

# 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

### Preparation

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 8<sup>th</sup>. 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 9<sup>th</sup>. 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 20<sup>th</sup>, 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	<p>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:</p> <table border="1"> <thead> <tr> <th>Name</th> <th>Description</th> </tr> </thead> <tbody> <tr> <td>Negligible</td> <td>The location of the observation is precisely known and mapped within a 20 foot radius (6.25m) of error or less.</td> </tr> <tr> <td>Aerial delimited</td> <td>Uncertainty is greater than 20' (6.25m) in any direction, but located within a larger area with identifiable boundaries.</td> </tr> <tr> <td>Linear</td> <td>Uncertainty is greater than 20' (6.25m) along one axis, but identifiable features that serve as endpoints are mapped.</td> </tr> <tr> <td>Aerial estimated</td> <td>Uncertainty is greater than 20' (6.25m) in any direction, but the extent cannot be delimited by boundaries on a map.</td> </tr> </tbody> </table>	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.
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.										
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.										

Forest Service Required Field

CNDDDB Required Field

Both FS and CNDDDB Required

Optional but encouraged



Figure 2. An example Rare Plant Fact Sheet.

<p><b>Calochortus fimbriatus (1B.3)</b> Late-flowered mariposa lily Liliaceae Perennial herb (bulb)</p>		
<p><b>Habit:</b> Bulb coat fibrous. <b>Stem:</b> erect, 30--90 cm, slender, generally branched, bulblets 0. <b>Leaf:</b> basal 20--40 cm, withering; cauline reduced upward, inrolled. <b>Inflorescence:</b> flowers 1--8, erect. <b>Flower:</b> perianth widely bell-shaped; sepals 20--30 mm, narrowly lanceolate, long-tapered; petals &lt; to &lt;&lt; sepals, +- square, pale cream, +- yellow, +- purple, or dark red to red-brown, dark-hairy; nectary +- round, depressed, +- glabrous, +- hidden by dense, long, cream-white to yellow bordering hairs; filaments 12--15 mm, dilated at base, anthers &gt; filaments, oblong, abruptly pointed, white, yellow to red-brown. <b>Fruit:</b> erect, 4--5 cm, linear, angled, tip acuminate. <b>Ecology:</b> Dry, open coastal woodland, chaparral; <b>Elevation:</b> &lt; 900 m. <b>Bioregional Distribution:</b> SCoRO, WTR. <b>Flowering Time:</b> Jul--Aug <b>Note:</b> Taxonomic limits uncertain; study needed <b>Syn.</b> <i>Calochortus weedi</i> var. <i>vestus</i></p>		
<p>20. Petal ± pink, generally toothed, not ciliate ..... <i>C. plummerae</i> 20' Petal tan, yellow, ± purple to red-brown, generally ± ciliate 21. Petal tip dark-hair-tufted ..... <i>C. obispoensis</i> 21' Petal tip fringed, not hair-tufted 22. Petal margin fringed with 2 rows of hairs; anthers abruptly pointed; Outer South Coast Ranges, Western Transverse Ranges ..... <b><i>C. fimbriatus</i></b> 22' Petal margin fringed with 1 row of hairs; anthers rounded; Outer South Coast Ranges, South Coast, Western Transverse Ranges, Peninsular Ranges ..... <i>C. weedi</i></p>	<p>copyright 2018 Calflora</p>	

## 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 Williams (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
<i>Baccharis plummerae</i> ssp. <i>plummerae</i>	26	>161
<i>Calochortus fimbriatus</i>	9	149
<i>Lonicera subspicata</i> var. <i>subspicata</i>	88	1,659
<i>Monardella hypoleuca</i> ssp. <i>lanata</i>	1	1
<i>Quercus dumosa</i>	17	3,835
<i>Thelypteris puberula</i> var. <i>sonorensis</i>	2	13
<b>TOTAL</b>	<b>142</b>	<b>5,644</b>

**Table 2.** Rare Plants mapped in the Zaca Fire scar

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

### 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.

Figure 3. All rare plant taxa mapped in the Jesusita Fire scar

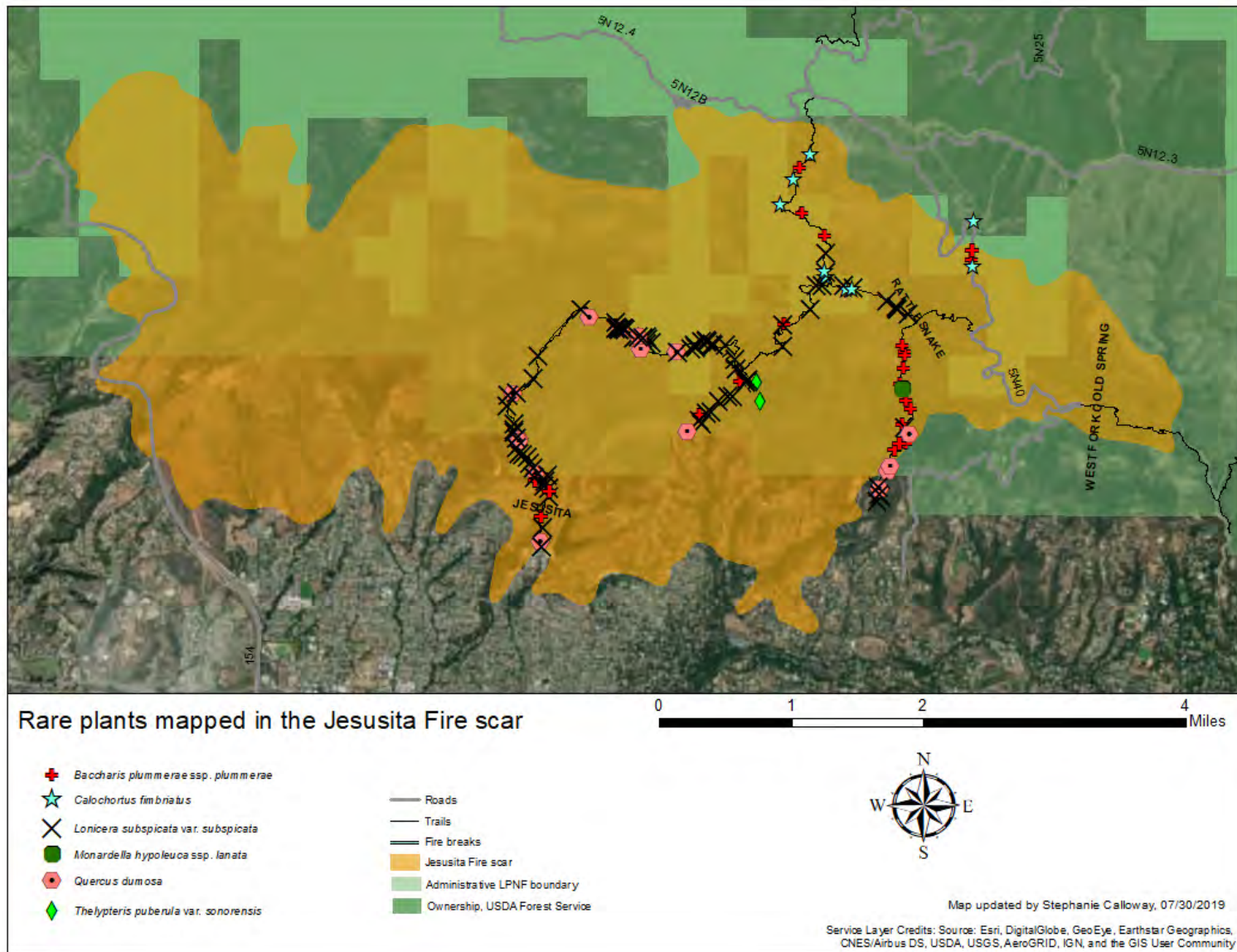
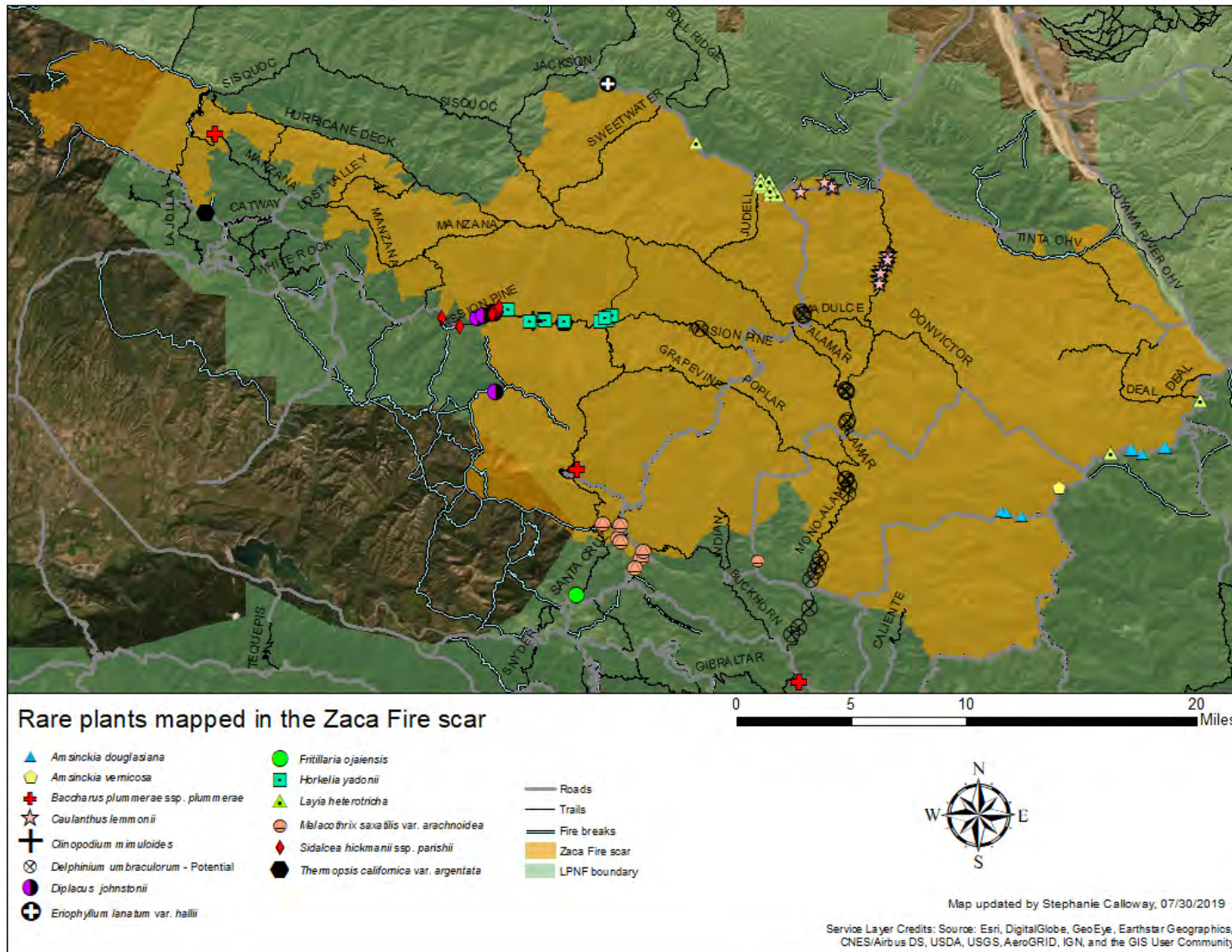


Figure 4. All rare plant taxa mapped in the Zaca Fire scar



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

Taxon	Zaca	Jesusita
<i>Ageratina adenophora</i>		X
<i>Araujia sericifera</i>		X
<i>Brassica nigra</i>	X	X
<i>Bromus tectorum</i>	X	
<i>Carduus pycnocephalus</i> ssp. <i>pycnocephalus</i>	X	X
<i>Centaurea melitensis</i>	X	X
<i>Centaurea solstitialis</i>	X	X
<i>Cistus incanus</i>		X
<i>Conium maculatum</i>		X
<i>Delairea odorata</i>		X
<i>Elymus caput-medusae</i>	X	
<i>Euphorbia terracina</i>		X
<i>Ficus carica</i>		X
<i>Foeniculum vulgare</i>	X	X
<i>Genista monspessulana</i>		X
<i>Hirschfeldia incana</i>	X	X
<i>Lactuca serriola</i>	X	
<i>Marrubium vulgare</i>	X	X
<i>Nicotiana glauca</i>		X
<i>Opuntia ficus-indica</i>		X
<i>Oxalis pes-caprae</i>		X
<i>Pennisetum setaceum</i>		X
<i>Plantago lanceolata</i>	X	
<i>Poa bulbosa</i> ssp. <i>vivipara</i>	X	
<i>Polygonum arenastrum</i>	X	
<i>Ricinus communis</i>		X
<i>Silybum marianum</i>	X	
<i>Sonchus asper</i>	X	
<i>Sonchus oleraceus</i>	X	
<i>Spartium junceum</i>	X	X
<i>Tamarix</i> sp.	X	X
<i>Tragopogon</i> sp.	X	
<i>Vinca major</i>		X
<b>Needs Further Information (timing issue)</b>		
Asteraceae sp.	X	
<i>Cardaria</i> sp.	X	
<i>Cirsium</i> sp.		X
<i>Dimorphotheca</i> sp.		X
Fabaceae sp.		X
<i>Lotus</i> sp.	X	
<i>Matricaria</i> sp.	X	
<i>Olea</i> sp.		X
Polygonaceae sp.	X	
<i>Rumex</i> sp.	X	
<i>Salsola</i> 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
<i>Ageratina adenophora</i>	5	0.01
<i>Araujia sericifera</i>	1	0.02
<i>Centaurea solstitialis</i>	3	2.16
<i>Cistus incanus</i>	5	0.02
<i>Delairea odorata</i>	10	0.07
<i>Euphorbia terracina</i>	1	0.01
<i>Genista monspessulana</i>	3	0.01
<i>Nicotiana glauca</i>	10	3.69
<i>Pennisetum setaceum</i>	6	3.71
<i>Ricinus communis</i>	13	5.31
<i>Spartium junceum</i>	1	0.14
<i>Tamarix sp.</i>	1	0.02
<i>Vinca major</i>	1	0.01
<i>Vinca sp.</i>	8	0.06
<b>TOTAL</b>	<b>73</b>	<b>15.24</b>

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

Taxon	# Polygons	Net Acres	Gross Acres	Average Count
<i>Centaurea melitensis</i>	64	>0.23	28.63	36,776
<i>Foeniculum vulgare</i>	38	>4.34	27.71	5095
<b>TOTAL</b>	<b>102</b>	<b>&gt;4.57</b>	<b>56.26</b>	<b>41,871</b>

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

Taxon	# Polygons	Gross Acres
<i>Elymus caput-medusae</i>	7	0.63
<i>Tamarix sp.</i>	40	3.51
<b>TOTAL</b>	<b>43</b>	<b>4.14</b>

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

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

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 14<sup>th</sup>, 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 30<sup>th</sup>, 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

