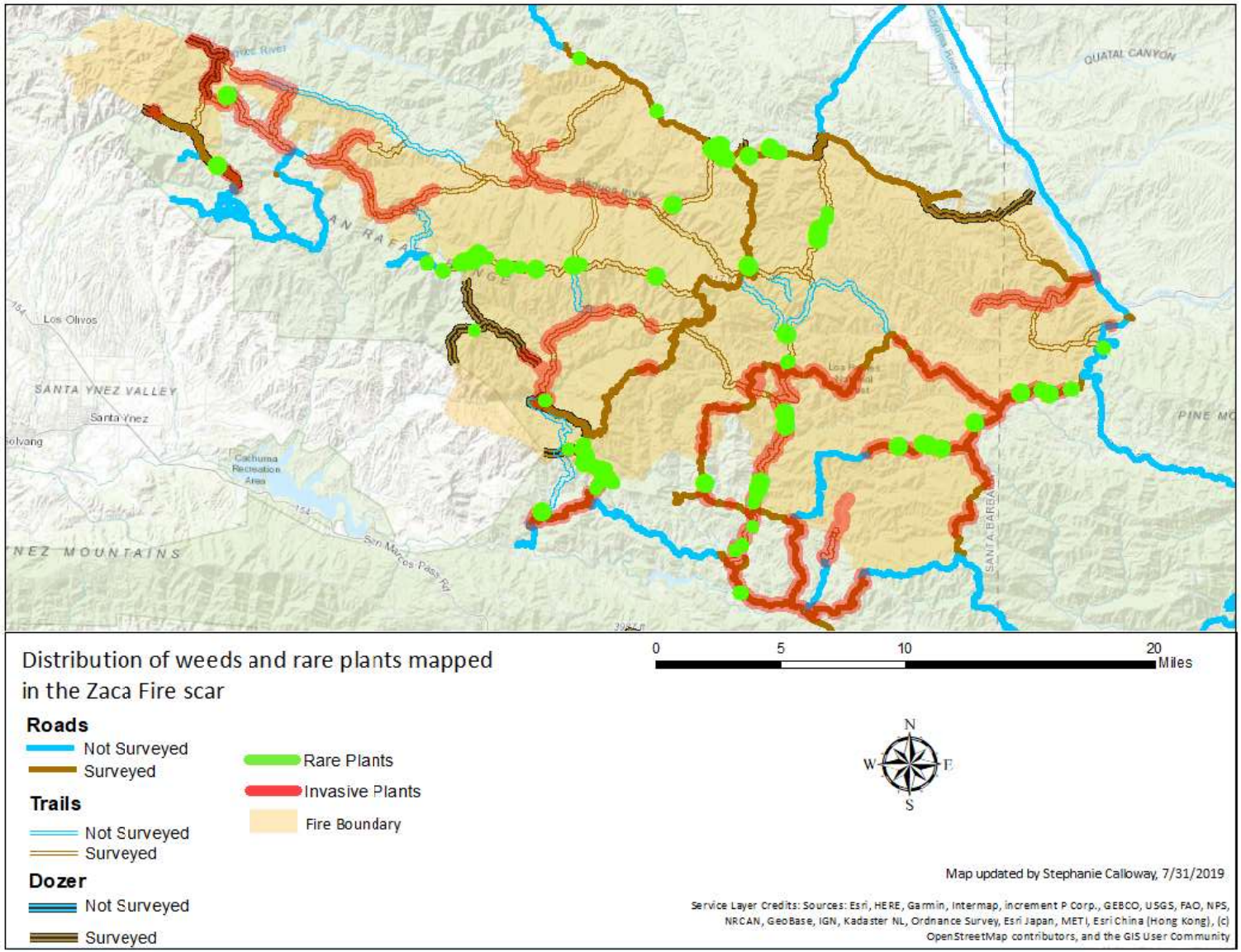
be an immense outreach opportunity, helping trail users to understand the rare plants in the area, the threat of invasive plants, and the value of habitat restoration.

We made conservation seed collections (accessions) of six rare plant taxa (**Table 10, Figure 14**) and made 24 collections of more common plant taxa (**Table 11**) for future restoration needs across the Zaca and Jesusita fire scars. Seed banks are an important conservation tool for protecting species and preserving plant diversity over the long-term by providing genetic redundancy and safeguarding against extinction in the wild. Best practices for conservation seed banking, especially for annual plants, call for repeated collections over time to capture sufficient genetic diversity to restore or reintroduce plant populations in the future. While seed collections of the six rare taxa collected serve as an immediate conservation action, repeated collections of these and more would provide for a more robust conservation collection. The Garden has a vested interest in continuing to seed bank the rare plants of the Los Padres in order to achieve this.

This project included a multiplicity of outreach actions, ranging from videos and Facebook posts to the botanical mentorship of local students. Our Facebook posts reached tens of thousands of people, while our face-to-face interactions, including exchanges on the trail, public talks, and conferences, reached nearly 1,000 people. We were able to mentor students and young professionals who were inspired by the botanical wonders of the Los Padres. In all of these ways, we were able to bring the importance and wonder of the Los Padres to a diversity of people. Furthermore, we have a multitude of media in the form of videos and photographs that can be used as a source for future outreach.

Finally, our data will be useful beyond the management recommendations that we provide. Several institutions have already requested our data to inform research and habitat restoration projects. With USFS Ecologist Nicole Molinari's permission, we have shared invasive plant mapping data with UCSB RivrLab, fuel breaks information with the UCSB D'Antonio lab, and specimen/invasive plant information for the Sierra Madre Road potreros with Channel Islands Restoration. We also sent invasive plant information to Tiffany Lunday (USFS) to aid with NEPA development. Additionally, these data will serve as a snapshot of plant distributions in time and space. If the natural history of the Los Padres tells us anything, it's that these areas are prone to future disturbance, associated with fire or otherwise. These data provide a unique comparison for future plant distributions as climate conditions change and as future disturbances occur.

Figure 16. The more inaccessible center of the Zaca Fire scar is a refugium from invasion for multiple rare plants, and should be protected