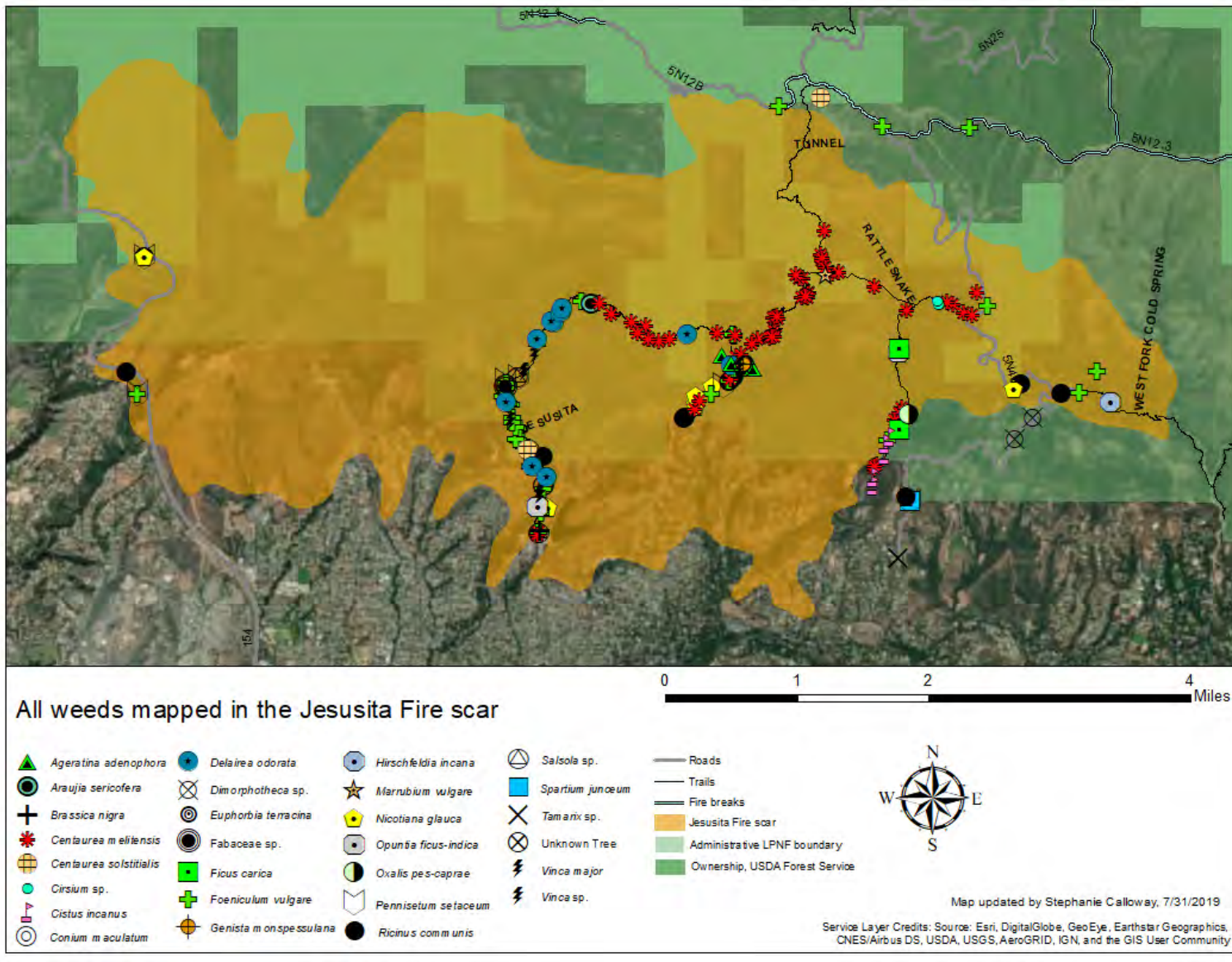


Figure 6. All weed taxa mapped comprehensively in the Jesusita Fire scar

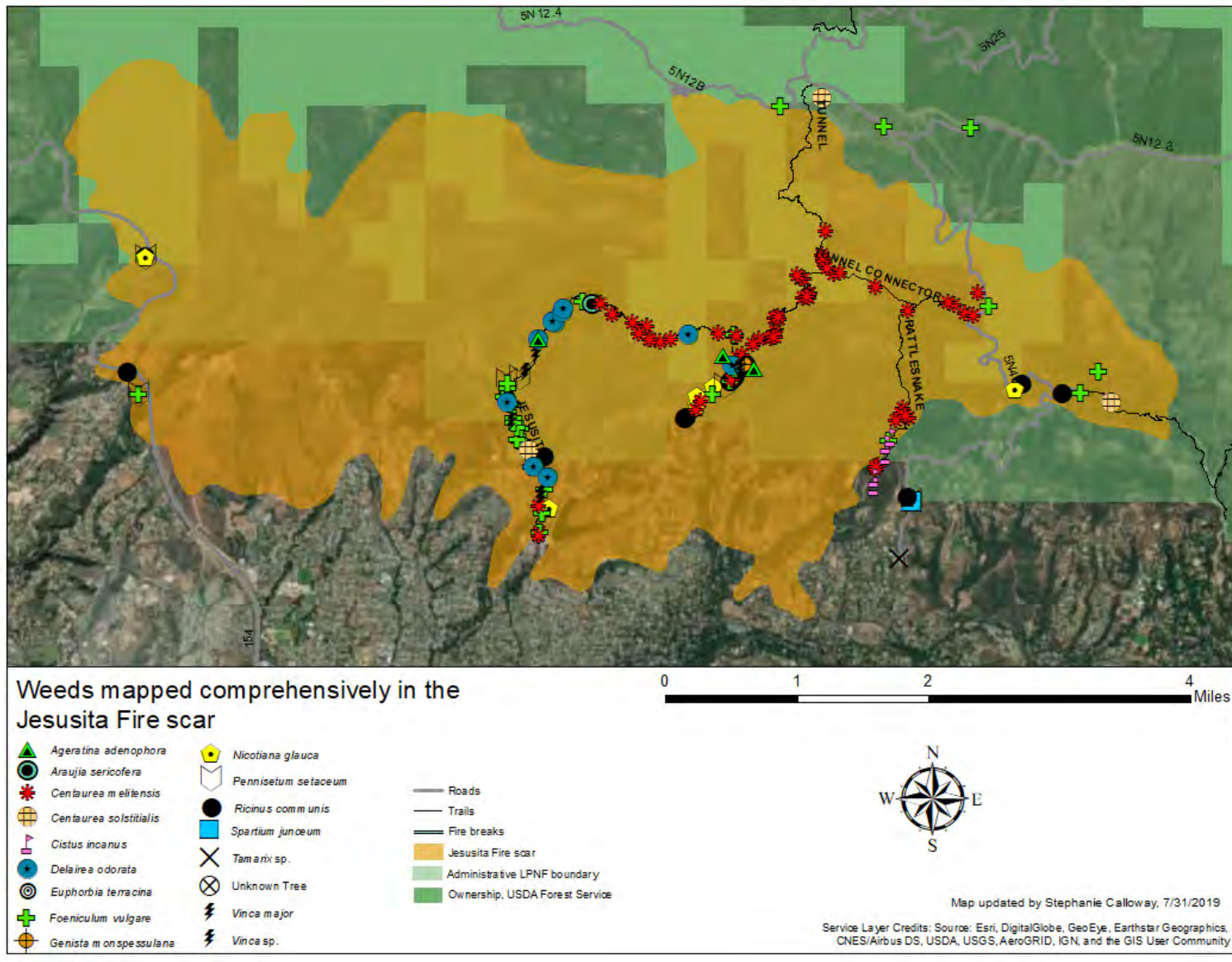


Figure 7. All weed taxa mapped in the Zaca Fire scar

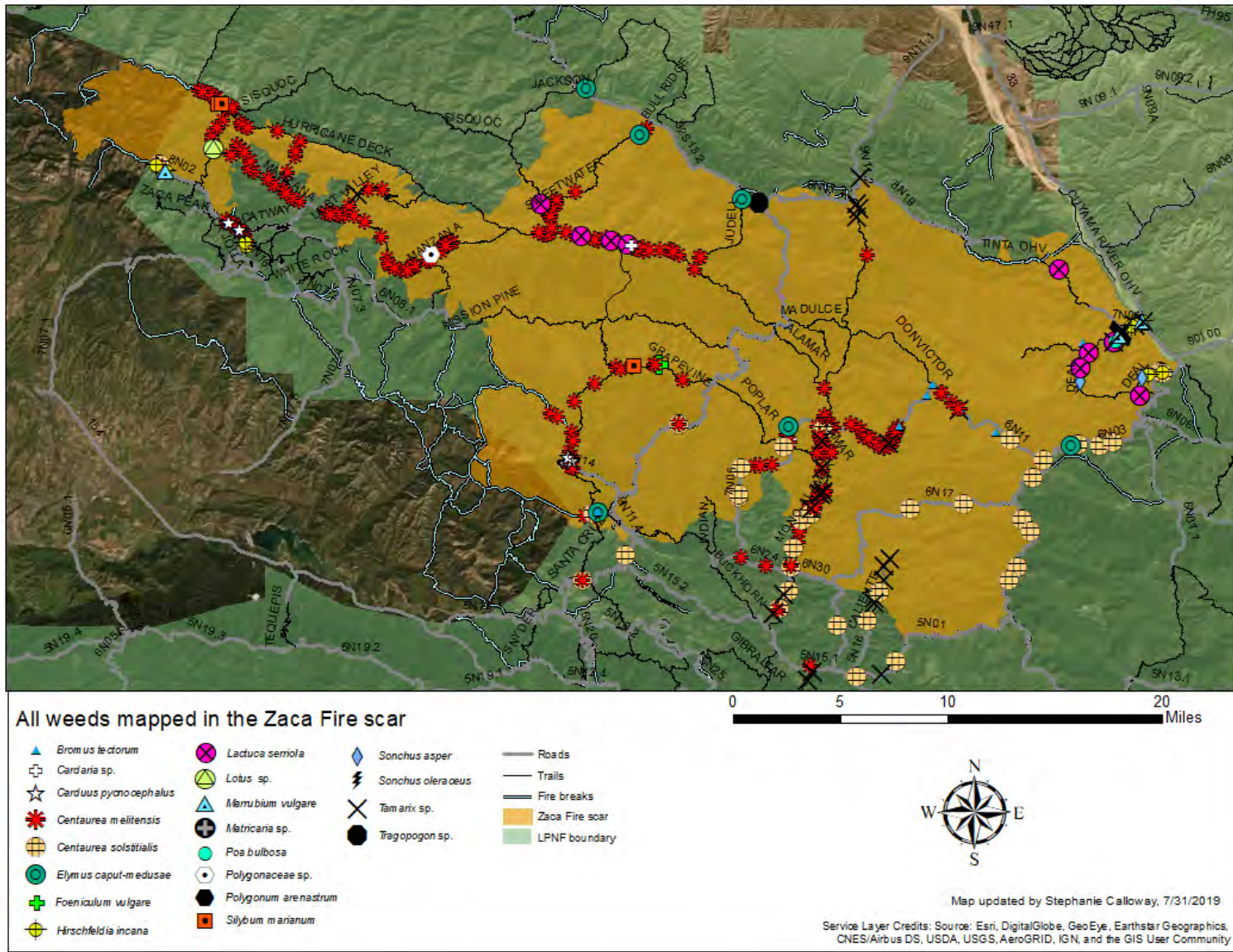
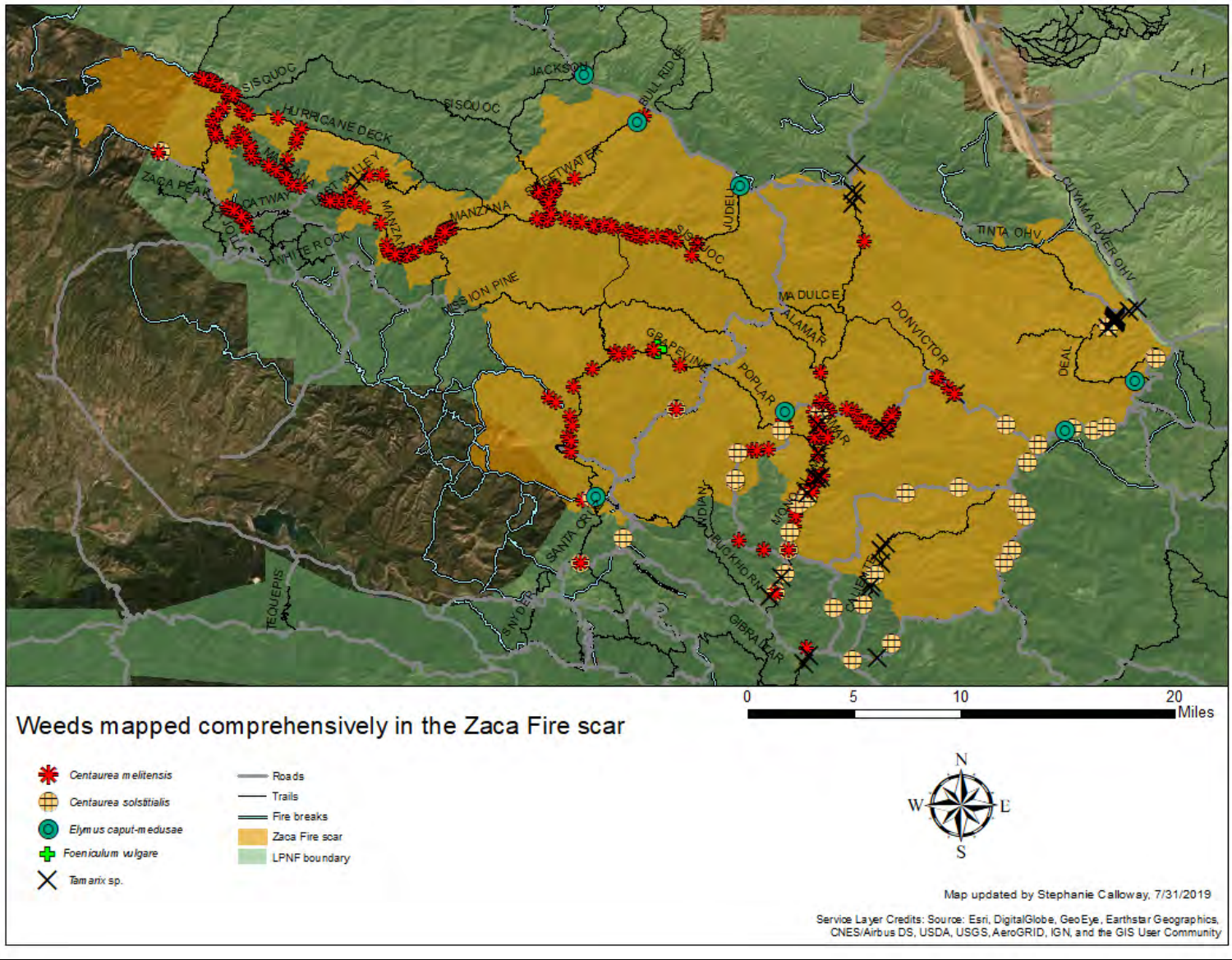


Figure 8. All weed taxa mapped comprehensively in the Zaca Fire scar



**Table 8.** Field survey data dictionary vs. curation to final dataset: Threatened, endangered and sensitive plants

SBBG Field Survey Data Dictionary		Final SBBG Data Dictionary Taken from the USDA TESP Element Occurrence Protocol and Field Guide					
SBBG Fields	Attribute Description	Corresponding Fields	Forest Service Fields	Description	Required	Optional	Lloyd's Dataset
		No	Site_ID	Unique identifier for an element occurrence. FS should assign these numbers. <b>SBBG created empty field in final dataset, but did not populate.</b>	X		X
Date	Date when the field data for this plant occurrence was collected.	Yes	Date	Date when the field data for this plant occurrence was collected.	X		X
		No	NRCS_Plant_Code	The NRCS accepted plant symbol for the species. <b>SBBG created and populated field in final dataset.</b>	X		X
Species	Scientific name of the documented taxa. Taxa we were contracted to map.	Yes	Scientific_Name	Accepted scientific name (not NRCS).	X		X
Other_Sp	Scientific name of rare taxa that we were not contracted to map.						
		No	Record_Source	The source of data for the EO record, such as field survey or herbarium specimen. SBBG created and populated field in final dataset. The data source for all records was "Field Survey".	X		X
Loc_Uncert	An indication of confidence in accuracy of defining the location of the EO.	Yes	Location_Uncertainty	An indication of confidence in accuracy of defining the location of the EO.	X		X
Aerial_Est	Conditionally required if "Aerial estimated" is selected from LOV menu.	Yes	Uncertainty_Distance	Conditionally required if "Aerial Estimated" is selected from LOV menu.	X		
Surv1	First and Last name(s) of the individuals that detected the element occurrence.	Yes	Examiner_1	First and Last name(s) of the individuals that detected the element occurrence.	X		X
Surv2			Examiner_2				
Surv3			Examiner_3				
Other_Surv			Examiner_4				
		No	Ownership	Land ownership where the occurrence is located. <b>SBBG created and populated field in final dataset. Ownership was left blank when records were located on Administrative Forest, but not owned by USFS</b>	X		X

		No	Parent_Unit_ID	05 - SBBG created and populated field in final dataset.			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
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 ArcGIS in Acres.	Yes	Area_Acres	Total area of the mapped polygon in acres. Calculated in GIS.		X	X
Count <20	Actual number of individuals counted if less than 20 in mapped area.	Yes	Plant_Count	Indicates the number of individual plants of the EO species within an occurrence. SBBG calculated the midpoint of the following value classes in the final dataset: <100; 100-500; 500-1,000; 1,000-5,000; 5,000-10,000; >10,000		X	X
Count>20	Estimated number of individuals if there were greater than 20 individuals in mapped area. We used the following classes: <100; 100-500; 500-1,000; 1,000-5,000; 5,000-10,000; >10,000	Yes					
		No	Plant_Count_Type	Indicate what was counted: Genets, Ramets, or Undetermined. Counts of genets represent the number of genetically independent individuals in an occurrence. Counts of ramets represent the number of vegetative units that are produced by the genets in an occurrence. For example, a plant occurrence that has five individual plants, each of which has produced five stems, consists of 5 genets and 25 ramets.		X	X
		No	Estimate	Yes or No flag field to indicate if the plant count was a precise count or an estimate. Recorded Yes if the count was a qualitative estimate or No if all plants were actually counted.		X	
%Cover	The vegetative cover of the documented TESP 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%	Yes	Percent_Cover	The percent cover or cover class of the TESP plant species within the EO polygon(s) or site in the following cover classes: 0-1%, 1-5%, 5-15%, 15-25%, 25-50%, 50-75%, 75-95%, 95-100%		X	X

		No	Cover_Class_Set	If cover values are recorded for any of the cover fields, then indicate the one method used for making any cover estimates at this site. Choices are Percent (0.1-100%), Daubenmire (modified) Cover Class Set, and National Range Cover Ten Class Set. <b>SBBG added to final dataset. We used DAUBEN, but added one extra class from 5-15%</b>		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	Included but different	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. <b>We did this differently than in the TESP Element Occurrence Protocol and Field Guide, which requires percentages for each phenological stage present.</b>		X	
Other_Phen	Any value that did not match the above						
Slope	The average slope that is characteristic of the EO polygon or site, expressed as a percentage as measured in the field. <b>Included, but measured differently than in TESP EO Protocol as: flat, gentle, moderate, steep.</b>	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. <b>Included, but measured differently than in TESP EO Protocol in the following classes: flat, gentle, moderate, steep.</b>		X	
Aspect	The generalized cardinal direction that the landscape predominantly faces at a defined position, such as the center point of the occurrence. (Accuracy Standard: $\pm 11.25$ degrees).	Yes	Aspect_Cardinal	The generalized cardinal direction that the landscape predominantly faces at a defined position, such as the center point of the occurrence. (Accuracy Standard: $\pm 11.25$ degrees).		X	X
Elevation	For the spatial extent of the occurrence, record the average (or a "predominant") elevation of the area occupied by the species as measured either in feet or meters above sea level. Minimum and maximum elevation should be recorded only if it is determined that the elevation range is significant for that particular occurrence (e.g., an occurrence on a steep slope or a large occurrence on an undulating landscape).	Yes	Elevation	For the spatial extent of the occurrence, record the average (or a "predominant") elevation of the area occupied by the species as measured either in feet or meters above sea level. Minimum and maximum elevation should be recorded only if it is determined that the elevation range is significant for that particular occurrence (e.g., an occurrence on a steep slope or a large occurrence on an undulating landscape).		X	X