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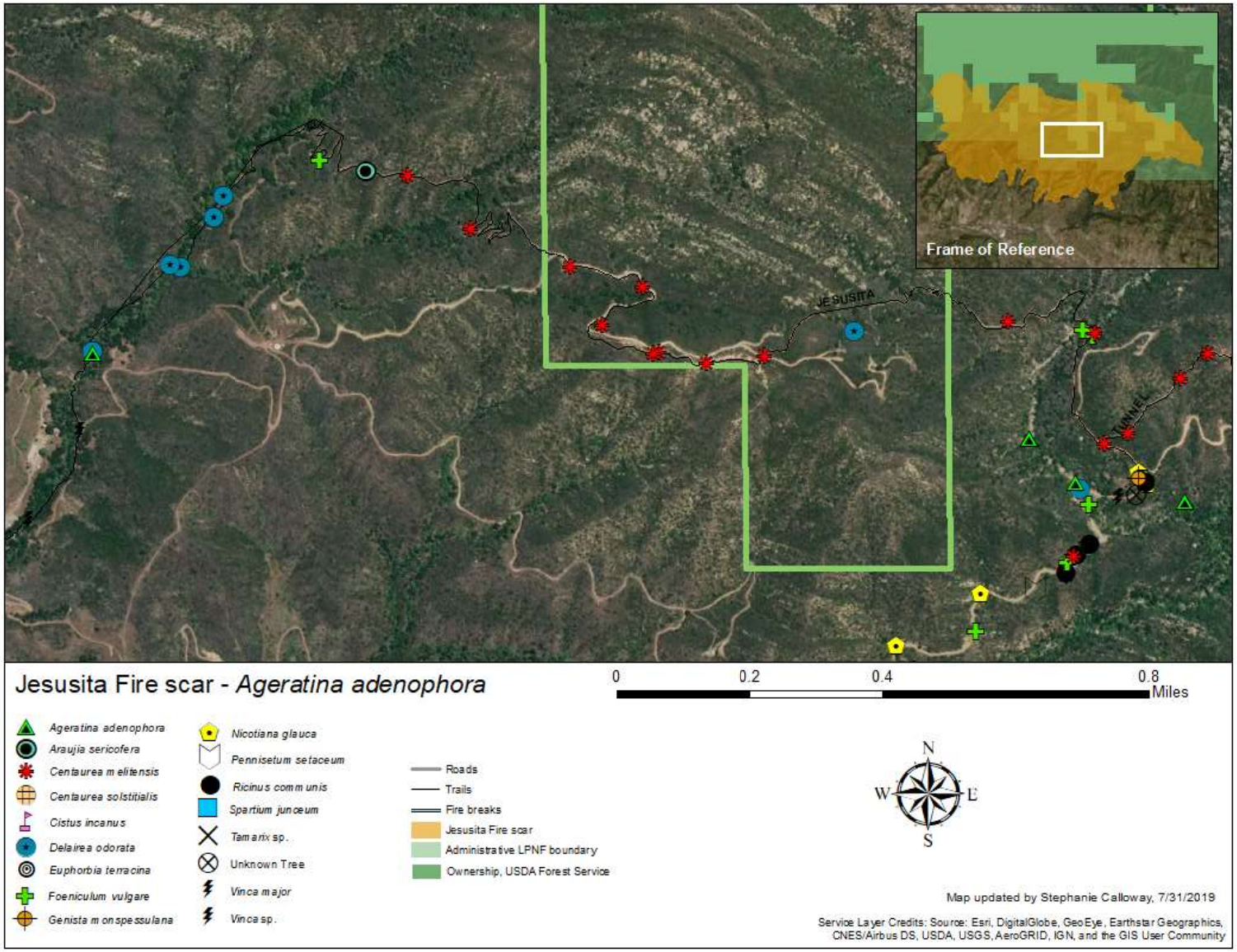
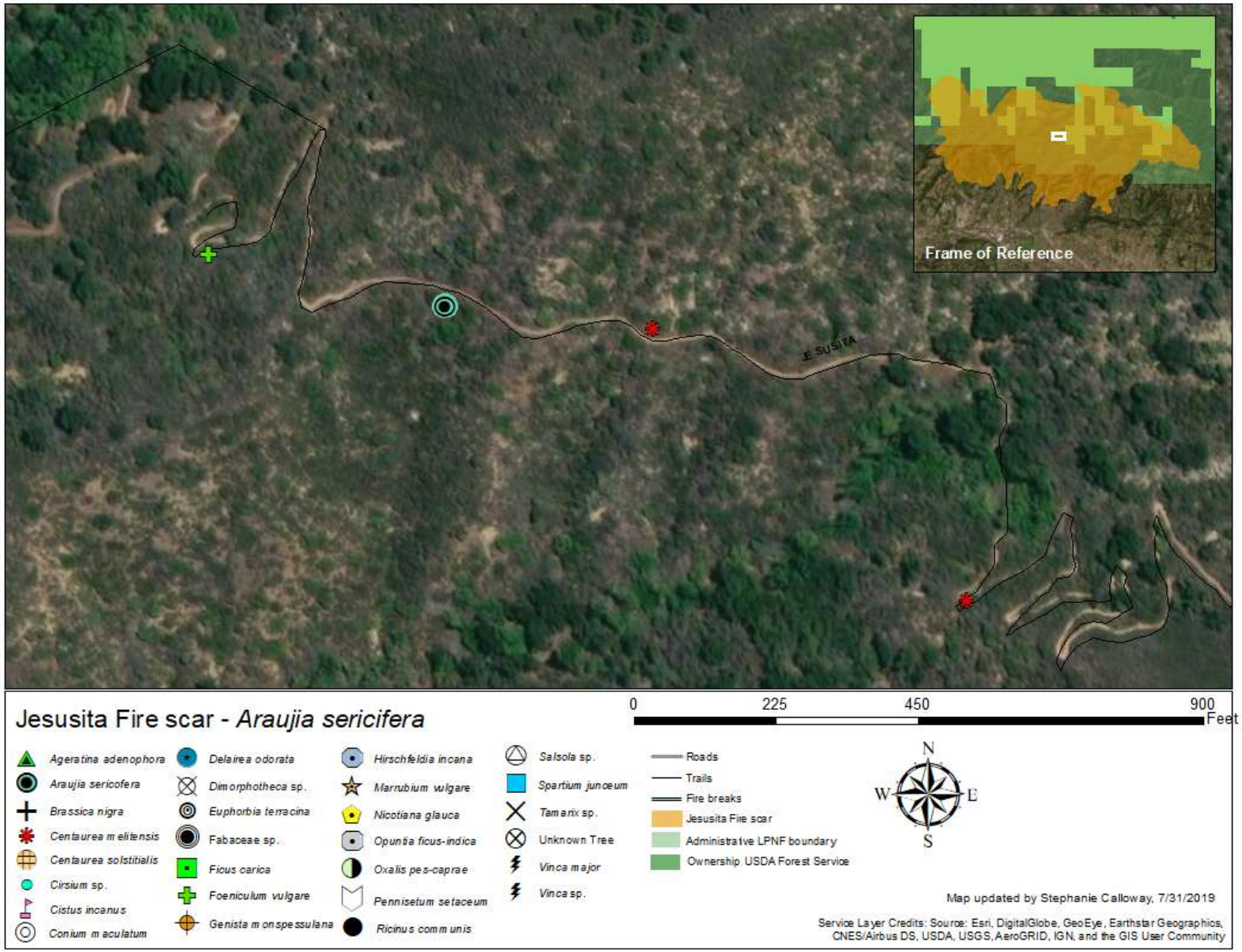
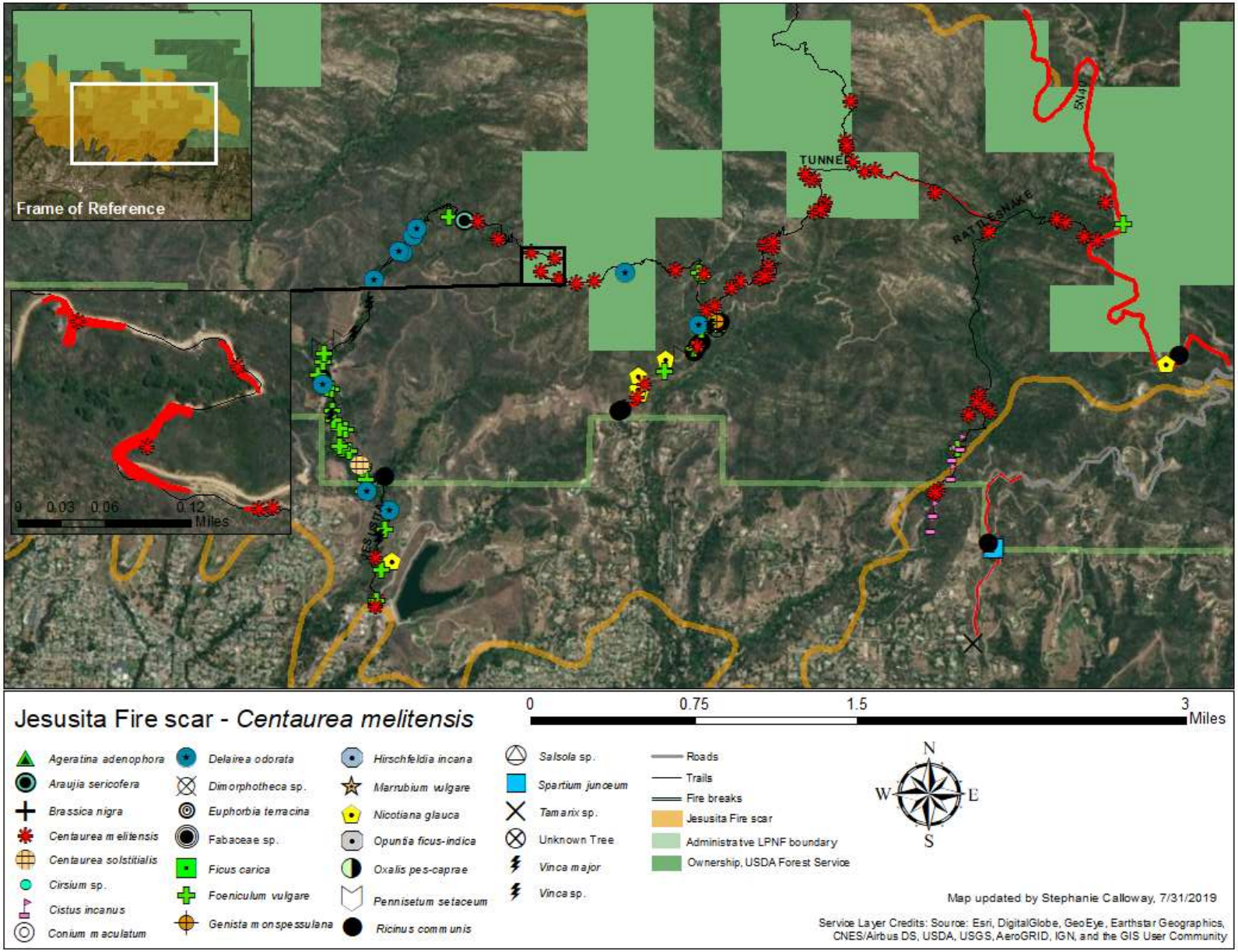
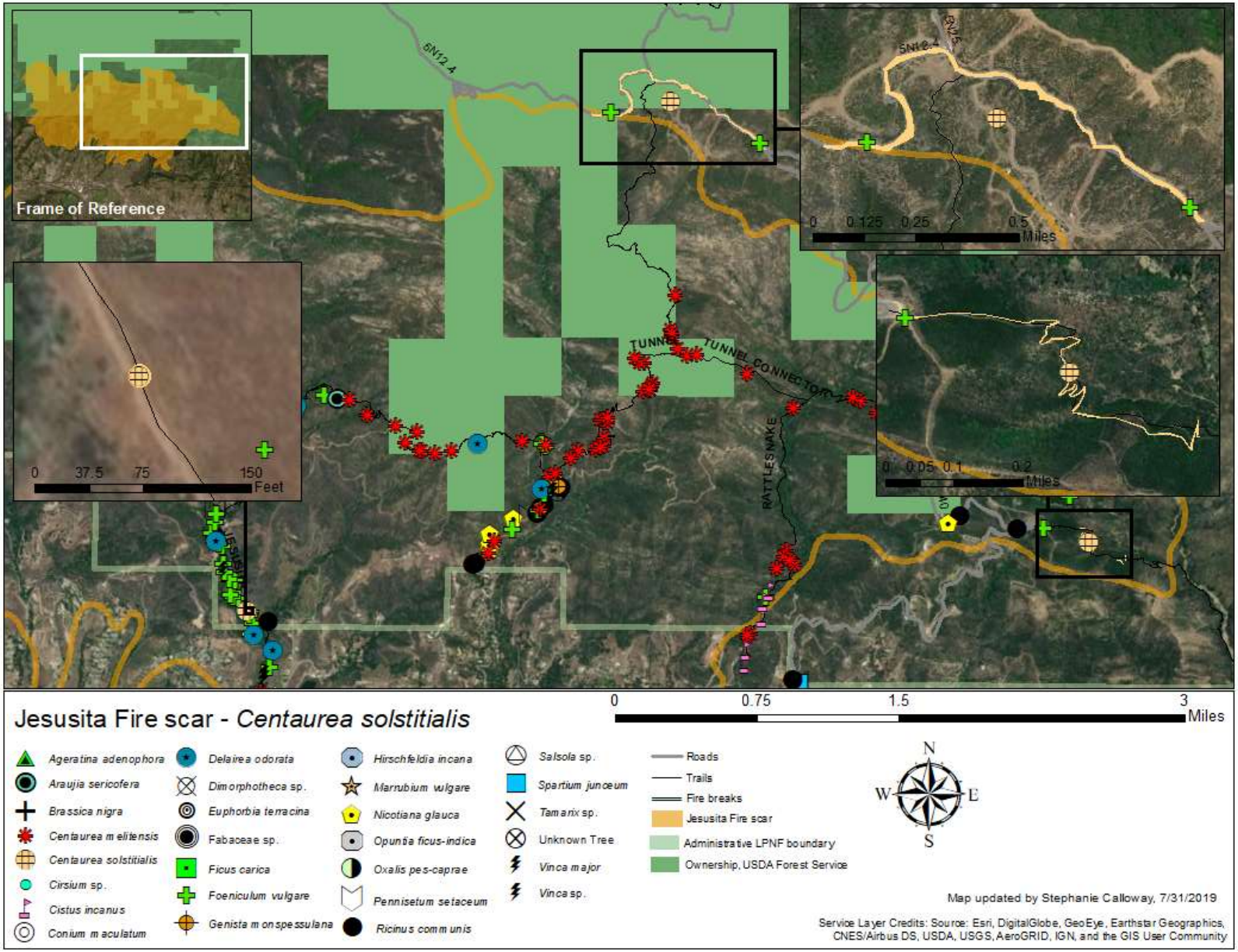
Padres National Forest who provided us with road conditions and access, including Pancho Smith, Ivanna Noell, and Kyah LaPorta. Thank you to Jennifer Gray for sharing our posts and providing us passes. Brian Conant was an indispensable fountain of knowledge about the trails and resources. The skilled pack team at Los Padres Outfitters, especially Boone Campbell and Dennis Vaca, carried us boldly into the wilderness, and even did a bit of trail clearing. And last but not least, the dedicated SBBG staff who literally put their blood, sweat, and tears into this massive project.

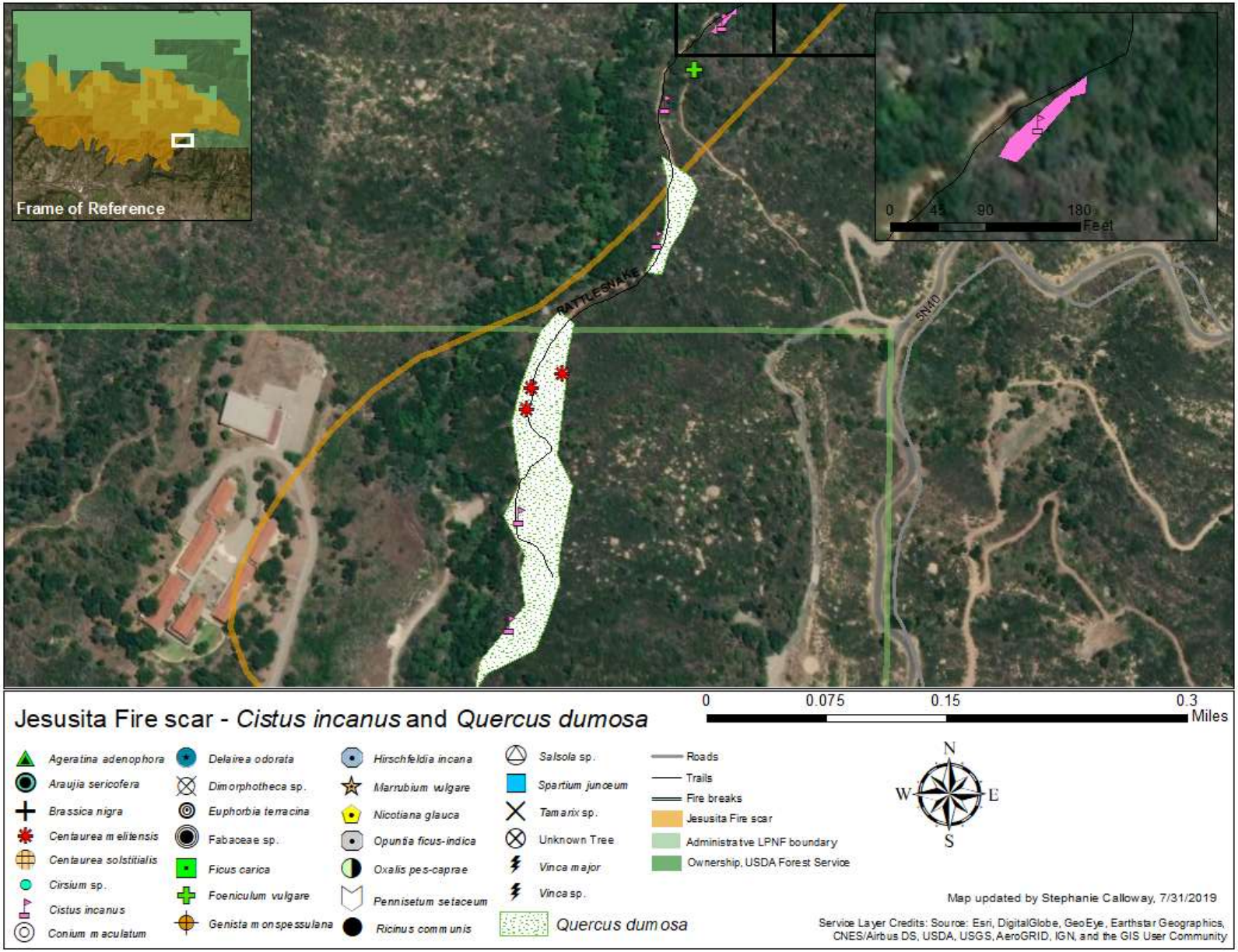
Appendix C. Invasive plants mapped within the Jesusita Fire scar as part of SBBG's Botanical Blackholes project