		No	Elevation_UOM	Record the unit elevation was measured in; feet or meters. SBBG added this field to the final dataset		X	
Hab1	Dominant habitat where mapped occurrence is located. Closely matches the following of Lloyd's dataset fields: potential_veg_class, existing_veg_class, and ecological type. SBBG is not sure what best corresponds to this field. Forest Service should adjust.	No	Habitat	We were not sure which of the following TESP EO Protocol fields our Habitat field would correspond to: potential_veg_class, existing_veg_class, and ecological type are all options. <b>The Forest Service should adjust as desired.</b>		X	
Hab2							
Hab3							
Other_Hab							
Threat1	Recorded threats or potential threats, e.g., noxious weeds, OHV trails, or environmental problems that could affect the TES plant habitat.	Yes	Threat1	Record threats or potential threats, e.g., noxious weeds, OHV trails, or environmental problems that could affect the TES plant habitat.		X	
Threat2			Threat2				
Threat3			Threat3				
Other_Threats			Threat_Comments	Record any comments about the extent or severity of the threat(s).			
Assoc_sp	The top 5-6 associated species.	Yes	Associated_Species	Associated species are those found in the same habitat and same location as the EO and should not include species that are not directly within or related to the EO polygon or site.		X	
Dom_sp	The top 1-2 dominant species. This field was rarely used, and because there is no corresponding field in the TESP EO protocol, these were added to the "Associated Species" field if they weren't already represented there. An additional note was added to the "Comments" field documenting the dominant taxa.						
		No	Completeness	It is helpful to know if the species list is a best attempt to document all associated species at the EO site (complete list) or if just certain species of interest were listed (selected or reduced by some abundance level, or due to time constraints). Indicate how thorough the list of associated species is for an EO observation by selecting one of the standard values from the LOV. This field is conditionally required if associated species are listed. <b>SBBG added to final dataset.</b>		X	

		No	Plant_List_Comment	A text field to describe what guidelines were used for recording species or to give a text description of how complete or thorough the associated species list is. It is good practice to explain in this comment section what criteria were used to collect any partial plant list. <b>SBBG added to final dataset.</b>		X	
		No	Lead_Collector	Required if a voucher specimen is collected. Record the lead collector of the specimen, who is responsible for assigning the collection number. <b>SBBG added to final dataset.</b>		X	
Voucher_ID		Yes	Collection_Number	Required if a specimen is collected. Record a unique number, assigned by the primary collector, for the specimen. If no collection number is assigned to the specimen, enter "s.n." <b>SBBG added to final dataset.</b>		X	
		No	ID_Confirmed	A Yes/No Field required if a specimen is collected. It indicates whether a positive identification has been confirmed for the specimen. <b>SBBG added to final dataset.</b>		X	
		No	Verified_by	A text field where name and institution or agency of the individual who provides authoritative verification of the specimen identification can be entered. <b>SBBG added to final dataset.</b>		X	
		No	Specimen_Repository	A locally stewarded list of values that indicates the herbarium or location where the collected specimen is stored. Required if a specimen is collected. <b>SBBG added to final dataset.</b>		X	
Notes	Any additional notes relevant to the occurrence	Yes	Comments	Include any additional comments related to the EO record that was not accounted for in other fields. Examples include details about subpopulations that may exist.		X	
<b>For Polygons</b>							
		No	Latitude_Centroid	Latitude of the polygon centroid.		X	
		No	Longitude_Centroid	Longitude of the polygon centroid		X	

		<b>No</b>	<b>Datum_Centroid</b>	Datum of the centroid		X	
<b>For Points</b>							
		<b>No</b>	<b>Latitude</b>	Latitude of the point		X	
		<b>No</b>	<b>Longitude</b>	Longitude of the point		X	
		<b>No</b>	<b>Datum</b>	Datum of the point		X	

**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, <u>Inventory</u> , 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. <b>SBBG created and populated field in final dataset.</b>	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. <b>SBBG created and populated field in final dataset.</b>		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%. <b>SBBG did not collect this data for various records.</b>	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. <b>Generated in ArcDesktop by SBBG.</b>	X		X
Surv1	First and Last name(s) of the individuals that detected the element occurrence.	Yes	Examiner_1	First and Last name(s) of the individuals that detected the element occurrence.	X		X
Surv2			Examiner_2				
Surv3			Examiner_3				
Other_Surv			Examiner_4				
		No	Ownership	Land ownership where the occurrence is located. <b>SBBG created and populated field in final dataset. Ownership was left blank when records were located on Administrative Forest, but not owned by USFS</b>	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 - <b>SBBG created and populated field in final dataset.</b>			X
		No	FS_Unit_ID	0507 - <b>SBBG created and populated field in final dataset.</b>			X
		No	FS_Unit_Name	Los Padres National Forest - <b>SBBG created and populated field in final dataset.</b>			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.						

<b>Elevation</b>	Recorded elevation of mapped area in meters	<b>Yes</b>	<b>Elevation</b>	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). <b>Feet will be the default units of measure (UOM). SBBG measured in Meters, and converted to feet.</b>		X	
<b>Aspect</b>	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.	<b>Yes</b>	<b>Cardinal_D</b>	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	
<b>Slope</b>	The average slope that is characteristic of the EO polygon or site, expressed as a percentage as measured in the field. <b>Included, but measured differently than in TESP EO Protocol as: flat, gentle, moderate, steep.</b>	<b>Included but different</b>	<b>Slope</b>	The average slope that is characteristic of the EO polygon or site, expressed as a percentage as measured in the field. <b>Included, but measured differently than in TESP EO Protocol as: flat, gentle, moderate, steep.</b>		X	
<b>Hab1</b>	Dominant habitat where mapped occurrence is located.	<b>Included but different</b>	<b>Habitat</b>	The Forest Service may choose to place this in		X*	



Hab2				Plant Community, potential Vegetation, or Ecological Type.			
Hab3							
Other_Hab							
Count<20	If there were less than 20 individuals, we recorded the exact 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	Yes	Count				
		No	Count_UOM	The unit of measure of the total count: Stem, Plant, Individuals. <b>SBBG always counted # Individuals. SBBG created field and populated.</b>		X	

<b>Assoc_sp</b>	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.	<b>Yes</b>	<b>Associated_Species</b>	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. <b>SBBG listed and did not enter as separate fields.</b>		X	
		<b>No</b>	<b>Latitude_Centroid</b>	Latitude in a degree value to at least 6 decimal places. <b>SBBG created field and populated.</b>	X		X
		<b>No</b>	<b>Longitude_Centroid</b>	Longitude in a degree value at least 6 decimal places. <b>SBBG created field and populated.</b>	X		X
		<b>No</b>	<b>Datum</b>	Datum of Latitude/Longitude. <b>Not in IS protocol, but in Lloyd's dataset.</b>			X

## Herbarium Specimens

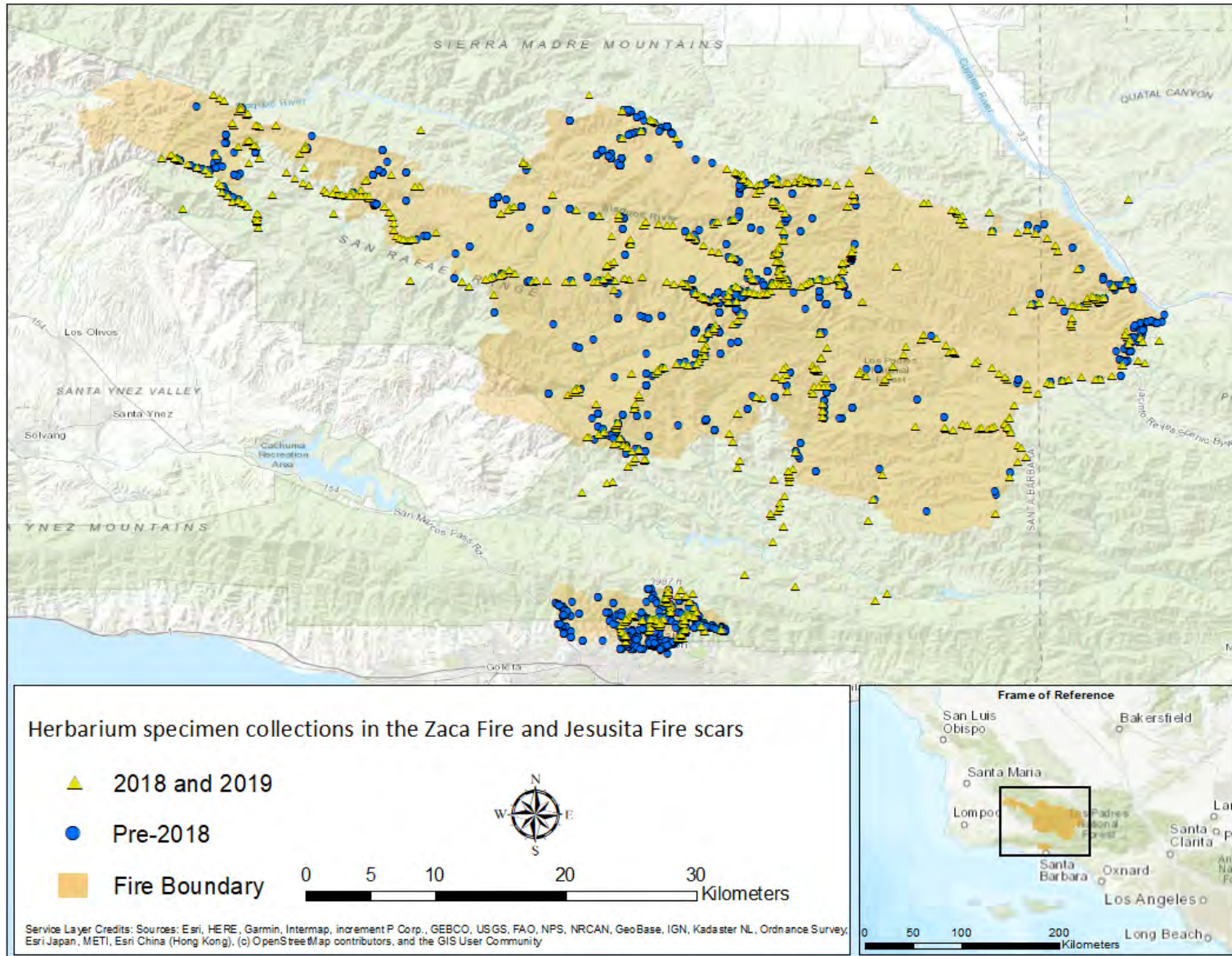
Our aim was to produce 2,680 herbarium specimens that can be used for an updated plant checklist and flora for Santa Barbara County. We far exceeded this goal, with 3,628 specimens mounted and databased to date (and more in process). As depicted in **Figure 9**, we were able to fill in large gaps where georeferenced specimens were largely lacking prior to this project (botanical blackholes). In the case of the Zaca Fire scar, our collections during 2018 and 2019 now represent approximately 44 percent of georeferenced specimens in this area. The specimens are databased and data made available online via the Consortium of California Herbaria (<http://www.cch2.org>). These data are also aggregated to the Global Biodiversity Information Facility (<https://www.gbif.org/>). Data associated with these specimens will aid future efforts to describe and map the Forest's plant communities, and have many other uses such as tracking how phenology changes with the climate and analyzing the evolutionary relationships and genetic diversity of plant species and populations. Some of our most interesting collections to date are described briefly below.

One specimen of the rare (CNPS 4 ranking) *Clinopodium mimuloides* was collected in Santa Barbara County for the first time since 1985.

Specimens of *Eriodictyon*, *Galium* and *Dudleya* collected during the LPNF project will be used for genetic studies. In particular, *Galium cliftonsmithii* (our local, very distinctive *Galium* species with limited distribution) was collected by multiple collectors during the 2018 and 2019 field season. We greatly increased our understanding of *Eriodictyon traskiae* subsp. *smithii*, which is more common in the backcountry of the Los Padres than previously known. When we mentioned to retired SBBG botanist Steve Junak how common it was away from the Santa Ynez, he was quite surprised. We also observed and documented the interaction between this taxon and the lower elevation *E. crassifolium* var. *nigrescens*, which appear to be forming hybrids at intermediate elevations where their ranges meet. These are otherwise very distinct plants, with conspicuous differences in leaves, inflorescences, and corolla shape/size/color.

The rare *Eriophyllum lanatum* var. *hallii* (CNPS 1B.1 ranking; **Figure 10**) only occurs on the Tejon Ranch and a couple of locations in the Sierra Madre mountains in Santa Barbara County. Our collectors had California Natural Diversity Database (CNDDDB) data loaded on their iPads, so they could see where botanist Cliff Smith had visited this population multiple times. Based on this and his description in his Santa Barbara County Flora, there were approximately 800 individuals in this area historically. But in spring 2018, there were only about 20 individuals seen. Because of this, we were unable to make a specimen collection. While there used to be a livestock enclosure surrounding the population, it was completely destroyed and there were many livestock trails/erosion on the slope where these 20 individuals occurred. Hopefully we can work with the Forest Service to reestablish the enclosure to protect this very rare plant.

**Figure 9.** Herbarium specimens collected have filled large gaps in our botanical knowledge



**Figure 10.** *Eriophyllum lanatum* var. *hallii*



*Thelypteris puberula* var. *sonorensis* is a relatively uncommon species that in Santa Barbara County reaches the northwestern edge of its range. *Thelypteris nevadensis* occurs to the north, but the genus and family are quite uncommon in the western United States.

*Fritillaria ojaiensis* is a listed species (CNPS 1B.2 ranking; **Figure 11**) that is rarely collected and was seen in person for the very first time by some collectors. Seeds from this plant are now stored in our seedbank.

**Figure 11.** *Fritillaria ojaiensis*.



The rare *Layia heterotricha* (CNPS 1B.1 ranking) was found in abundance and collectors were pleased not only by its beauty (**Figure 9**) but also by its strong banana smell.

**Figure 12.** *Layia heterotricha*.



The rare *Caulanthus lemmonii* (**Figure 13**) had not been collected in Santa Barbara County since 1962. Including this year's collection, we have only 3 specimens from Santa Barbara County in our herbarium. Seeds were collected to be stored in our conservation seedbank.

**Figure 13.** *Caulanthus lemmonii*.



### Threat Identification

We mapped erosion and treefall issues along the trails and roads as we encountered them to aid the Forest Service and Los Padres Forest Association (LPFA) in planning their maintenance activities. We collected GPS points and brief descriptions of the damage and gave this information to Bryan Conant of LPFA. We did not encounter significant trash (although we picked up minor trash as we saw it) or other threats.

### Seed Collections

We made eight independent conservation seed collections (accessions) of six rare plant taxa in 2018 (**Table 10, Figure 14**). At the Garden, we collect rare plant seeds along maternal lines (by genetic individual), to ensure the control of genetic mixes in research and re-introduction efforts. Following Center for Plant Conservation Guidelines, we collected 50 maternal lines of each of these taxa, for a total of at least 17,000 seeds weighing at least 173.5 grams. For one taxon, *Fritillaria ojaiensis*, we collected only four maternal lines because there was a low amount of available seed. For a second taxon, *Diplacus johnstonii*, we made a bulk collection (not separated by maternal line) from 20 individuals because there was a low amount of available seed. These collections are stored in our conservation seedbank, with emergency power backup.

We made 24 collections of more common plant taxa for future restoration needs. (**Table 11**). This includes at least 16 taxa, including the genera *Amsinckia*, *Arctostaphylos*, *Astragalus*, *Calystegia*, *Ceanothus*, *Cercocarpus*, *Elymus*, *Eriogonum*, *Hesperoyucca*, *Monolopia*, *Nicotiana*, *Phacelia*, and *Prunus*. These seeds are stored in our horticulture seed bank, but we are seeking uses for them, and may not be able to store them for longer than 5 years.

### Volunteer Help

Our goal was to enlist the help of approximately 45 volunteers, for over 2,500 hours of service. Over the course of the project, we received 2,390 hours from 60 different volunteers. This included 23 different volunteers helping with herbarium specimens and seed curation, representing over 656 hours of service, and 37 different volunteers helping with field work, for over 1,312 hours of service. The Santa Ynez Chumash Environmental Office were invaluable in both aspects of this project, with eight individuals contributing 682 hours of service. Our three Santa Barbara City College Apprentices contributed 175 hours. SBBG Board Chair Peter Schuyler was our most prolific volunteer, helping with no fewer than 259 hours on our field projects.

We had twelve volunteers help with our Rare Plant Treasure Hunt, looking for rare *Calochortus* off of Tunnel Road. Our California Native Plant Society (CNPS) partners helped to get the word out about this opportunity, which is a CNPS tradition. We had a second Treasure Hunt scheduled, but had to cancel because the Buckhorn Road was not yet open.

In appreciation for all of this volunteer help, we held a catered barbecue on September 7<sup>th</sup> at Peter Schuyler's house. We had 65 people in attendance. We designed and printed t-shirts to further thank them and provide additional outreach about this project. These expenses were an in-kind contribution that we had not anticipated, but thought appropriate.

**Table 10.** Conservation seed collections made of rare plants

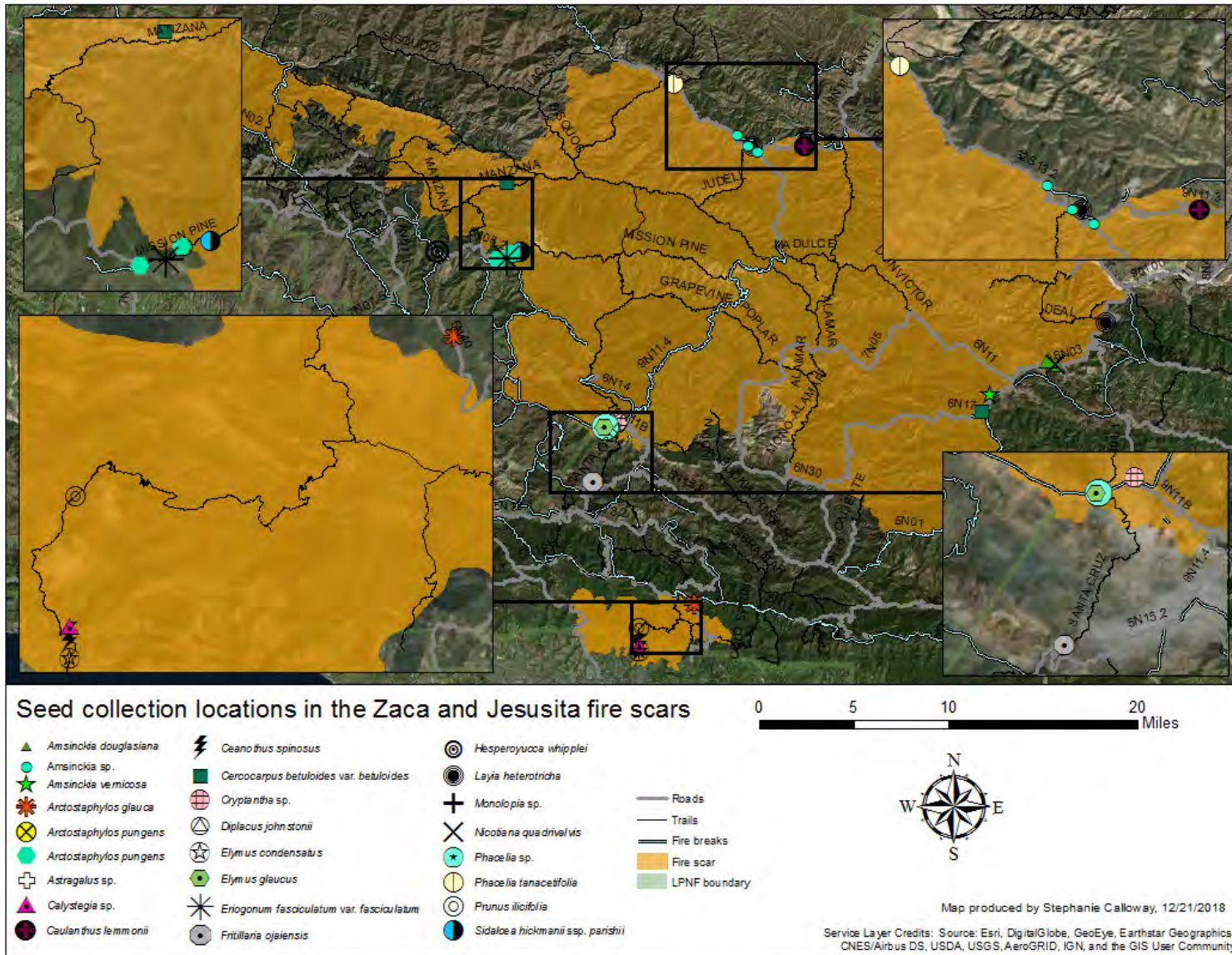
SBBG Accession	Species	Status	# Seeds	Weight (g)	# Lines	Collection Date	Lat	Long	Locality
2018-058	<i>Amsinckia douglasiana</i>	Rare (4.2)	1,639	33.4	50	7/10/18	34.63912	-119.40939	Off Potrero Seco Road
2018-059	<i>Amsinckia douglasiana</i>	Rare (4.2)	2,634	32.1	50	7/10/18	34.64079	-119.41479	Off Potrero Seco Road
2018-063	<i>Caulanthus lemmonii</i>	Rare (1B.2)	2,163	14.1	50	6/24/18	34.7755509	119.601996	Buckhorn Road, Sierra Madre area
2018-074	<i>Diplacus johnstonii</i>	Rare (4.3)	Not cleaned yet	2.7	Bulk	7/12/18	34.70789	-119.82493	Mission Pine Trail
2018-060	<i>Fritillaria ojaiensis</i>	Rare (1B.2)	258	N/A	4	6/11/2018	34.565159	119.763077	Santa Cruz Trail
2018-061	<i>Layia heterotricha</i>	Rare (1B.1)	1,828	5.9	50	6/23/18	34.7755965	119.641313	Sierra Madre Rd.
2018-062	<i>Layia heterotricha</i>	Rare (1B.1)	3,288	3.5	50	5/31/18	34.66527	-119.37124	Hwy 33
2018-090	<i>Sidalcea hickmanii</i> ssp. <i>parishii</i>	Rare (1B.2, CA Rare)	5,490	81.8	50	8/20/18	34.70932	-119.81801	Mission Pine Trail
		<b>Totals</b>	≥17,042	173.5	300				



**Table 11.** Seed collections made of common plants for future restoration needs.

SBBG Accession #	Species	Weight (g)	Collection Date	Lat	Long	Locality
2018-066	<i>Amsinckia</i> sp. 1	35	6/23/2018	34.78205	-119.65274	Sierra Madre Rd.
2018-067	<i>Amsinckia</i> sp. 2	63.5	6/24/2018	34.7716392	-119.6373	Sierra Madre Rd.
2018-068	<i>Amsinckia</i> sp. 3	33.7	6/23/2018	34.7755965	-119.644467	Sierra Madre Rd.
2018-069	<i>Amsinckia vernicosa</i>	34.8	7/10/2018	34.6202309	-119.460169	Off Potrero Seco Road
2018-080	<i>Arctostaphylos glauca</i>	165.2	8/9/2018	34.4878	-119.6858	Gibraltar Rd.
2018-070	<i>Arctostaphylos pungens</i>	117.7	7/2/2018	34.70810	-119.74623	Mission Pine Basin Camp
2018-089	<i>Arctostaphylos pungens</i>	43.2	8/20/2018	34.70407	-119.83581	Mission Pine Trail
2018-087	<i>Arctostaphylos pungens</i>	29.9	8/20/2018	34.70789	-119.82542	Mission Pine Trail
2018-071	<i>Astragalus</i> sp.	313.4	7/2/2018	34.5993406	-119.753898	Firebreak near Happy Hollow
2018-083	<i>Calystegia</i> sp.	13.2	8/9/2018	34.46141	-119.72828	Jesusita Trail
2018-082	<i>Ceanothus spinosus</i>	83	8/9/2018	34.46058	-119.72825	Jesusita Trail
2018-079	<i>Cercocarpus betuloides</i> var. <i>betuloides</i>	45.9	8/9/2018	34.4878	-119.6858	Gibraltar Rd.
2018-072	<i>Cercocarpus betuloides</i> var. <i>betuloides</i>	24.5	7/10/2018	34.6083293	-119.466289	Off Potrero Seco Road
2018-092	<i>Cercocarpus betuloides</i> var. <i>betuloides</i>	19	8/20/2018	34.7526	-119.82987	Mission Pine Trail
2018-073	<i>Cryptantha</i> or <i>Plagiobothrys</i>	40.9	7/2/2018	34.6025805	-119.744149	Firebreak near Happy Hollow
2018-084	<i>Elymus condensatus</i>	37.9	8/9/2018	34.45858	-119.72835	Jesusita Trail
2018-085	<i>Elymus glaucus</i>	55.2	7/2/2018	34.598947	-119.7546	Firebreak near Happy Hollow
2018-091	<i>Eriogonum fasciculatum</i>	269	8/20/2018	34.70527	-119.82949	Mission Pine Trail
2018-088	<i>Hesperoyucca whipplei</i>	254	8/20/2018	34.70984	-119.88251	Mission Pine Trail
2018-075	<i>Monolopia lanceolata</i>	19	6/24/2018	34.81493	-119.701803	Sierra Madre Rd.
2018-076	<i>Nicotiana quadrivalvis</i>	5	7/10/2018	34.63912	-119.40939	Off Potrero Seco Road
2018-077	<i>Phacelia</i> sp.	31.9	7/2/2018	34.5993406	-119.753898	Firebreak near Happy Hollow
2018-078	<i>Phacelia tanacetifolia</i>	46.5	6/24/2018	34.814913	-119.701822	Sierra Madre Rd.
2018-081	<i>Prunus ilicifolia</i>	66.4	8/9/2018	34.47335	-119.72761	Jesusita Trail

Figure 14. Conservation and restoration seed collections made in the Zaca and Jesusita fire scars



## 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.

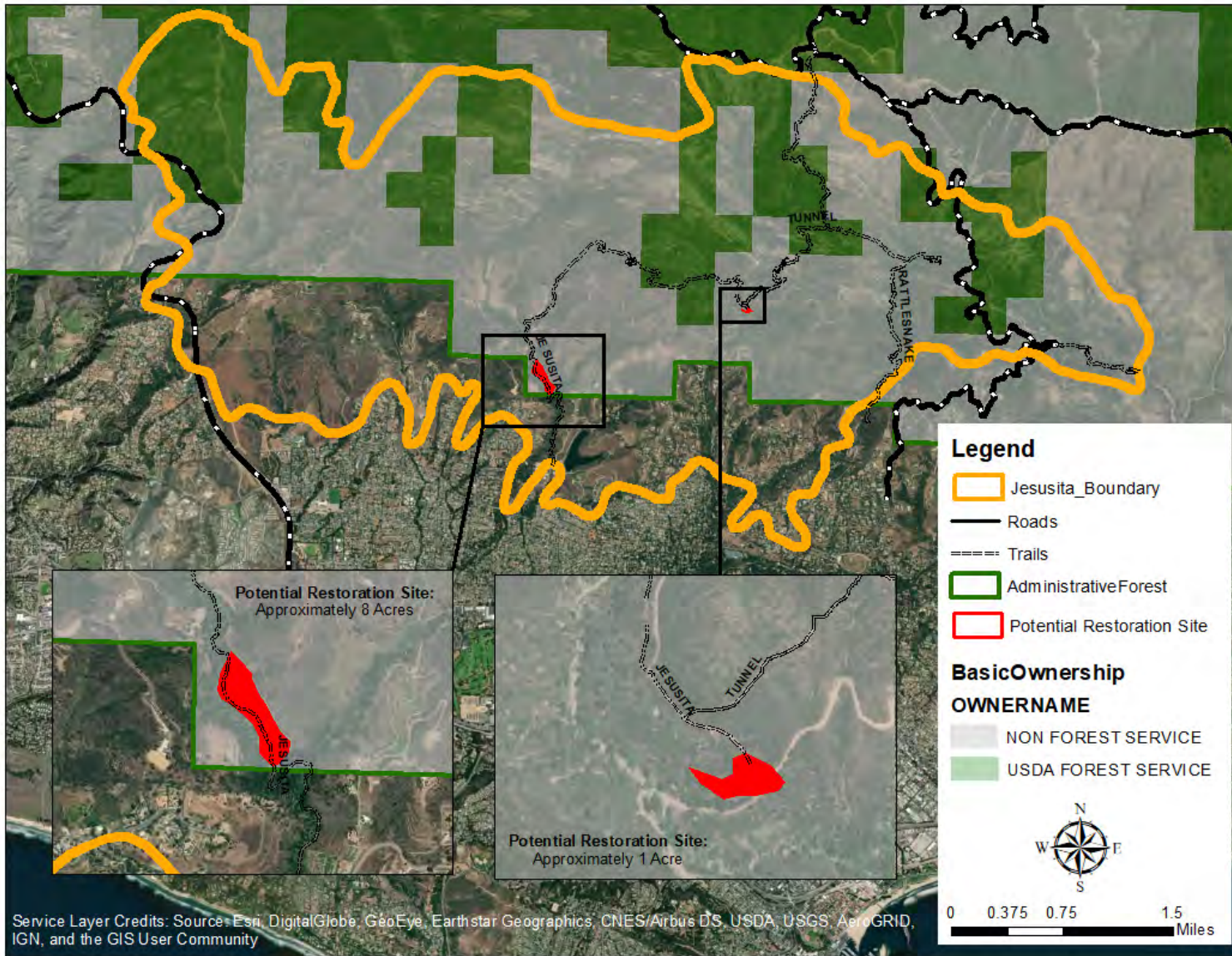
While we did not identify *Tamarix* sp. to species, one of the most widely distributed taxa of *Tamarix* in the Los Padres National Forest is *Tamarix ramosissima* (tamarisk). Tamarisk can form dense stands in riparian areas (Neill 1985), where it can lower the water table and redistribute salts to the 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 Jesuita 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

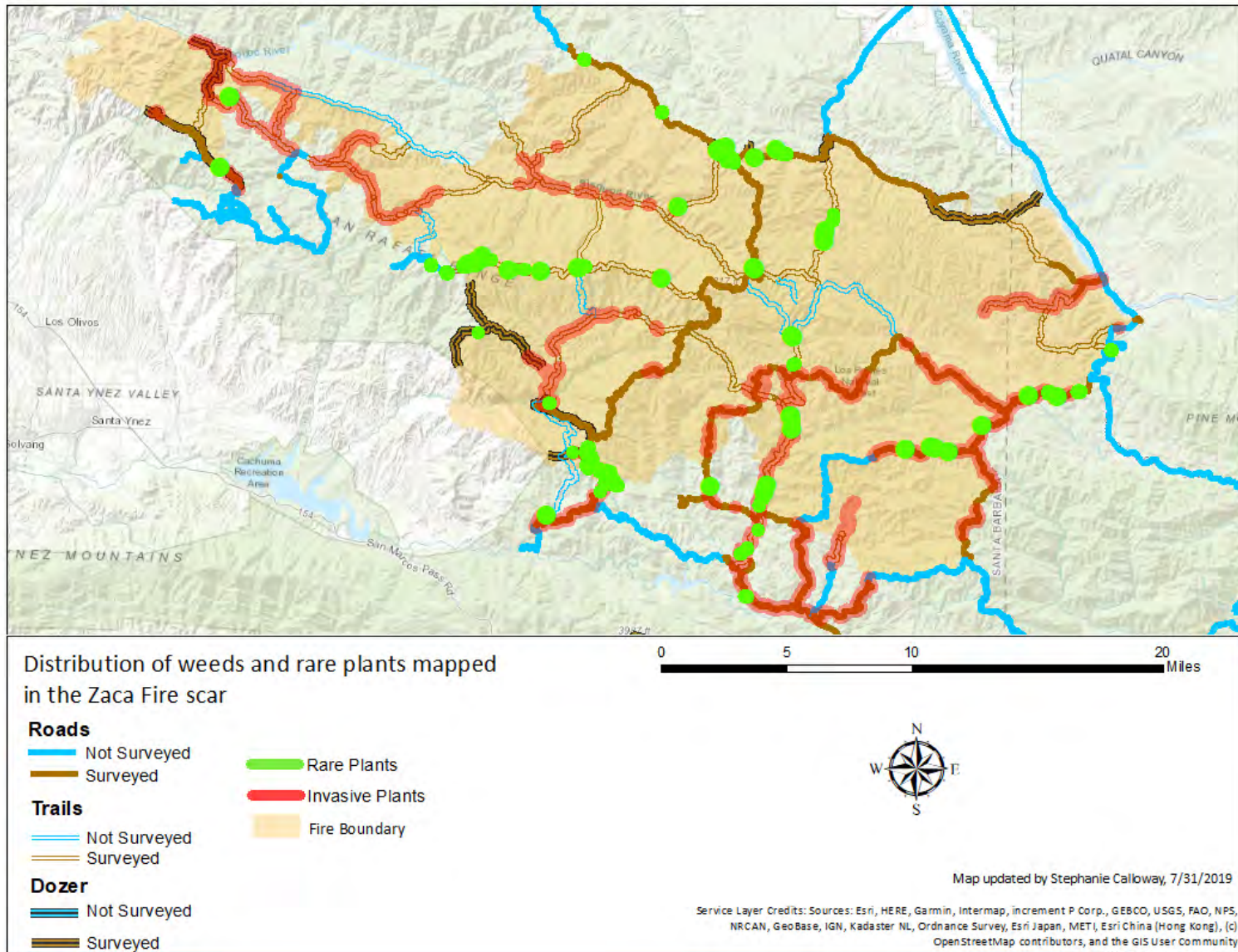
be an immense outreach opportunity, helping trail users to understand the rare plants in the area, the threat of invasive plants, and the value of habitat restoration.