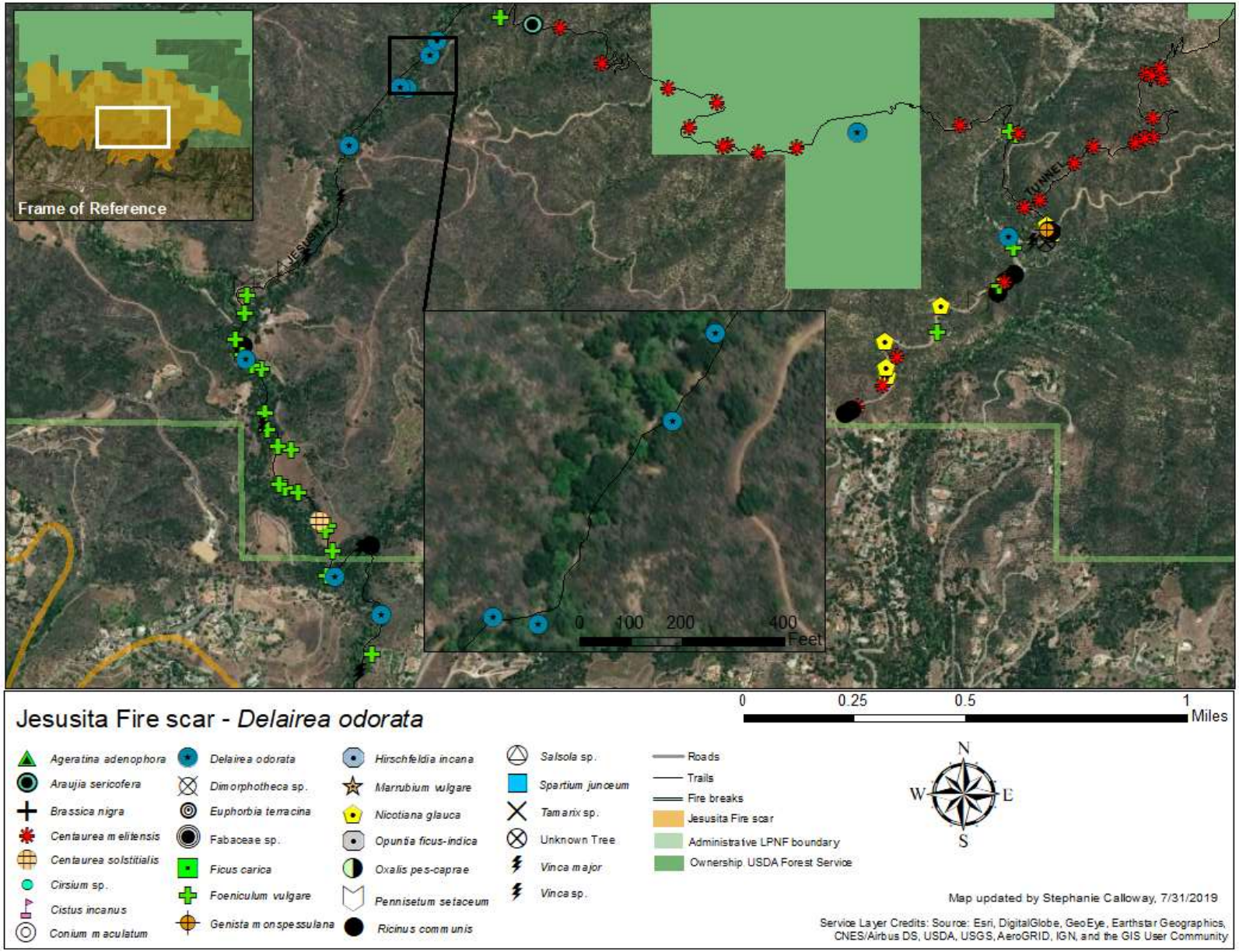



Frame of Reference
E SUSITA
Jesusita Fire scar - Araujia sericifera
0
225
450
900
Feet
Ageratina adenophora
Araujia sericofera
Brassica nigra
Centaurea melitensis
Centaurea solstitialis
Cirsium sp.
Cistus incanus
Conium maculatum
Delairea odorata
Dimorphotheca sp.
Euphorbia terracina
Fabaceae sp.
Ficus carica
Foeniculum vulgare
Genista monspessulana
Hirschfeldia incana
Marrubium vulgare
Nicotiana glauca
Opuntia ficus-indica
Oxalis pes-caprae
Pennisetum setaceum
Ricinus communis
Salsola sp.
Spartium junceum
Tamarix sp.
Unknown Tree
Vinca major
Vinca sp.
Roads
Trails
Fire breaks
Jesusita Fire scar
Administrative LPNF boundary
Ownership USDA Forest Service
N
W
E
S
Map updated by Stephanie Calloway, 7/31/2019
Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

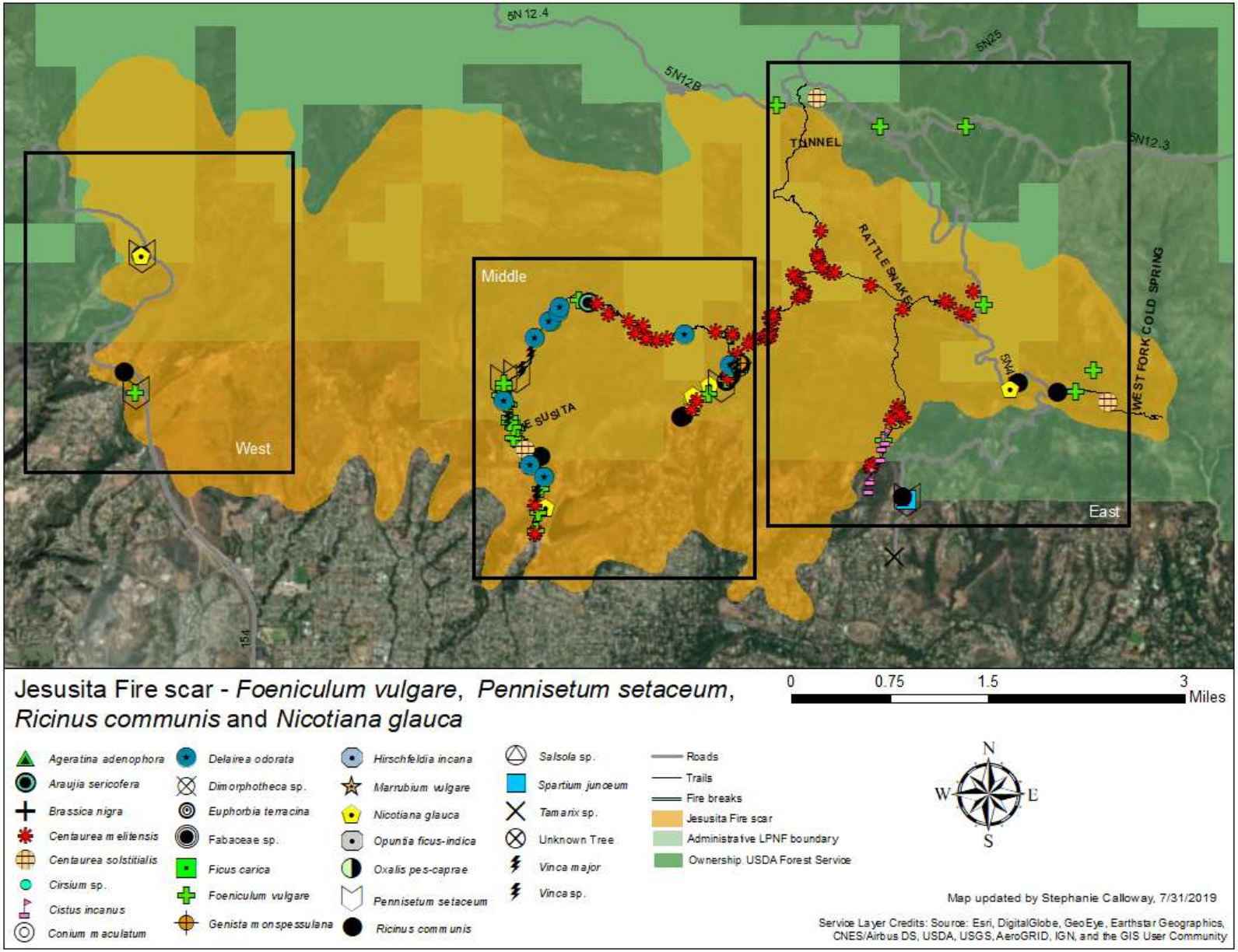

Frame of Reference
TUNNEL
RATTLESNAKE
5N45
0 0.03 0.06 0.12 Miles
Jesusita Fire scar - Centaurea melitensis
0 0.75 1.5 3 Miles
Ageratina adenophora
Araujia sericofera
Brassica nigra
Centaurea melitensis
Centaurea solstitialis
Cirsium sp.
Cistus incanus
Conium maculatum
Delairea odorata
Dimorphotheca sp.
Euphorbia terracina
Fabaceae sp.
Ficus carica
Foeniculum vulgare
Genista monspessulana
Hirschfeldia incana
Marrubium vulgare
Nicotiana glauca
Opuntia ficus-indica
Oxalis pes-caprae
Pennisetum setaceum
Ricinus communis
Salsola sp.
Spartium junceum
Tamarix sp.
Unknown Tree
Vinca major
Vinca sp.
Roads
Trails
Fire breaks
Jesusita Fire scar
Administrative LPNF boundary
Ownership, USDA Forest Service
N
W
E
S
Map updated by Stephanie Calloway, 7/31/2019
Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