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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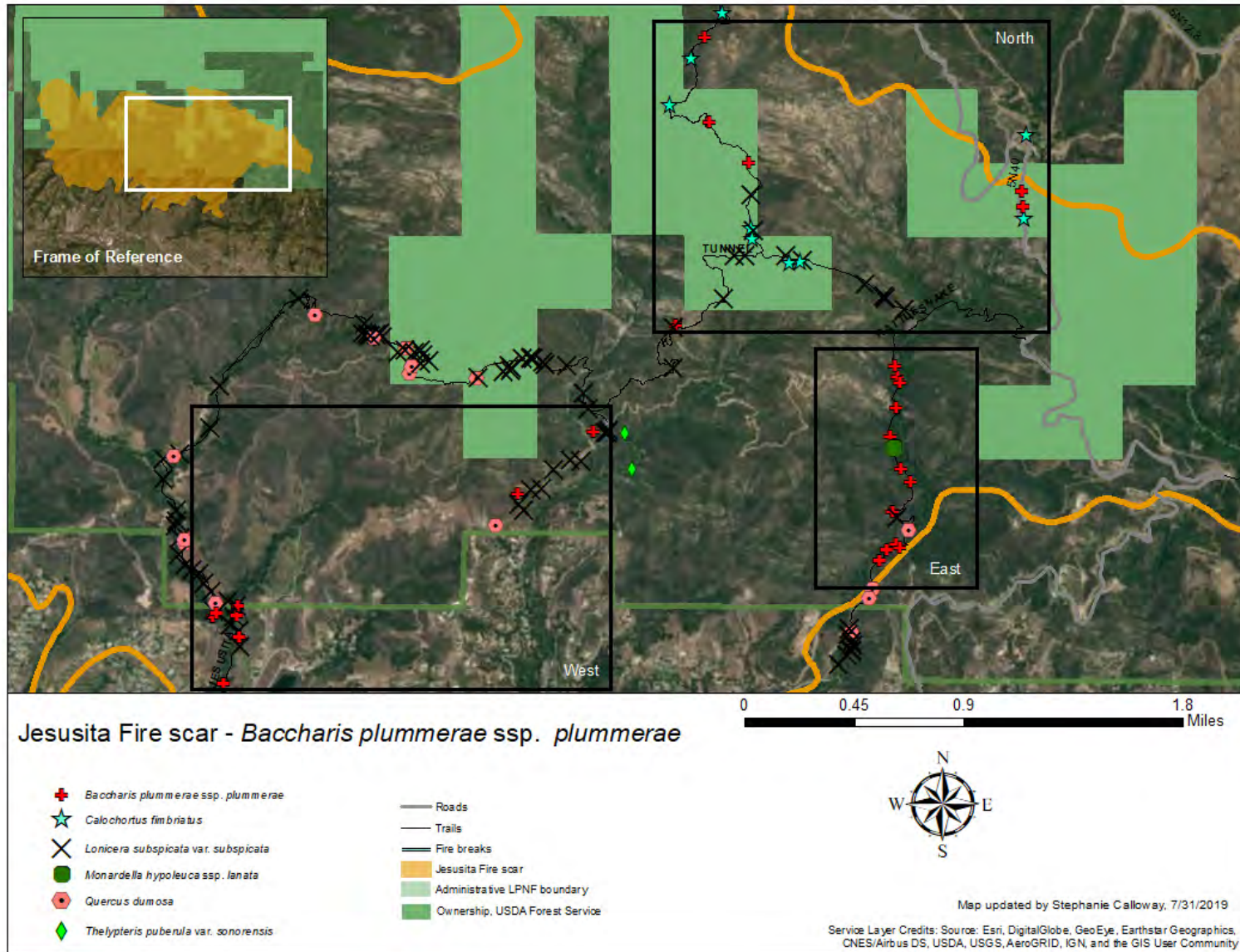
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## Acknowledgements

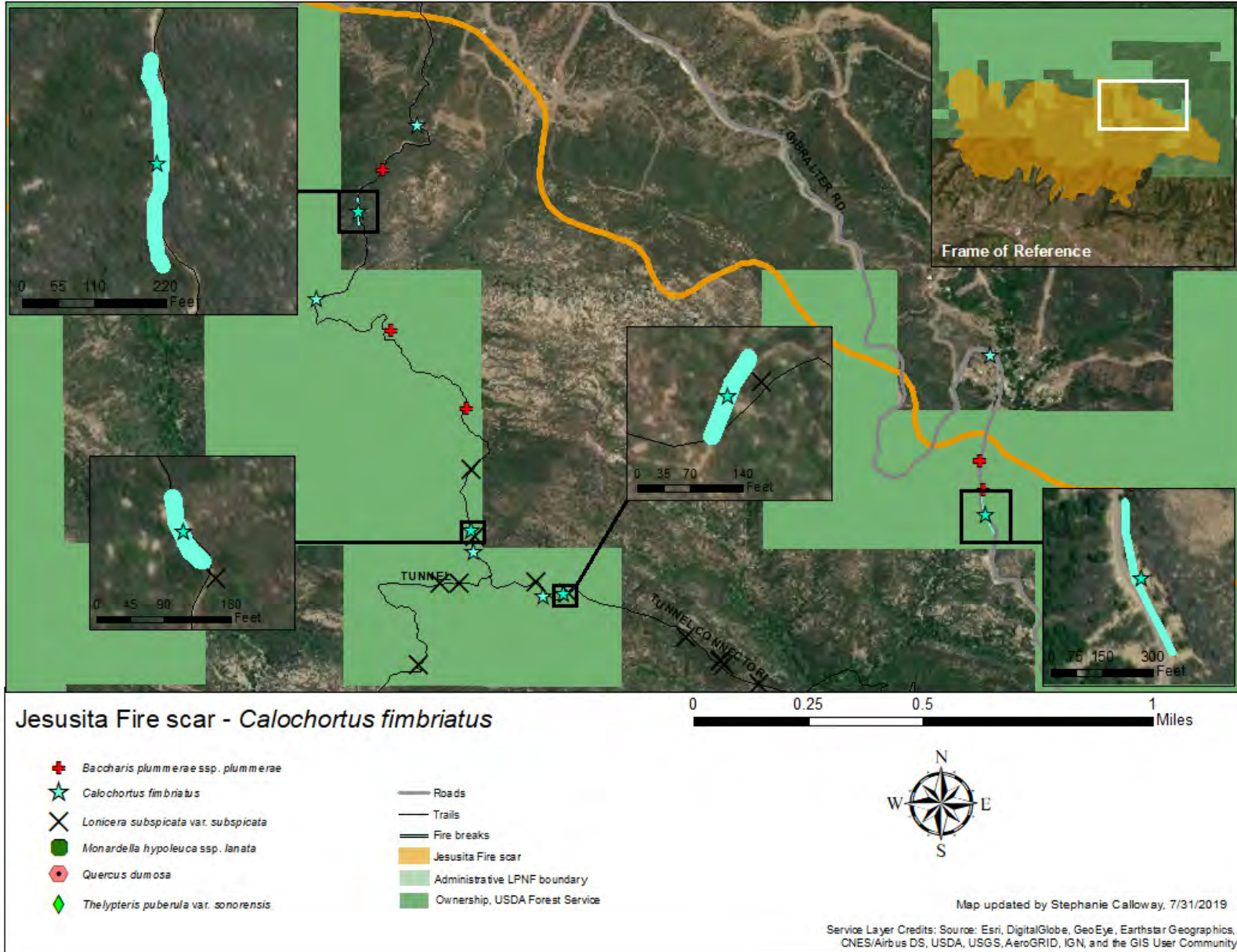
The National Fish and Wildlife Foundation provided 48% of the funding for this project (\$180,947.95). Of the remaining 52%, \$50,000 was provided by Jack and Judy Stapelman, and the remainder of our matching funds were provided through the valuable time of our dedicated volunteers. Our sincere thanks go to all of those wonderful volunteers, especially Peter Schuyler and Greg Wahlert, who logged nearly as many hours as our staff. This includes the crew with the Santa Ynez Band of Chumash Environmental Office, Matt Kay and our Santa Barbara City College apprentices, Susan Mazer and her students at UCSB, John Parke and his steady horses Remington and Mocha. Many thanks to Nicole Molinari and Lloyd Simpson of the Forest Service for their feedback on our original proposal ideas, to all of the employees of the Los

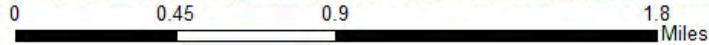
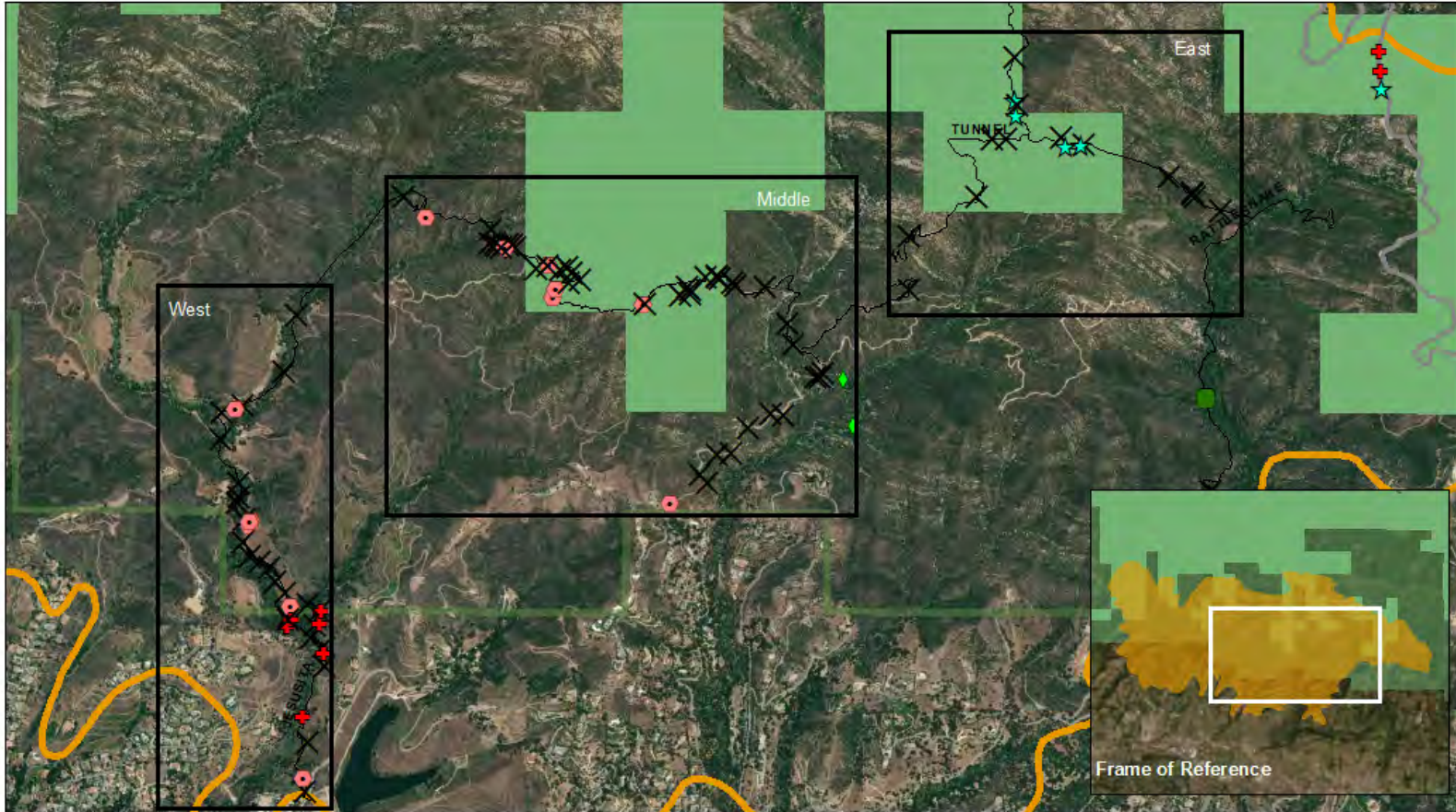
Padres National Forest who provided us with road conditions and access, including Pancho Smith, Ivanna Noell, and Kyah LaPorta. Thank you to Jennifer Gray for sharing our posts and providing us passes. Brian Conant was an indispensable fountain of knowledge about the trails and resources. The skilled 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 A. Rare plants mapped within the Jesusita Fire scar as part of the SBBG Botanical Blackholes project**









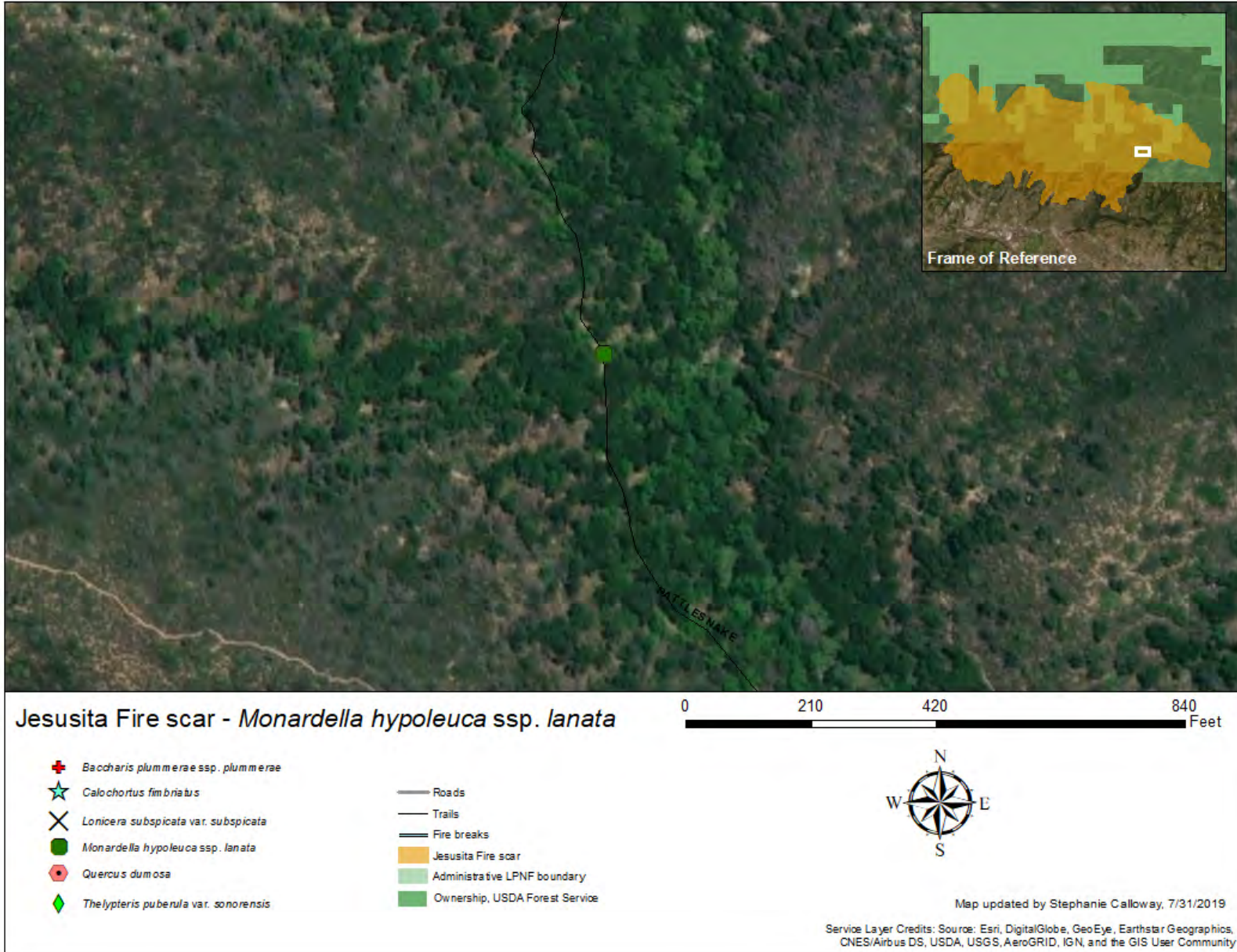
Jesusita Fire scar - *Lonicera subspicata* var. *subspicata*