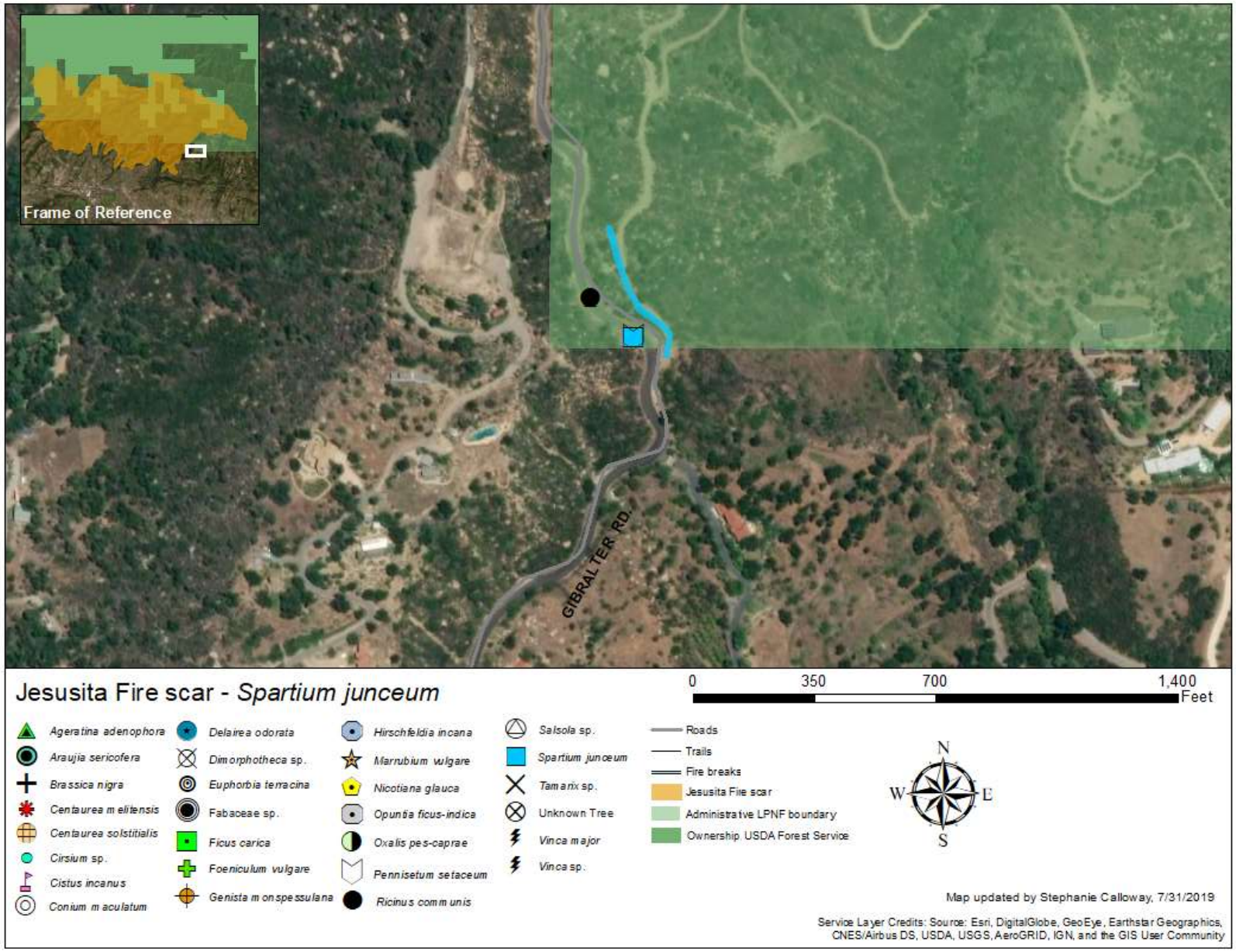

Frame of Reference
5N12.4
5N12.5
TUNNEL
TUNNEL CONNECTOR
RATTLESNAKE
0 37.5 75 150 Feet
0 0.125 0.25 0.5 Miles
0 0.05 0.1 0.2 Miles
Jesusita Fire scar - Centaurea solstitialis
0 0.75 1.5 3 Miles
Ageratina adenophora
Araujia sericofera
Brassica nigra
Centaurea melitensis
Centaurea solstitialis
Cirsium sp.
Cistus incanus
Conium maculatum
Delairea odorata
Dimorphotheca sp.
Euphorbia terracina
Fabaceae sp.
Ficus carica
Foeniculum vulgare
Genista monspessulana
Hirschfeldia incana
Marrubium vulgare
Nicotiana glauca
Opuntia ficus-indica
Oxalis pes-caprae
Pennisetum setaceum
Ricinus communis
Salsola sp.
Spartium junceum
Tamarix sp.
Unknown Tree
Vinca major
Vinca sp.
Roads
Trails
Fire breaks
Jesusita Fire scar
Administrative LPNF boundary
Ownership, USDA Forest Service
N
W
E
S
Map updated by Stephanie Calloway, 7/31/2019
Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

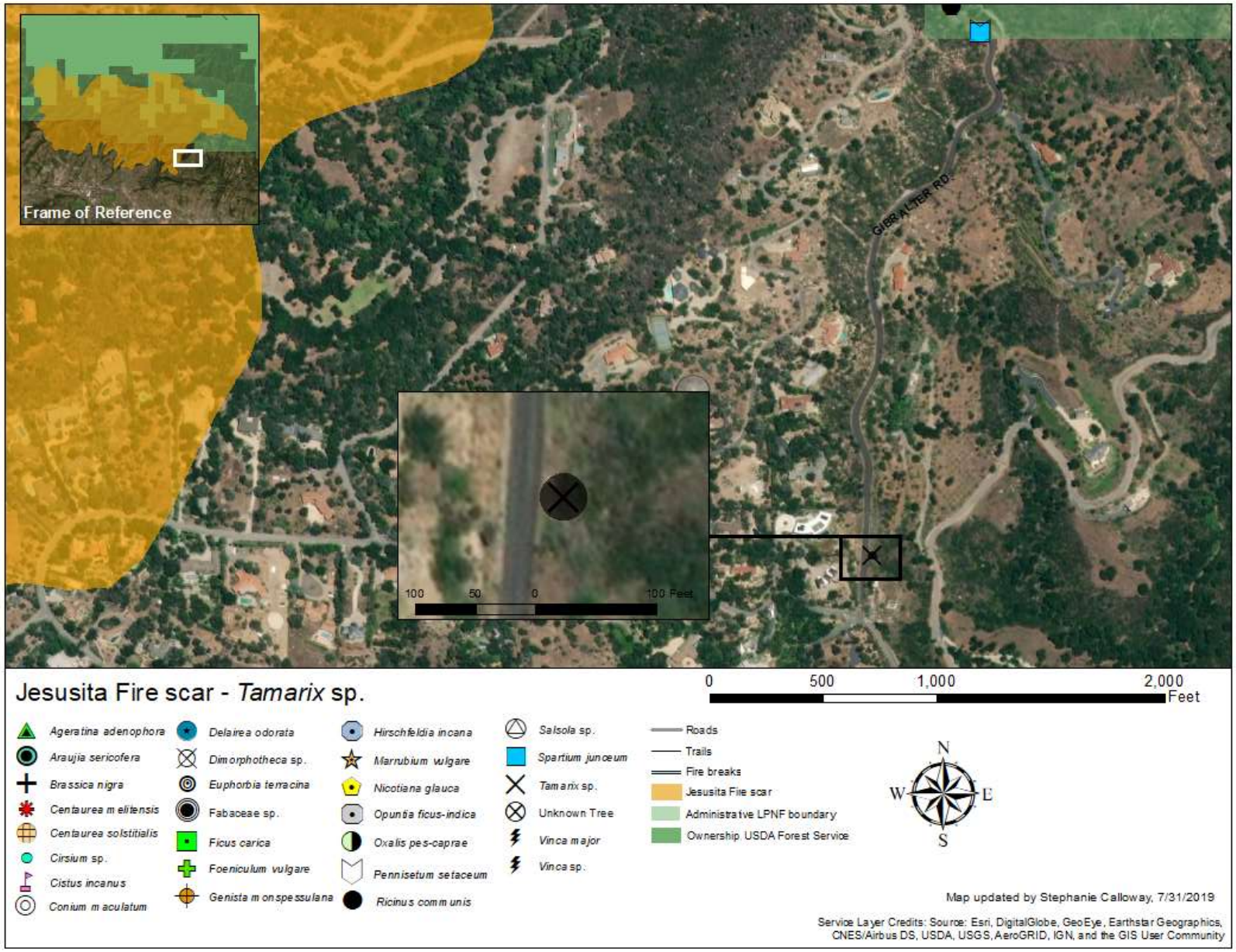

Frame of Reference
0 45 90 180
Feet
RATTLESNAKE
SN40
Jesusita Fire scar - Cistus incanus and Quercus dumosa
0 0.075 0.15 0.3
Miles
Ageratina adenophora
Araujia sericofera
Brassica nigra
Centaurea melitensis
Centaurea solstitialis
Cirsium sp.
Cistus incanus
Conium maculatum
Delairea odorata
Dimorphotheca sp.
Euphorbia terracina
Fabaceae sp.
Ficus carica
Foeniculum vulgare
Genista monspessulana
Hirschfeldia incana
Marrubium vulgare
Nicotiana glauca
Opuntia ficus-indica
Oxalis pes-caprae
Pennisetum setaceum
Ricinus communis
Salsola sp.
Spartium junceum
Tamarix sp.
Unknown Tree
Vinca major
Vinca sp.
Quercus dumosa
Roads
Trails
Fire breaks
Jesusita Fire scar
Administrative LPNF boundary
Ownership, USDA Forest Service
N
W
E
S
Map updated by Stephanie Calloway, 7/31/2019
Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

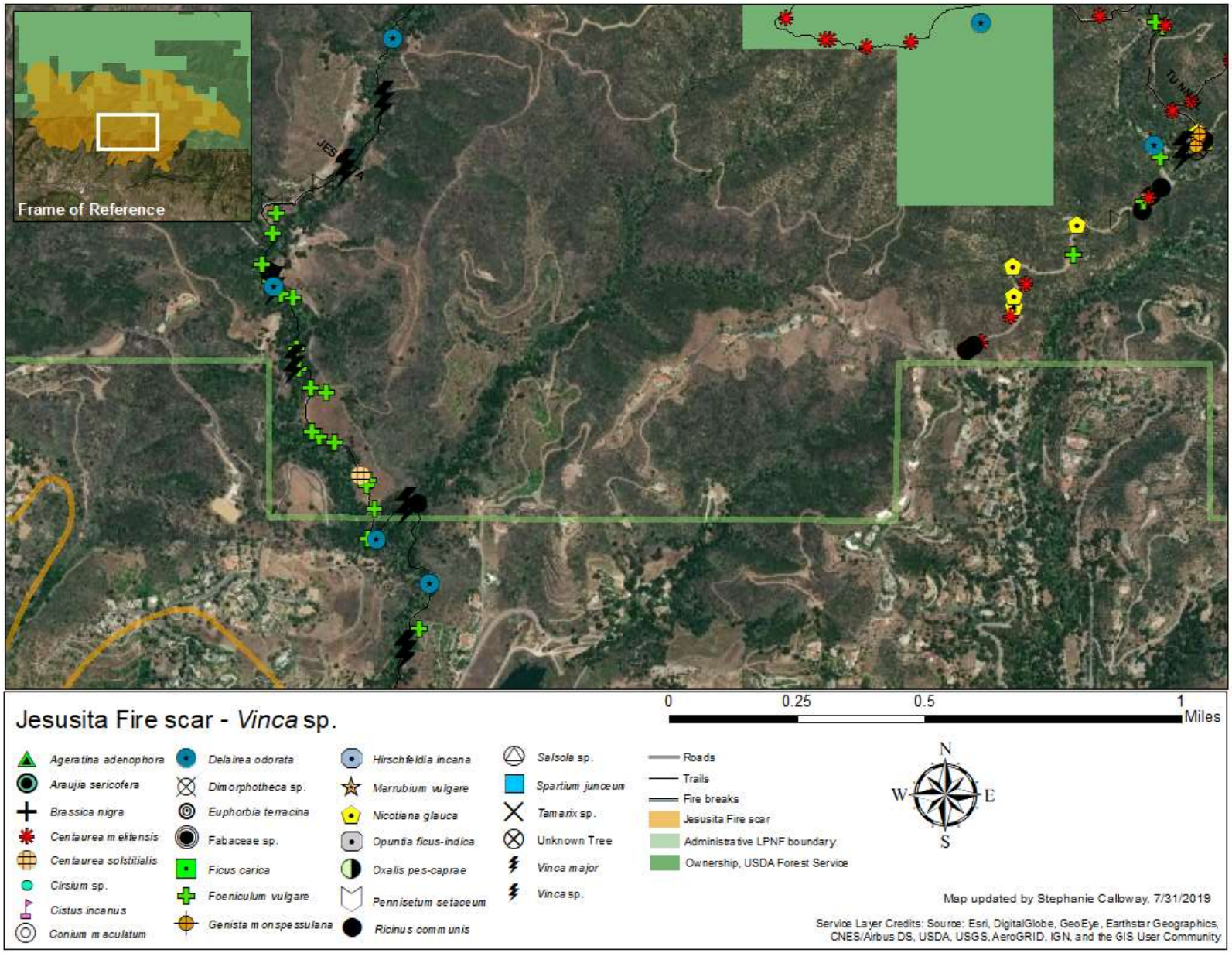

Frame of Reference
JESUSITA
TUNNEL
0 100 200 400
Feet
Jesusita Fire scar - Delairea odorata
0 0.25 0.5 1
Miles
Ageratina adenophora
Araujia sericofera
Brassica nigra
Centaurea melitensis
Centaurea solstitialis
Cirsium sp.
Cistus incanus
Conium maculatum
Delairea odorata
Dimorphotheca sp.
Euphorbia terracina
Fabaceae sp.
Ficus carica
Foeniculum vulgare
Genista monspessulana
Hirschfeldia incana
Marrubium vulgare
Nicotiana glauca
Opuntia ficus-indica
Oxalis pes-caprae
Pennisetum setaceum
Ricinus communis
Salsola sp.
Spartium junceum
Tamarix sp.
Unknown Tree
Vinca major
Vinca sp.
Roads
Trails
Fire breaks
Jesusita Fire scar
Administrative LPNF boundary
Ownership USDA Forest Service
N
W
E
S
Map updated by Stephanie Calloway, 7/31/2019
Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community


Frame of Reference
TUNNEL
TUNNEL CONNECTOR
TUNNEL
Jesusita Fire scar - Euphorbia terracina and Genista monspessulana
0
75
150
300
Feet
Ageratina adenophora
Araujia sericofera
Brassica nigra
Centaurea melitensis
Centaurea solstitialis
Cirsium sp.
Cistus incanus
Conium maculatum
Delairea odorata
Dimorphotheca sp.
Euphorbia terracina
Fabaceae sp.
Ficus carica
Foeniculum vulgare
Genista monspessulana
Hirschfeldia incana
Marrubium vulgare
Nicotiana glauca
Opuntia ficus-indica
Oxalis pes-caprae
Pennisetum setaceum
Ricinus communis
Salsola sp.
Spartium junceum
Tamarix sp.
Unknown Tree
Vinca major
Vinca sp.
Roads
Trails
Fire breaks
Jesusita Fire scar
Administrative LPNF boundary
Ownership USDA Forest Service
N
W
E
S
Map updated by Stephanie Calloway, 7/31/2019
Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