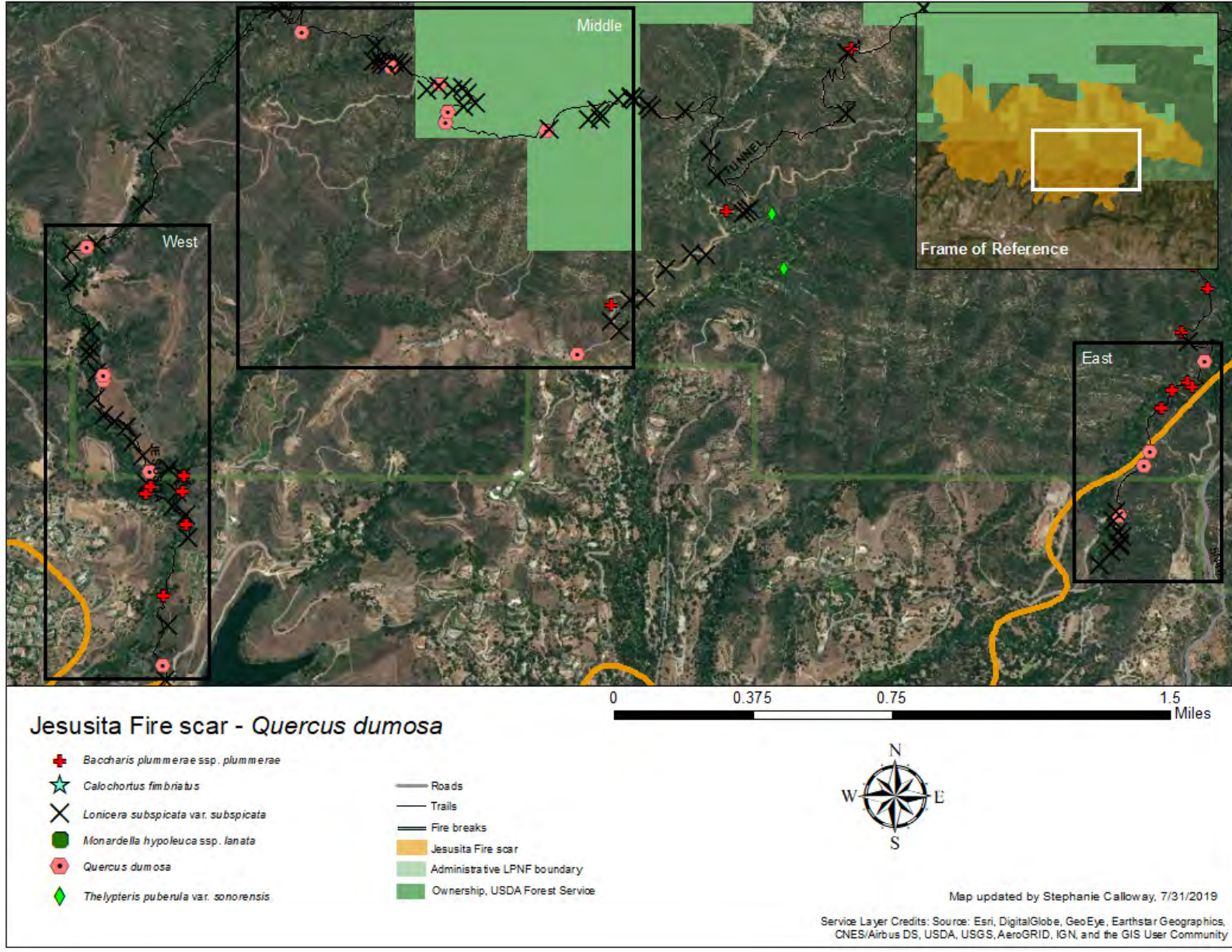
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|--|--|
| <ul style="list-style-type: none"> <li><span style="color: red;">+</span> <i>Baccharis plummerae</i> ssp. <i>plummerae</i></li> <li><span style="color: cyan;">★</span> <i>Calochortus fimbriatus</i></li> <li><span style="color: black;">×</span> <i>Lonicera subspicata</i> var. <i>subspicata</i></li> <li><span style="color: green;">●</span> <i>Monardella hypoleuca</i> ssp. <i>lanata</i></li> <li><span style="color: red;">⊙</span> <i>Quercus dumosa</i></li> <li><span style="color: green;">◆</span> <i>Thelypteris puberula</i> var. <i>sonorensis</i></li> </ul> | <ul style="list-style-type: none"> <li>— Roads</li> <li>— Trails</li> <li>— Fire breaks</li> <li>— Jesusita Fire scar</li> <li>— Administrative LPNF boundary</li> <li>— Ownership, USDA Forest Service</li> </ul> |
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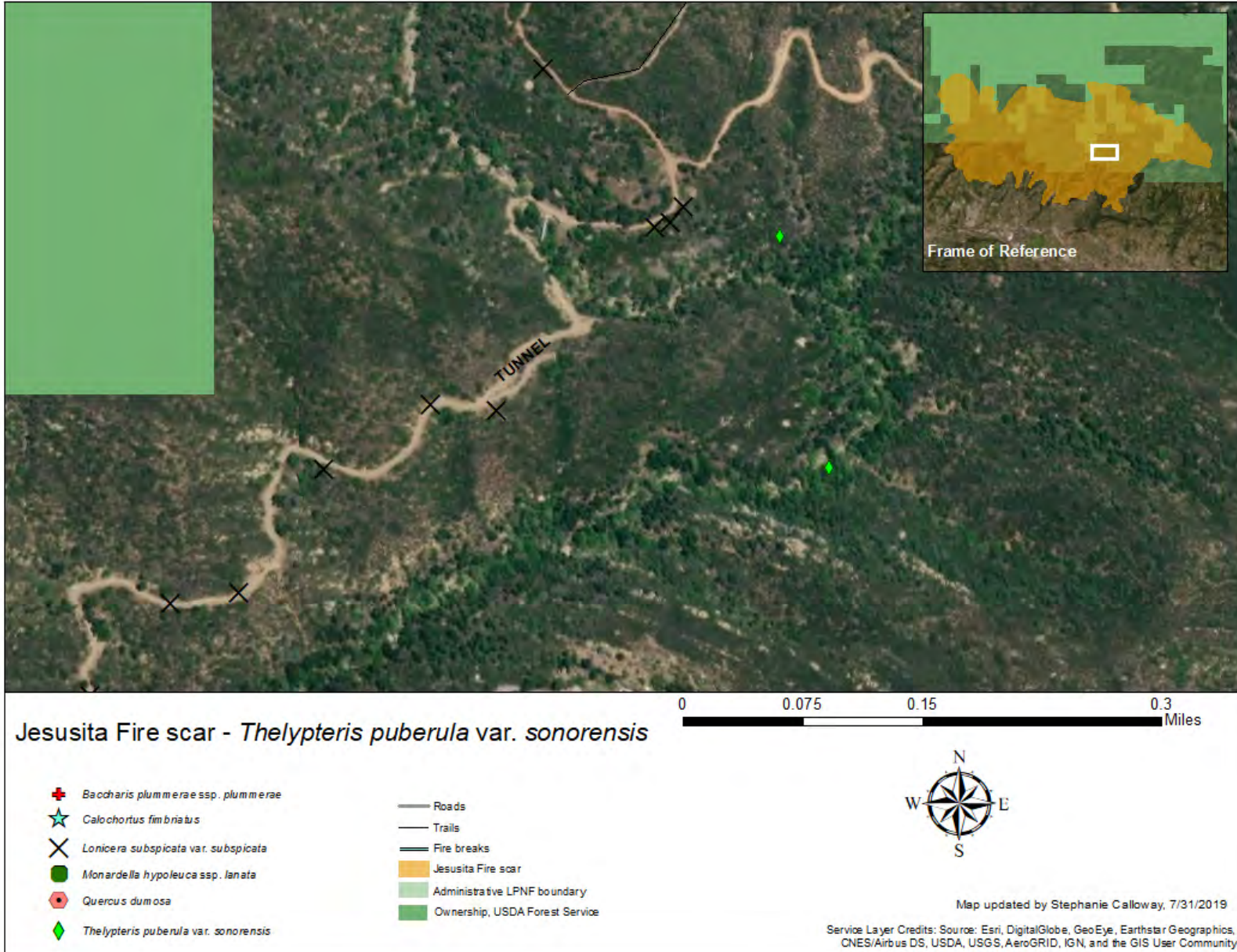


Map produced by Stephanie Calloway, 7/31/2019

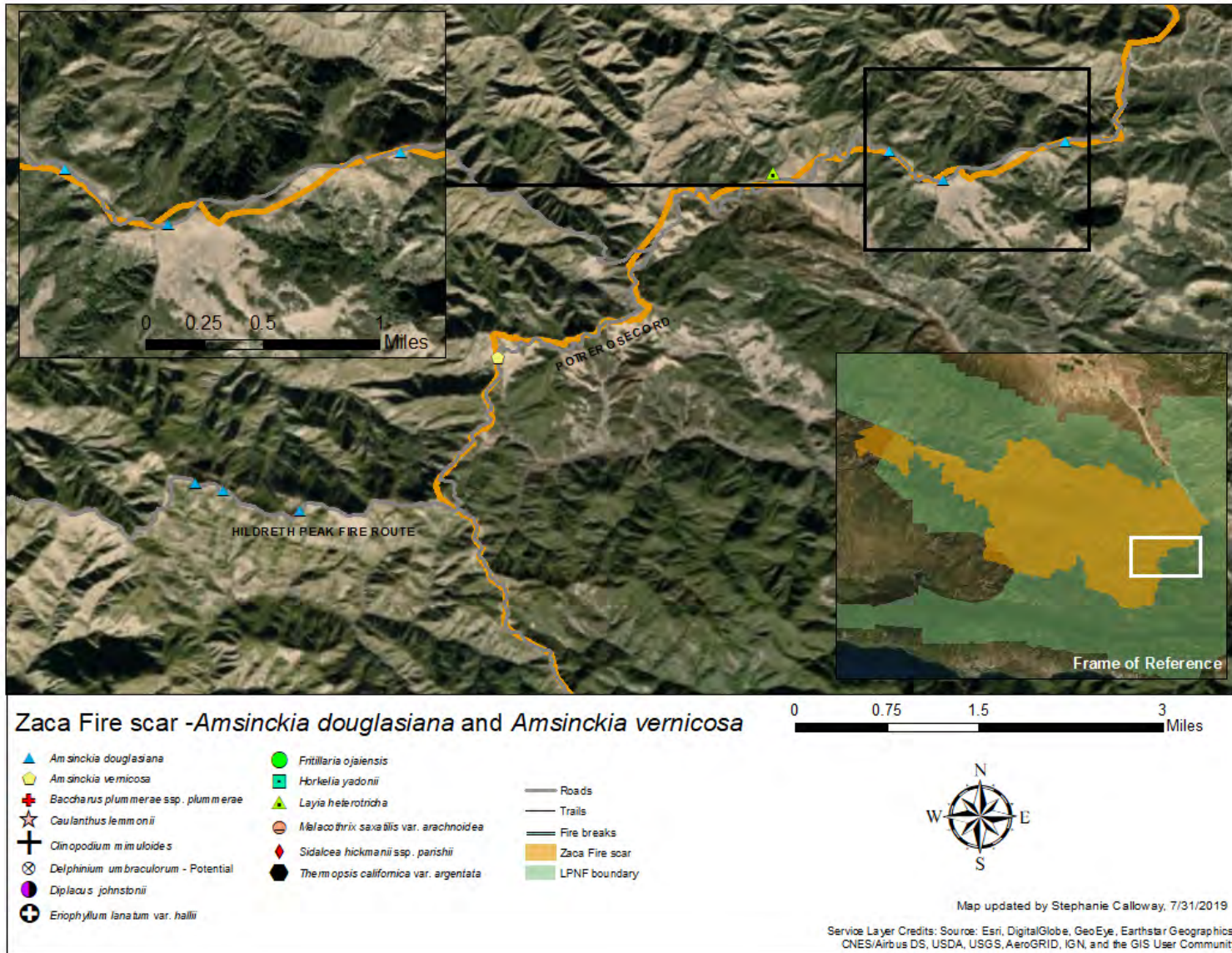
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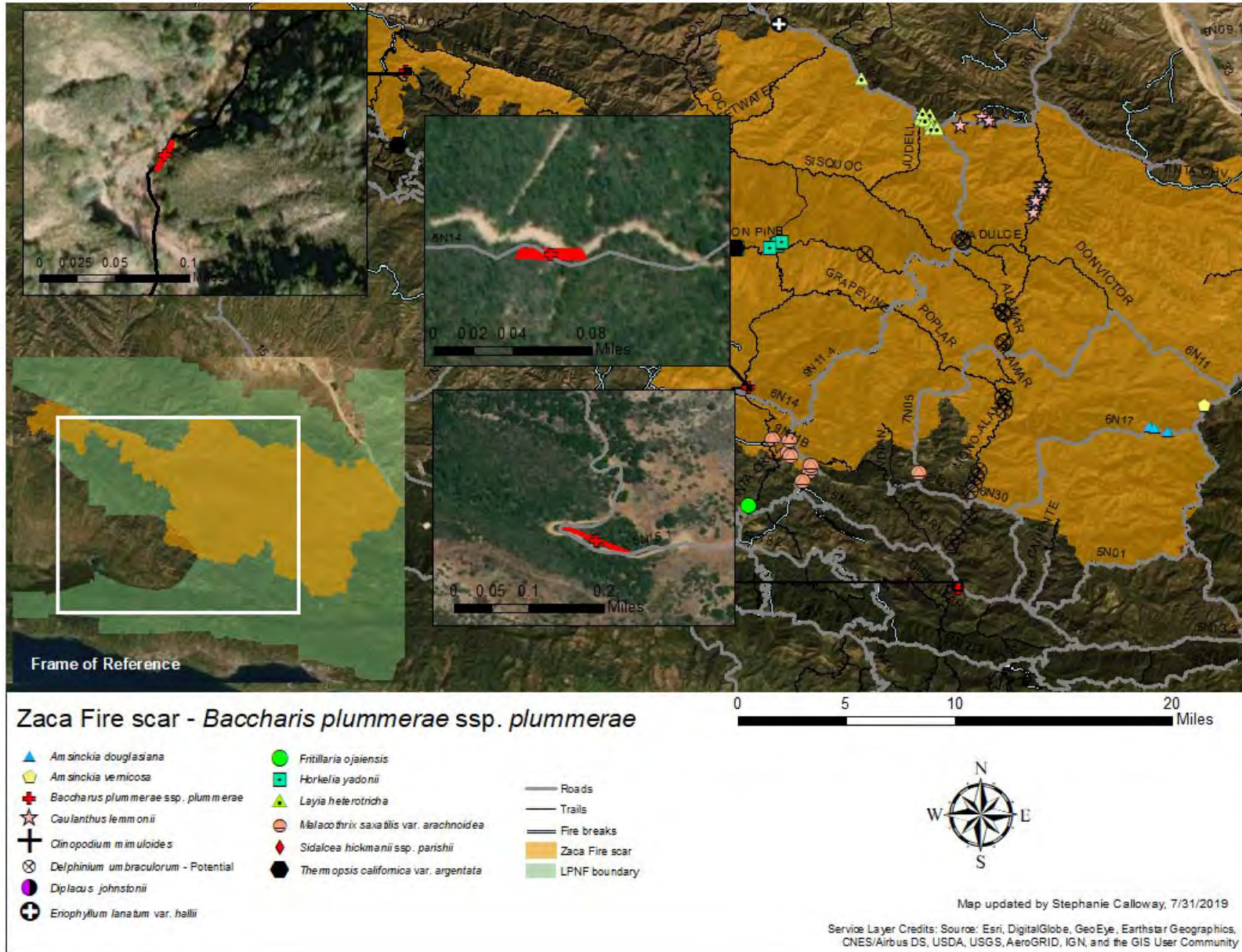


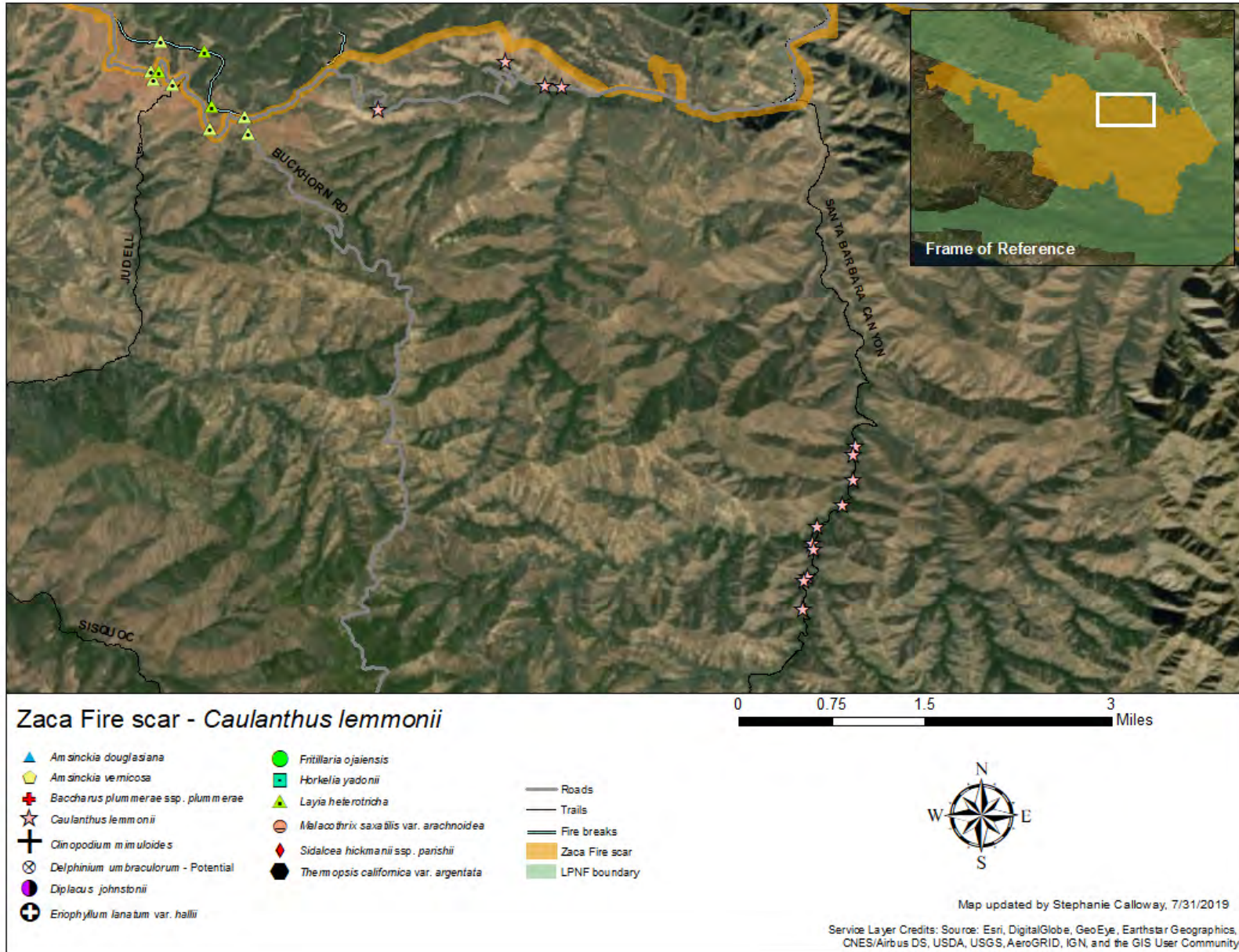




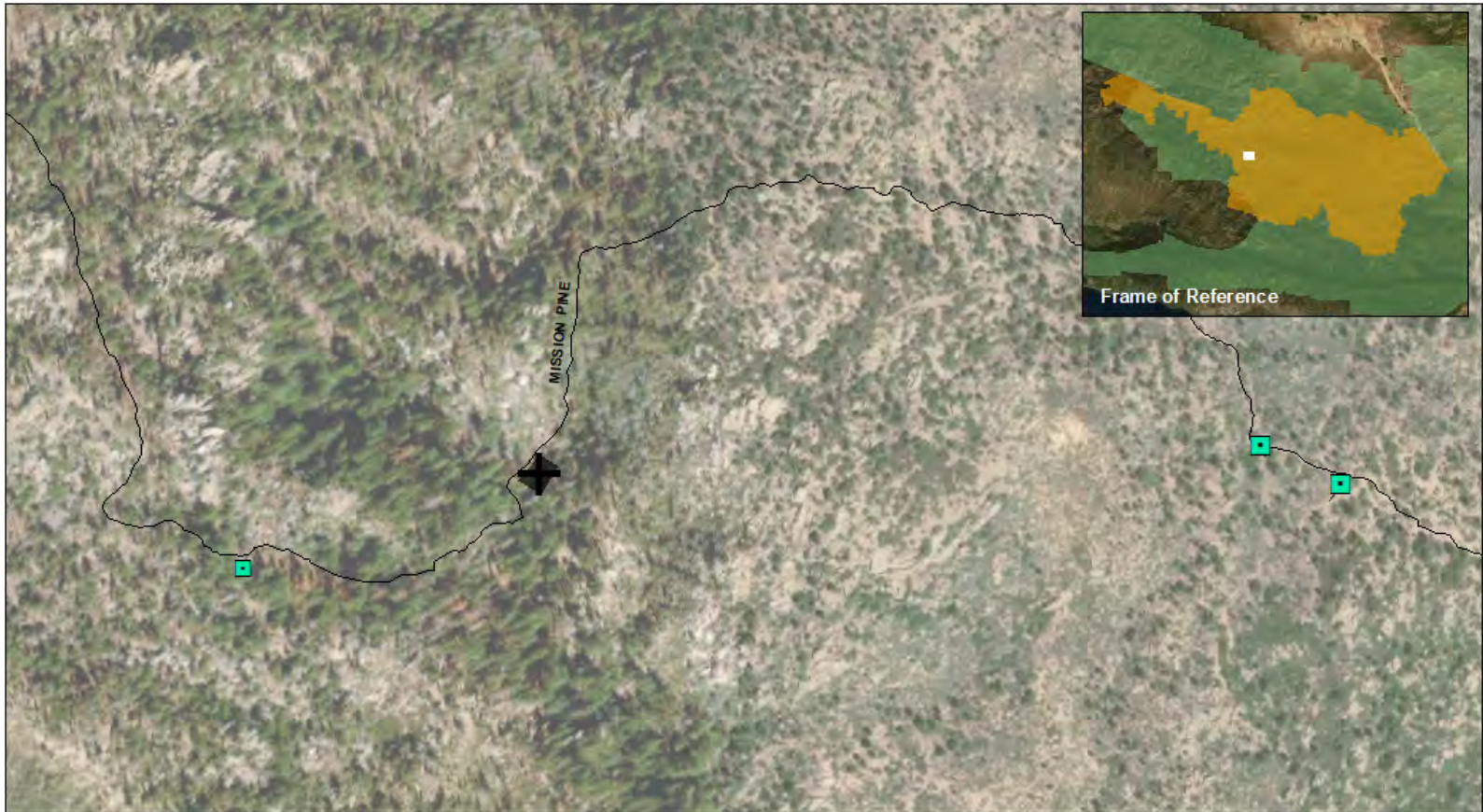
**Appendix B. Rare plants mapped within the Zaca Fire scar as part of SBBG's Botanical Blackholes project**



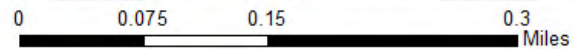








Zaca Fire scar - *Clinopodium mimuloides*

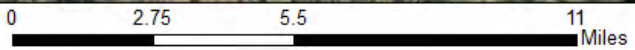
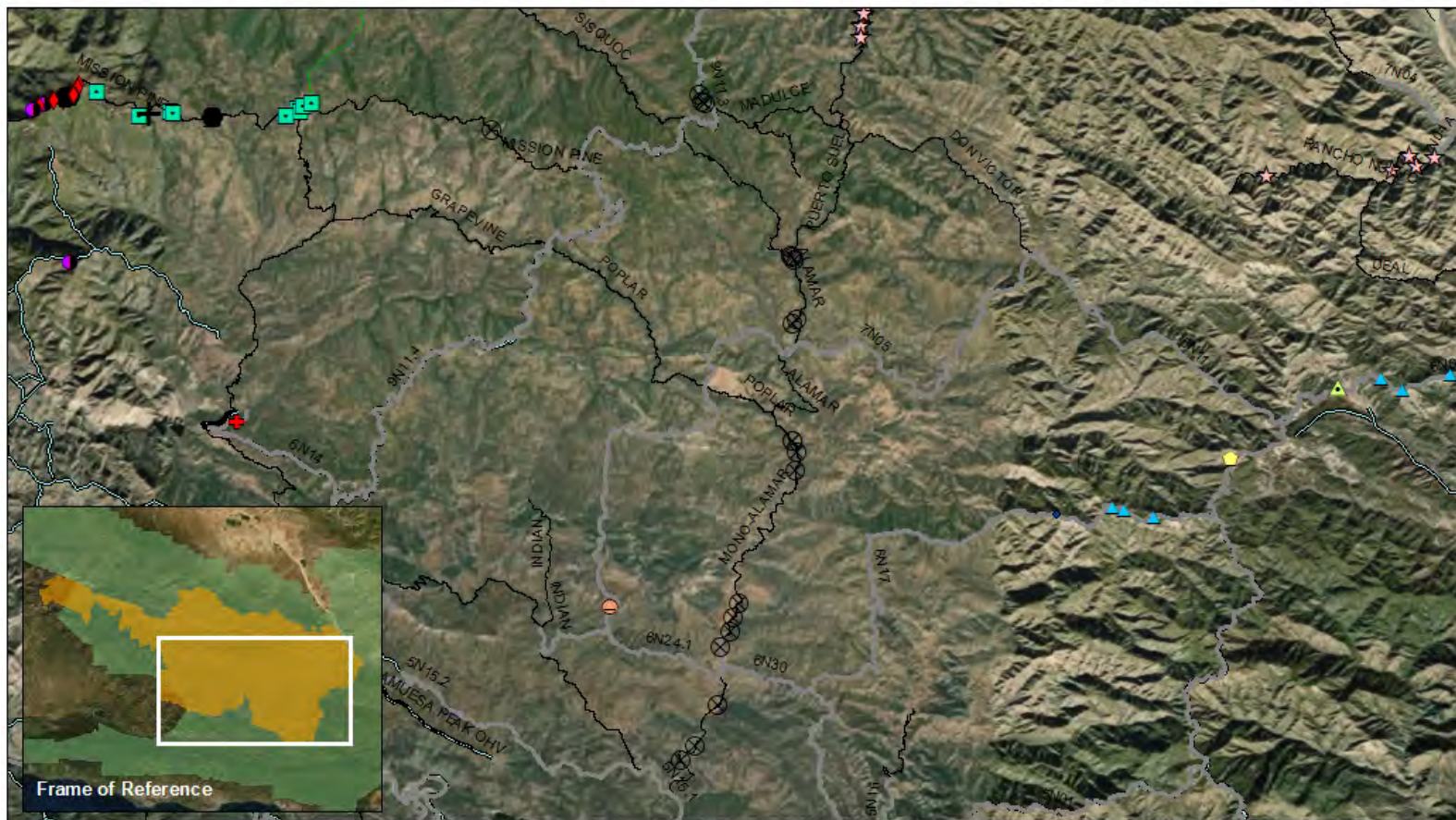


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| <i>Amsinckia douglasiana</i>                     | <i>Fritillaria ojaiensis</i>                         | Roads          |
| <i>Amsinckia vermicosa</i>                       | <i>Horkelia yadonii</i>                              | Trails         |
| <i>Baccharis plummerae</i> ssp. <i>plummerae</i> | <i>Layia heterotricha</i>                            | Fire breaks    |
| <i>Caulanthus lemmonii</i>                       | <i>Melacothrix saxatilis</i> var. <i>arachnoidea</i> | Zaca Fire scar |
| <i>Clinopodium mimuloides</i>                    | <i>Sidalcea hickmanii</i> ssp. <i>parishii</i>       | LPNF boundary  |
| <i>Delphinium umbracolorum</i> - Potential       | <i>Thermopsis californica</i> var. <i>argentata</i>  |                |
| <i>Diplacus johnstonii</i>                       |  |                |
| <i>Eriophyllum lanatum</i> var. <i>hallii</i>    |  |                |



Map updated by Stephanie Calloway, 7/31/2019

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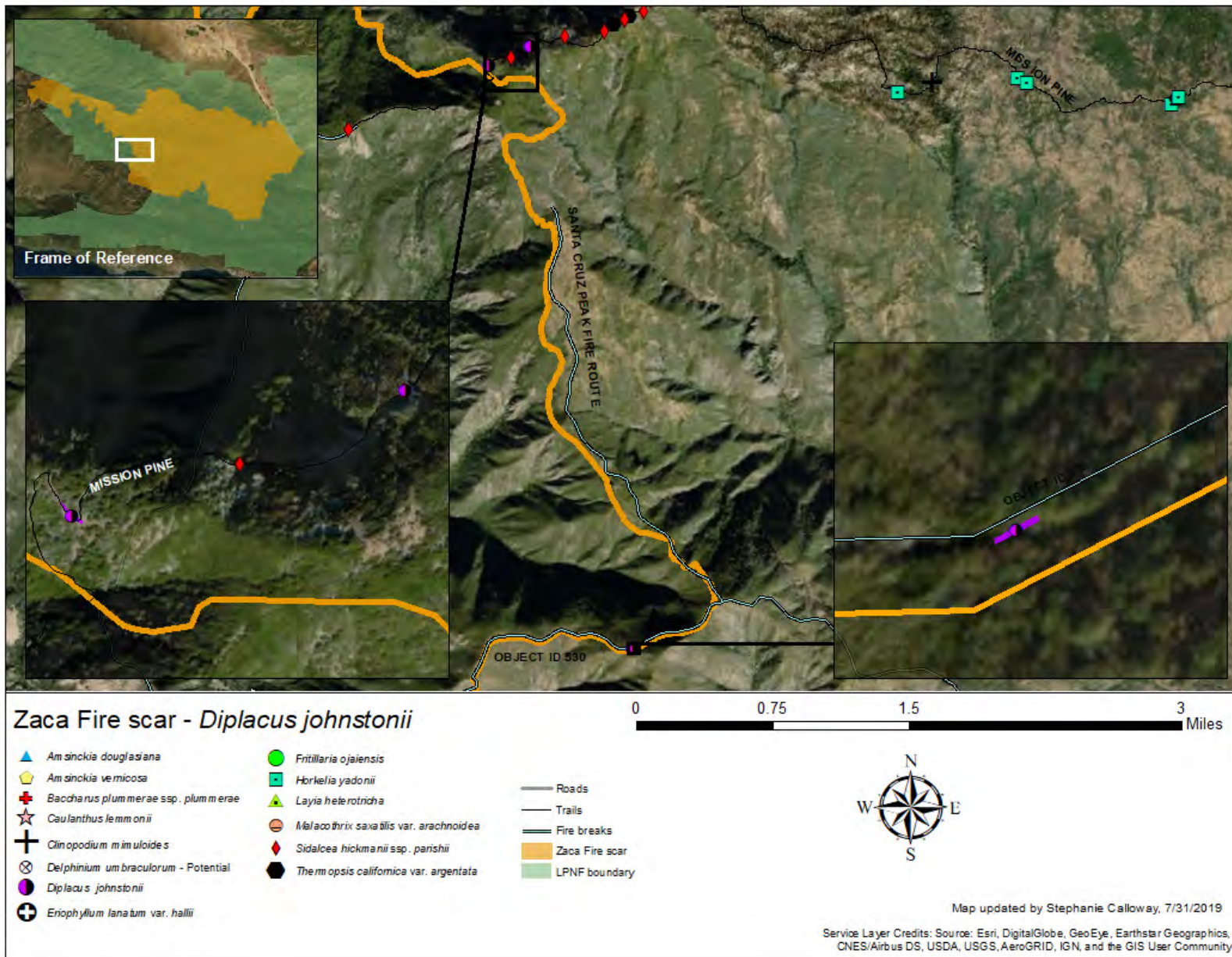
Zaca Fire scar - Potential *Delphinium umbraculorum*

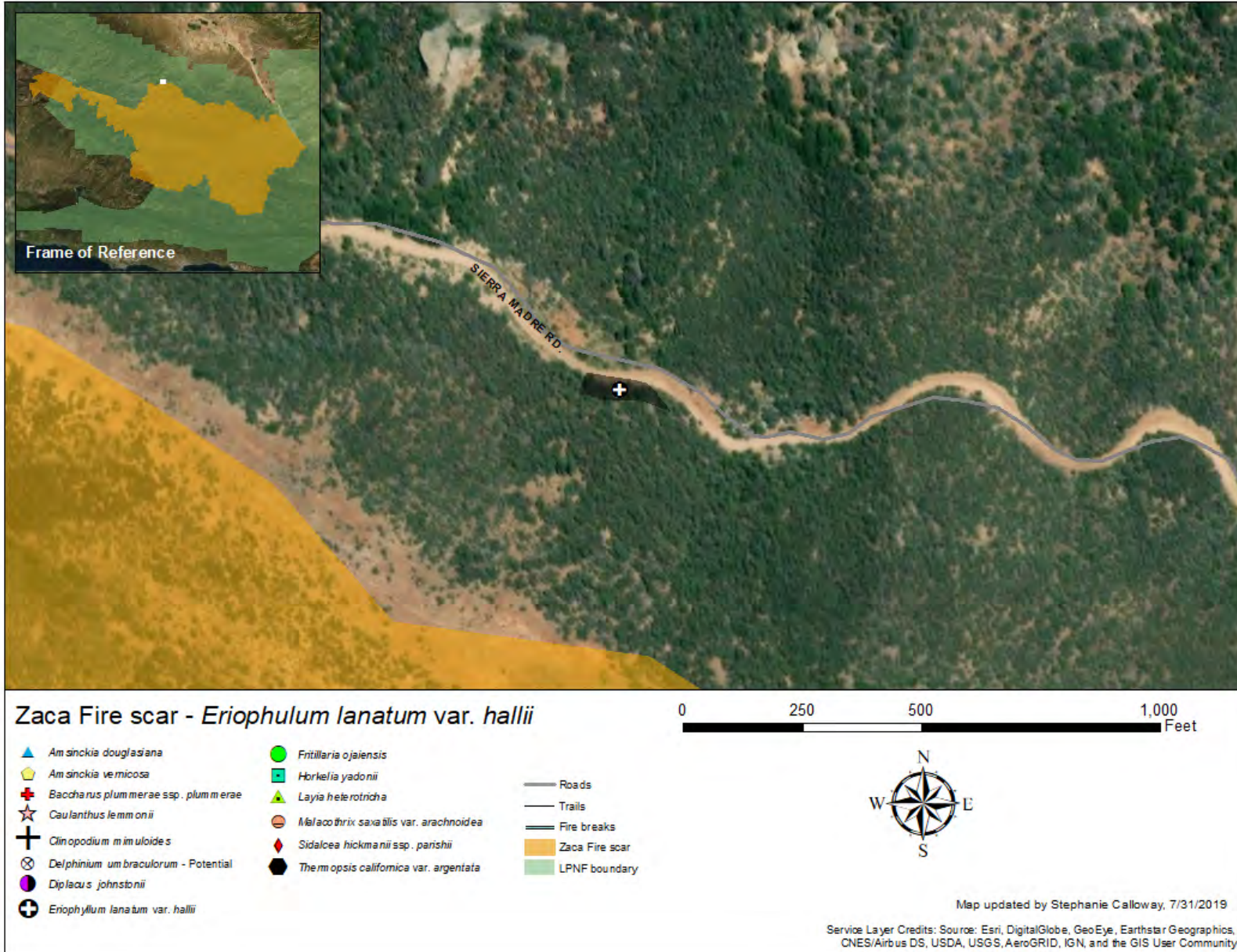
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| ▲ <i>Am sinokia douglasiana</i>                      | ● <i>Fritillaria ojaiensis</i>                         | — Roads          |
| ⬠ <i>Am sinokia vermicosa</i>                        | ■ <i>Horkelia yadonii</i>                              | — Trails         |
| ⊕ <i>Baccharis plum merae</i> ssp. <i>plum merae</i> | ▲ <i>Layia heterotricha</i>                            | — Fire breaks    |
| ★ <i>Caulanthus lemmonii</i>                         | ● <i>Malacothrix saxatilis</i> var. <i>arachnoidea</i> | ■ Zaca Fire scar |
| ⊕ <i>Clinopodium mimuloide s</i>                     | ◆ <i>Sidalcea hickmanii</i> ssp. <i>parishii</i>       | ■ LPNF boundary  |
| ⊕ <i>Delphinium umbraculorum</i> - Potential         | ● <i>Thymopsis californica</i> var. <i>argentata</i>   |                  |
| ● <i>Diplacus johnstonii</i>                         |  |                  |
| ⊕ <i>Eriophyllum lanatum</i> var. <i>hallii</i>      |  |                  |