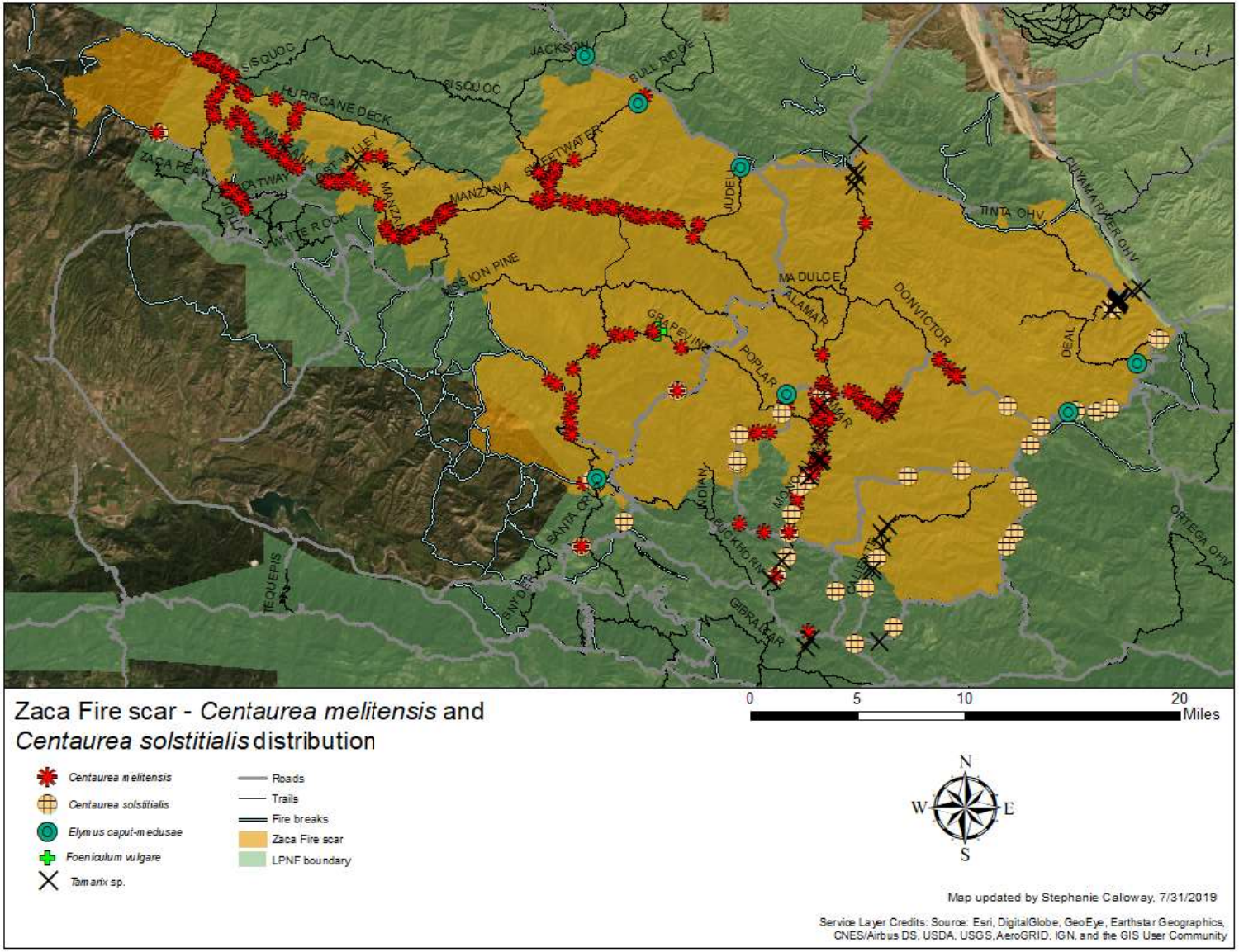

5N 12.4
5N12B
5N25
5N12.3
TUNNEL
RATTLESNAKE
WEST FORK COLD SPRING
5N4
Middle
JESUSITA
West
East
154
Jesusita Fire scar - Foeniculum vulgare, Pennisetum setaceum, Ricinus communis and Nicotiana glauca
0
0.75
1.5
3
Miles
Ageratina adenophora
Araujia sericofera
Brassica nigra
Centaurea melitensis
Centaurea solstitialis
Cirsium sp.
Cistus incanus
Conium maculatum
Delairea odorata
Dimorphotheca sp.
Euphorbia terracina
Fabaceae sp.
Ficus carica
Foeniculum vulgare
Genista monspessulana
Hirschfeldia incana
Marrubium vulgare
Nicotiana glauca
Opuntia ficus-indica
Oxalis pes-caprae
Pennisetum setaceum
Ricinus communis
Salsola sp.
Spartium junceum
Tamarix sp.
Unknown Tree
Vinca major
Vinca sp.
Roads
Trails
Fire breaks
Jesusita Fire scar
Administrative LPNF boundary
Ownership USDA Forest Service
N
W
E
S
Map updated by Stephanie Calloway, 7/31/2019
Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

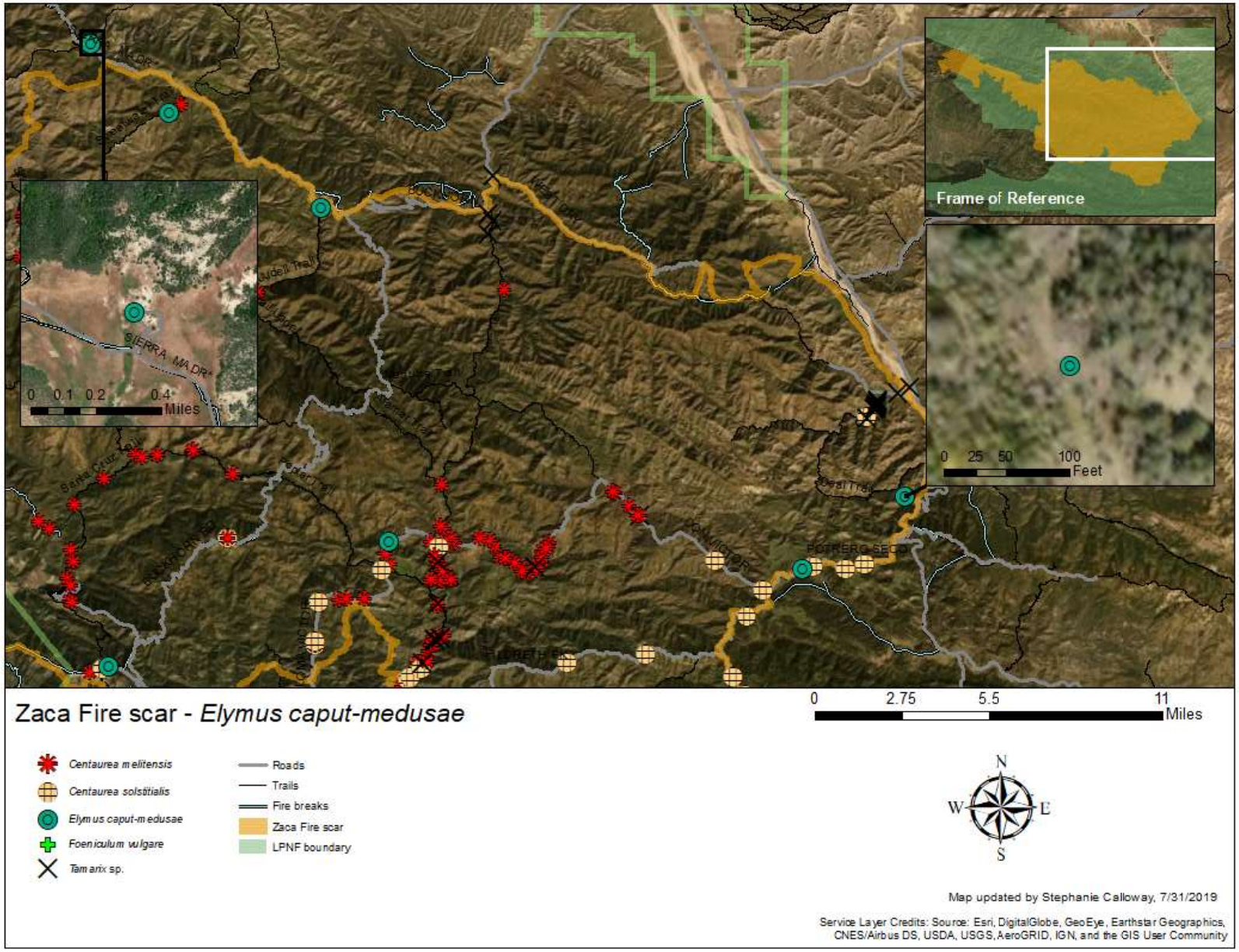

Frame of Reference
GIBRALTER RD.
Jesusita Fire scar - Spartium junceum
0
350
700
1,400
Feet
Ageratina adenophora
Araujia sericofera
Brassica nigra
Centaurea melitensis
Centaurea solstitialis
Cirsium sp.
Cistus incanus
Conium maculatum
Delairea odorata
Dimorphotheca sp.
Euphorbia terracina
Fabaceae sp.
Ficus carica
Foeniculum vulgare
Genista monspessulana
Hirschfeldia incana
Marrubium vulgare
Nicotiana glauca
Opuntia ficus-indica
Oxalis pes-caprae
Pennisetum setaceum
Ricinus communis
Salsola sp.
Spartium junceum
Tamarix sp.
Unknown Tree
Vinca major
Vinca sp.
Roads
Trails
Fire breaks
Jesusita Fire scar
Administrative LPNF boundary
Ownership USDA Forest Service
N
W
E
S
Map updated by Stephanie Calloway, 7/31/2019
Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

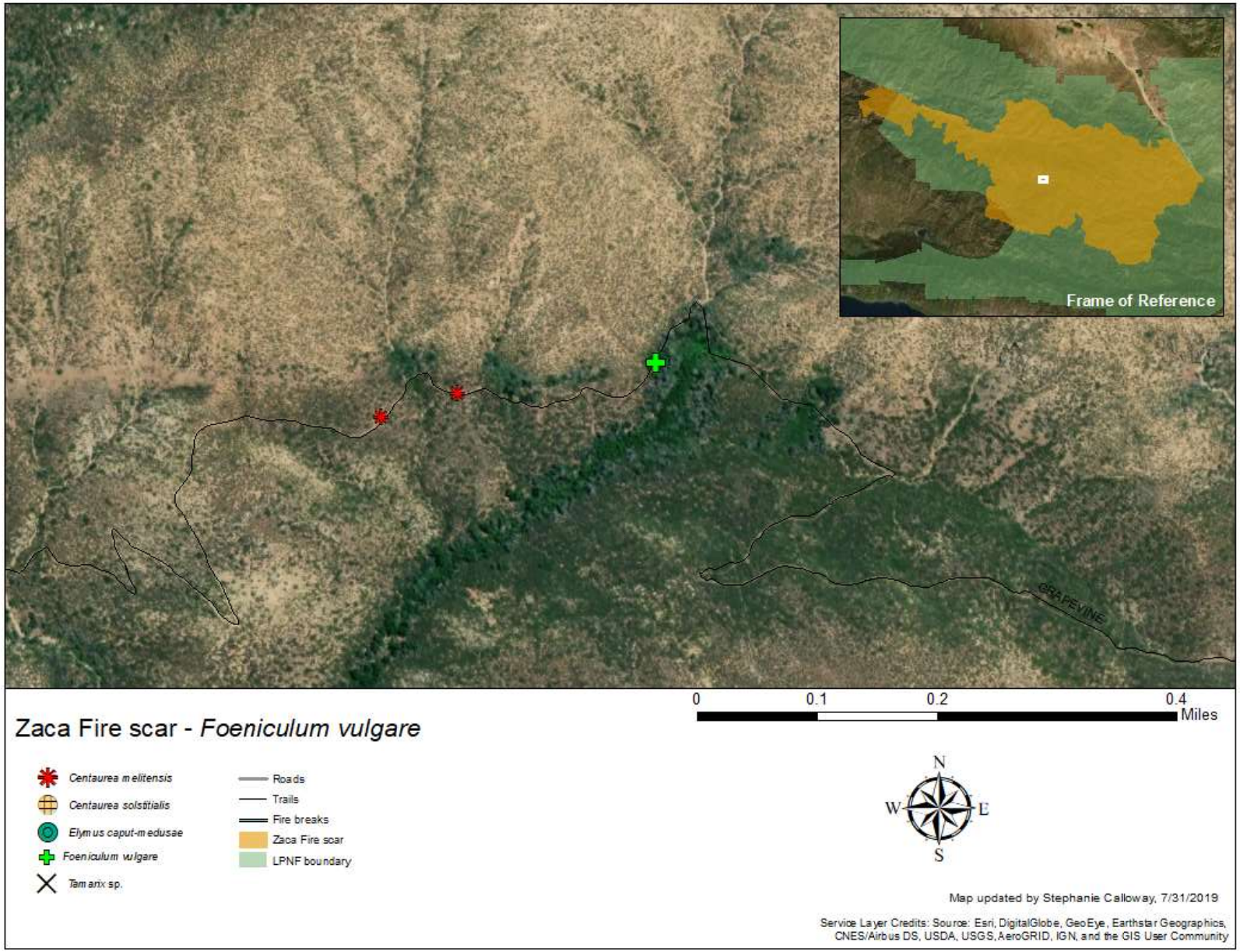

Frame of Reference
GIBRALTER RD.
100 50 0 100 Feet
Jesusita Fire scar - Tamarix sp.
0 500 1,000 2,000
Feet
Ageratina adenophora
Araujia sericofera
Brassica nigra
Centaurea melitensis
Centaurea solstitialis
Cirsium sp.
Cistus incanus
Conium maculatum
Delairea odorata
Dimorphotheca sp.
Euphorbia terracina
Fabaceae sp.
Ficus carica
Foeniculum vulgare
Genista monspessulana
Hirschfeldia incana
Marrubium vulgare
Nicotiana glauca
Opuntia ficus-indica
Oxalis pes-caprae
Pennisetum setaceum
Ricinus communis
Salsola sp.
Spartium junceum
Tamarix sp.
Unknown Tree
Vinca major
Vinca sp.
Roads
Trails
Fire breaks
Jesusita Fire scar
Administrative LPNF boundary
Ownership USDA Forest Service
N
W
E
S
Map updated by Stephanie Calloway, 7/31/2019
Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community


Frame of Reference
JESUSITA
TUNNEL
Jesusita Fire scar - Vinca sp.
0
0.25
0.5
1
Miles
Ageratina adenophora
Araujia sericofera
Brassica nigra
Centaurea melitensis
Centaurea solstitialis
Cirsium sp.
Cistus incanus
Conium maculatum
Delairea odorata
Dimorphotheca sp.
Euphorbia terracina
Fabaceae sp.
Ficus carica
Foeniculum vulgare
Genista monspessulana
Hirschfeldia incana
Marrubium vulgare
Nicotiana glauca
Opuntia ficus-indica
Oxalis pes-caprae
Pennisetum setaceum
Ricinus communis
Salsola sp.
Spartium junceum
Tamarix sp.
Unknown Tree
Vinca major
Vinca sp.
Roads
Trails
Fire breaks
Jesusita Fire scar
Administrative LPNF boundary
Ownership, USDA Forest Service
N
W
E
S
Map updated by Stephanie Calloway, 7/31/2019
Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Appendix D. Invasive plants mapped within the Zaca fire scar as part of SBBG's Botanical Blackholes project




Frame of Reference
0 0.1 0.2 0.4 Miles
0 25 50 100 Feet
SIERRA MADRE
Zaca Fire scar - Elymus caput-medusae
0 2.75 5.5 11 Miles
Centaurea melitensis
Centaurea solstitialis
Elymus caput-medusae
Foeniculum vulgare
Tamarix sp.
Roads
Trails
Fire breaks
Zaca Fire scar
LPNF boundary
N
W
E
S
Map updated by Stephanie Calloway, 7/31/2019
Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community


Frame of Reference
GRAPEVINE
0
0.1
0.2
0.4
Miles
Zaca Fire scar - Foeniculum vulgare
Centaurea melitensis
Centaurea solstitialis
Elymus caput-medusae
Foeniculum vulgare
Tamarix sp.
Roads
Trails
Fire breaks
Zaca Fire scar
LPNF boundary
N
W
E
S
Map updated by Stephanie Calloway, 7/31/2019
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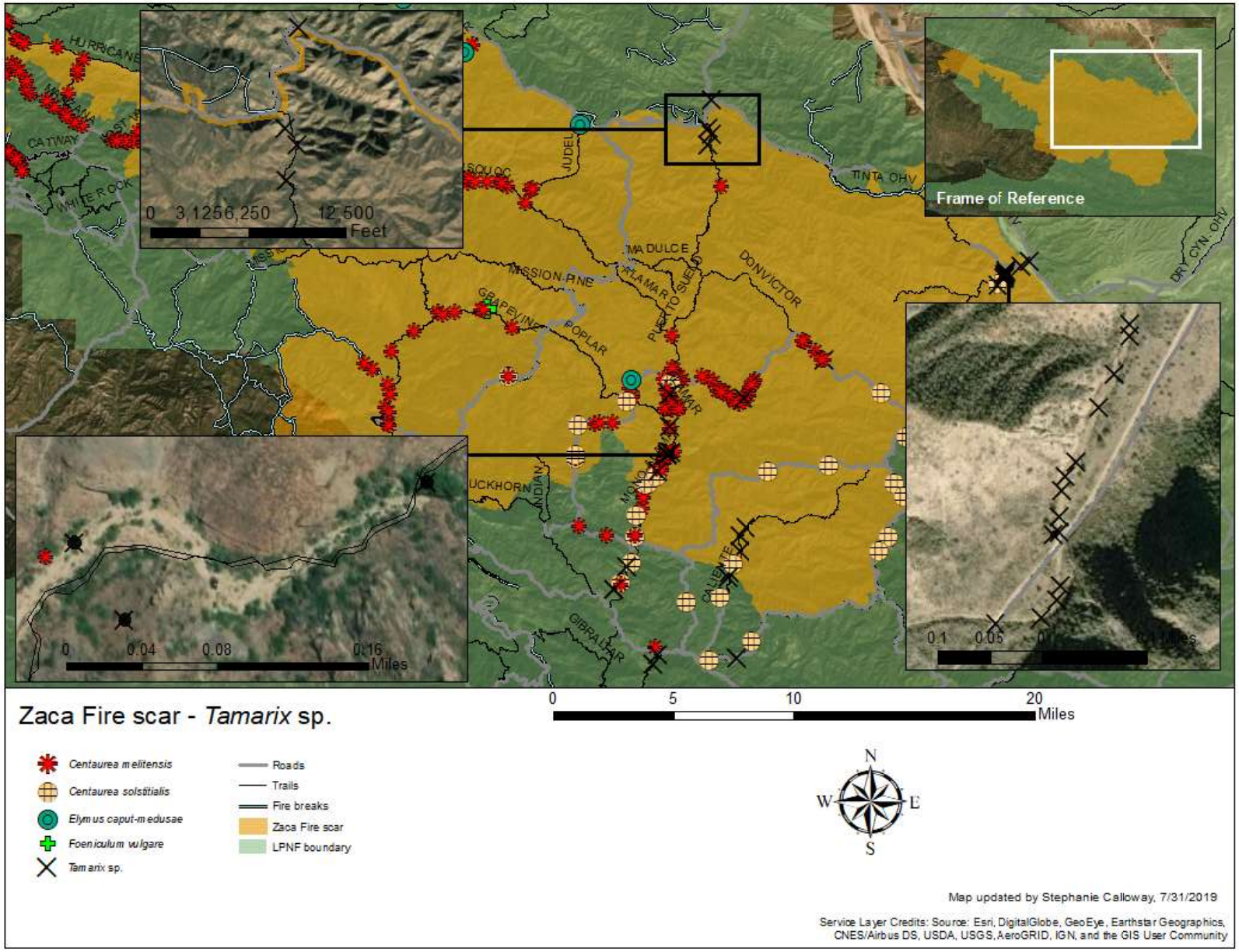
Zaca Fire scar - *Tamarix* sp.
Frame of Reference
0 3,1256,250 12,500 Feet
0 0.04 0.08 0.16 Miles
0 5 10 20 Miles
0.1 0.05
Centaurea melitensis
Centaurea solstitialis
Elymus caput-medusae
Foeniculum vulgare
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