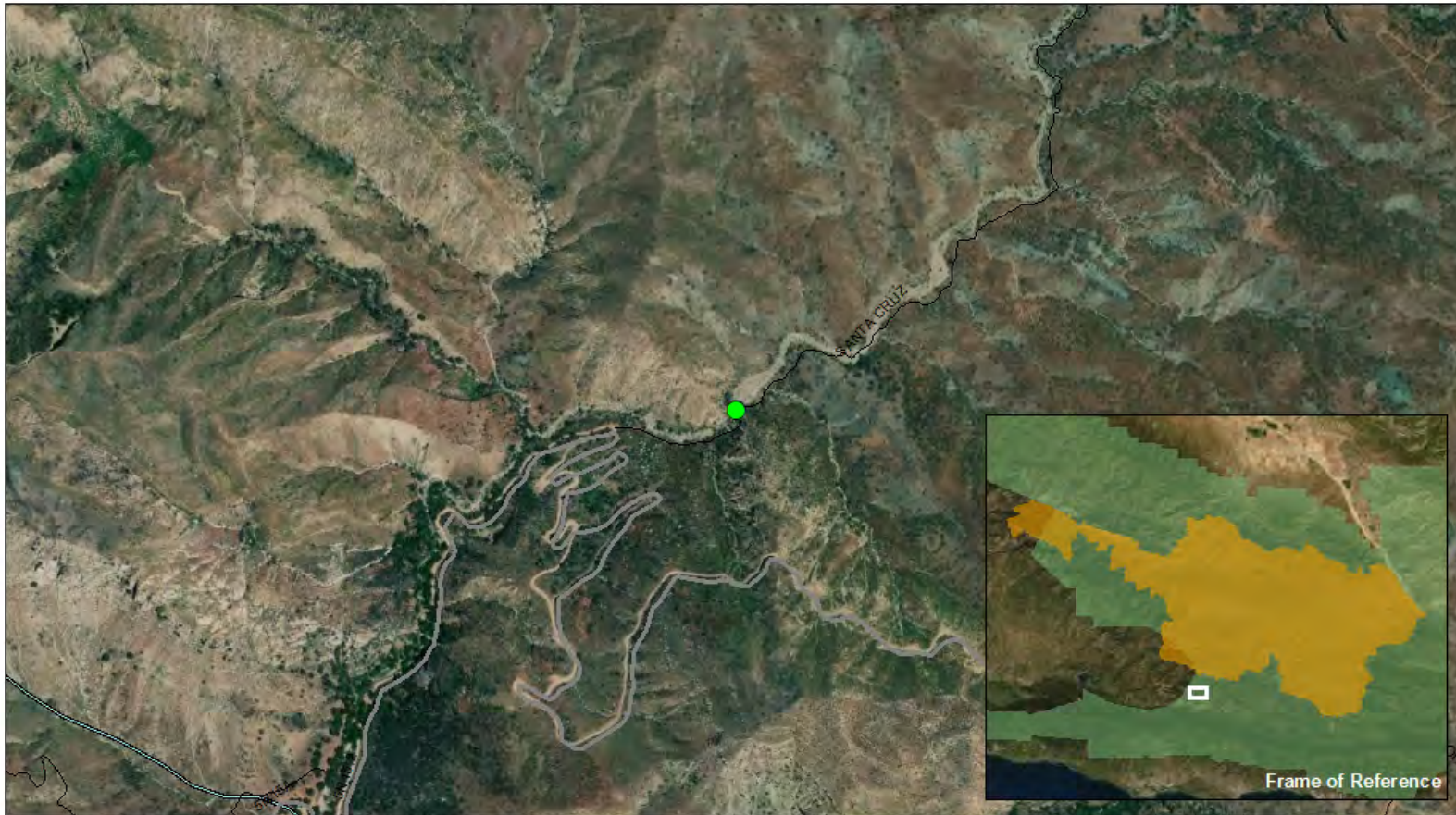


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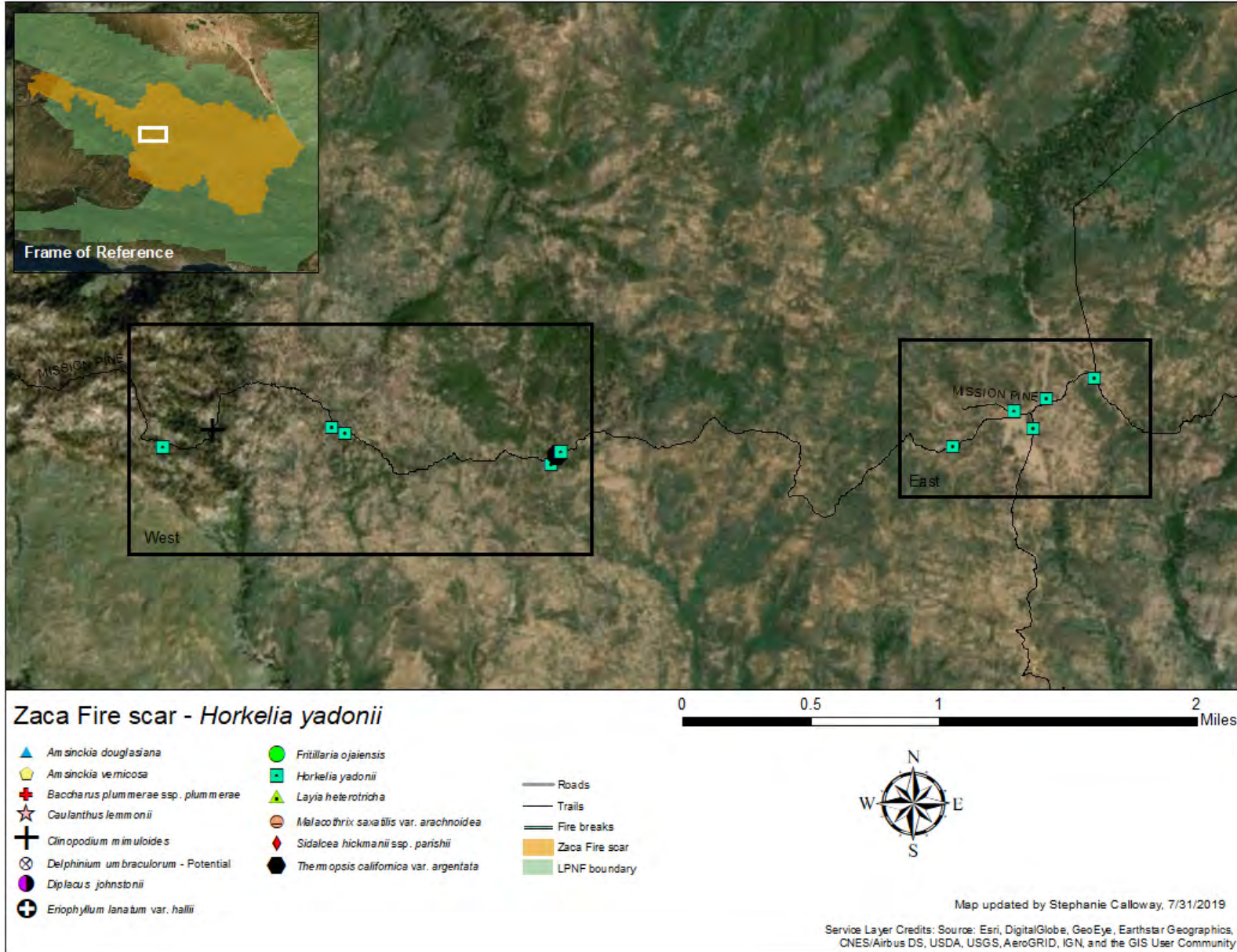
**Zaca Fire scar - *Fritillaria ojaiensis***

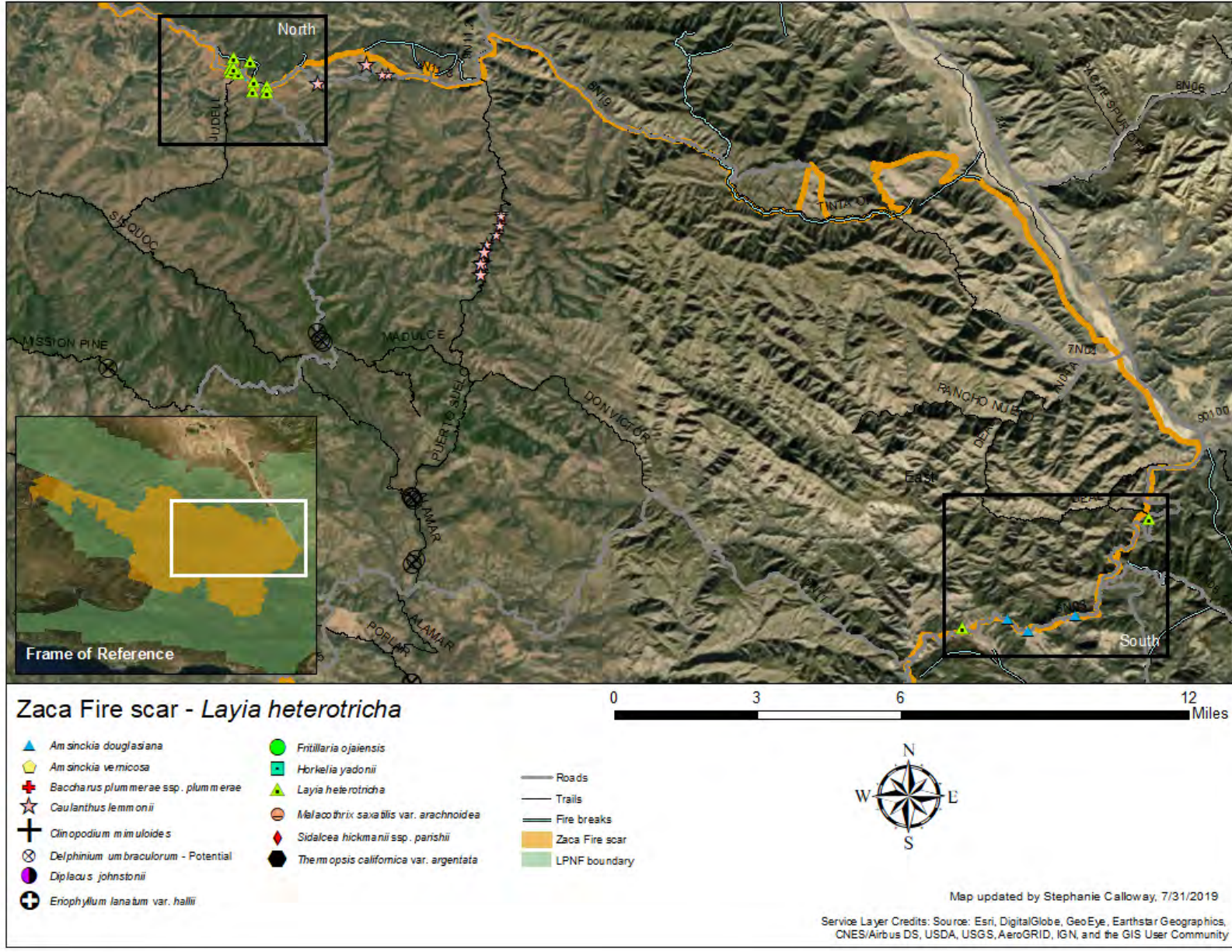
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| <i>Am sinckia douglasiana</i>                    | <i>Fritillaria ojaiensis</i>                         | Roads          |
| <i>Am sinckia vermicosa</i>                      | <i>Horkelia yadonii</i>                              | Trails         |
| <i>Baccharis plummerae</i> ssp. <i>plummerae</i> | <i>Layia heterotricha</i>                            | Fire breaks    |
| <i>Caulanthus lemmingii</i>                      | <i>Melacothrix saxatilis</i> var. <i>arachnoidea</i> | Zaca Fire scar |
| <i>Clinopodium mimuloideus</i>                   | <i>Sidalcea hickmanii</i> ssp. <i>parishii</i>       | LPNF boundary  |
| <i>Delphinium umbracolorum</i> - Potential       | <i>Thermopsis californica</i> var. <i>argentata</i>  |                |
| <i>Diplacus johnstonii</i>                       |  |                |
| <i>Eriophyllum lanatum</i> var. <i>hallii</i>    |  |                |

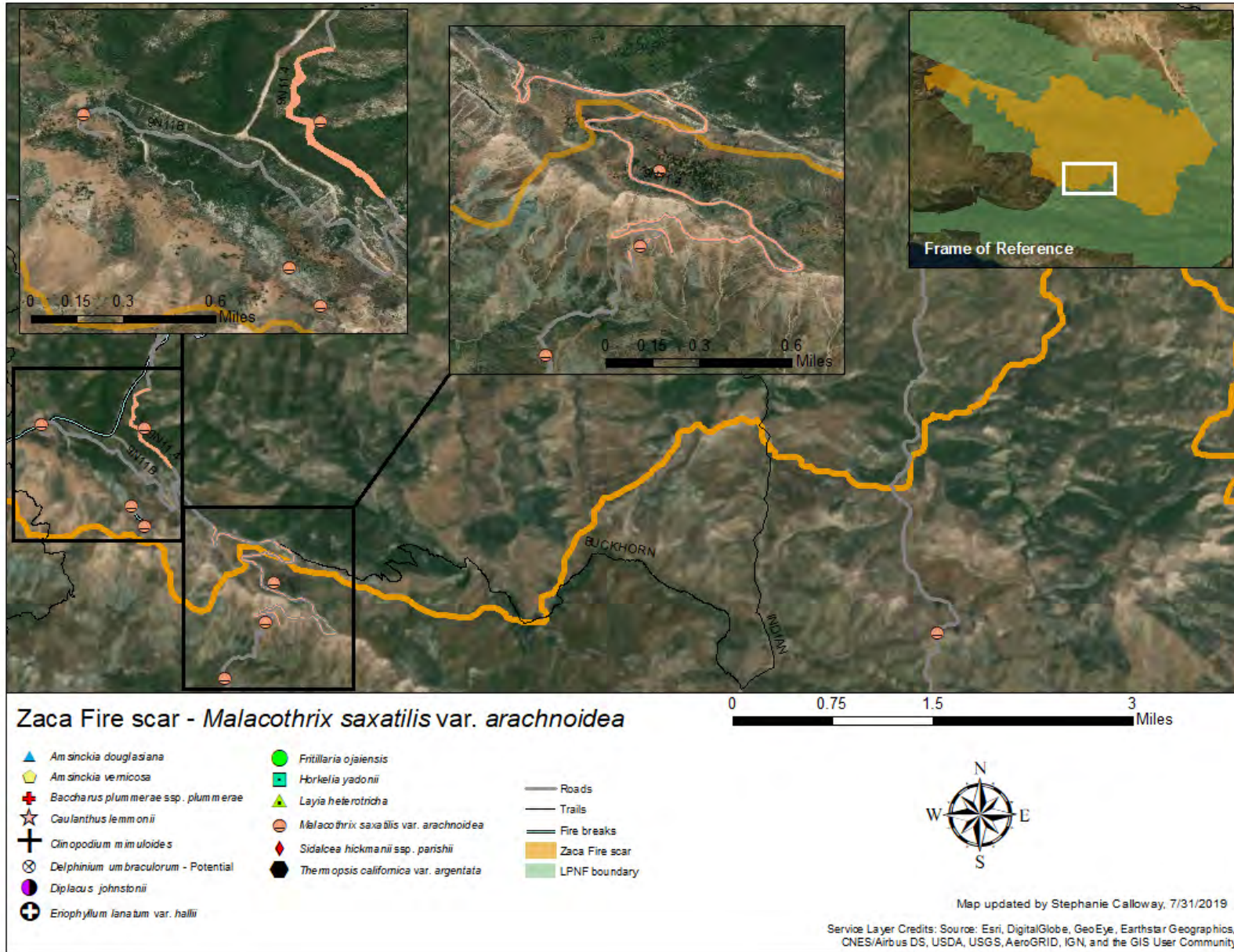


Map updated by Stephanie Calloway, 7/31/2019

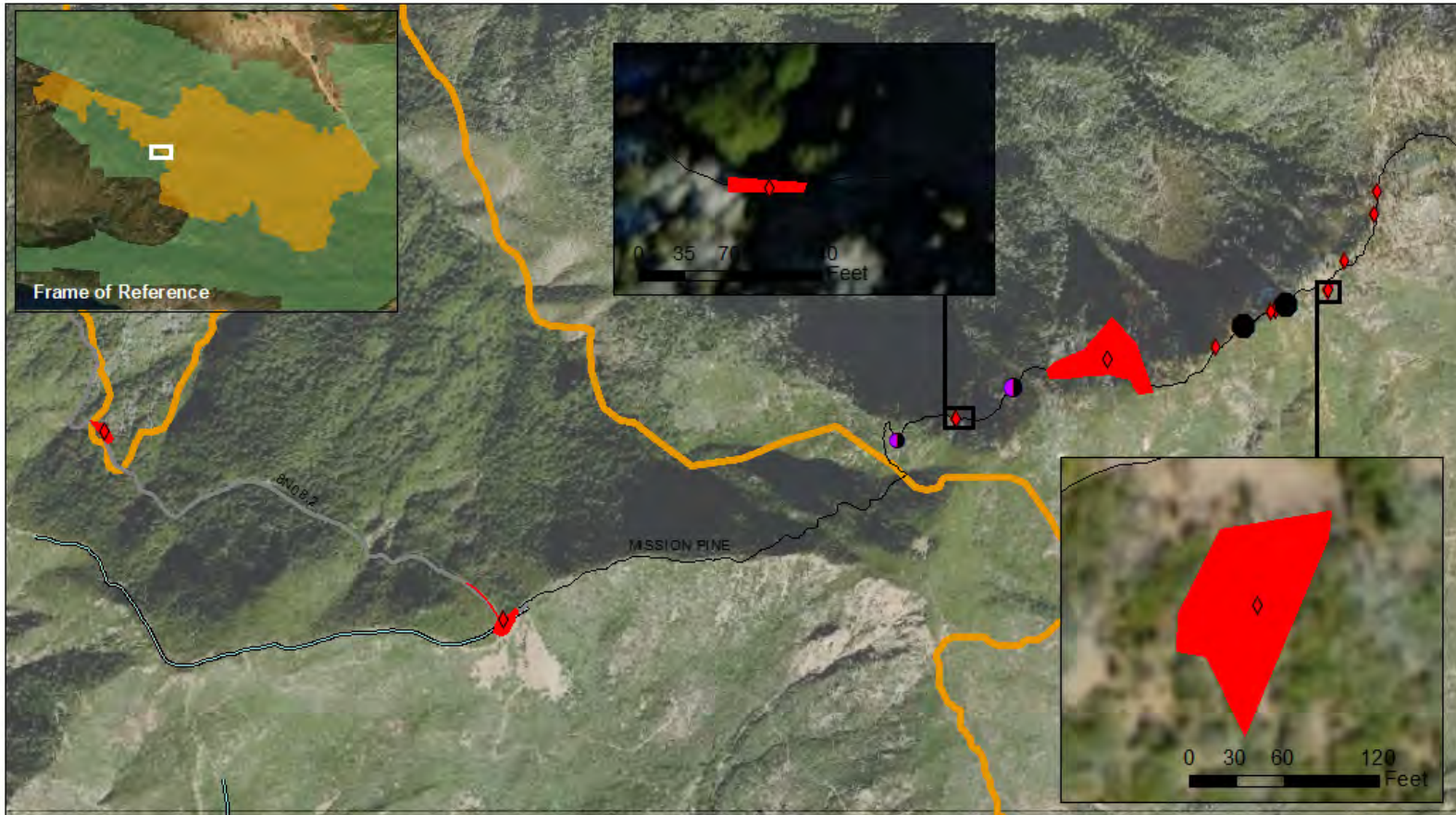
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Zaca Fire scar - *Sidalcea hickmanii* ssp. *parishii*

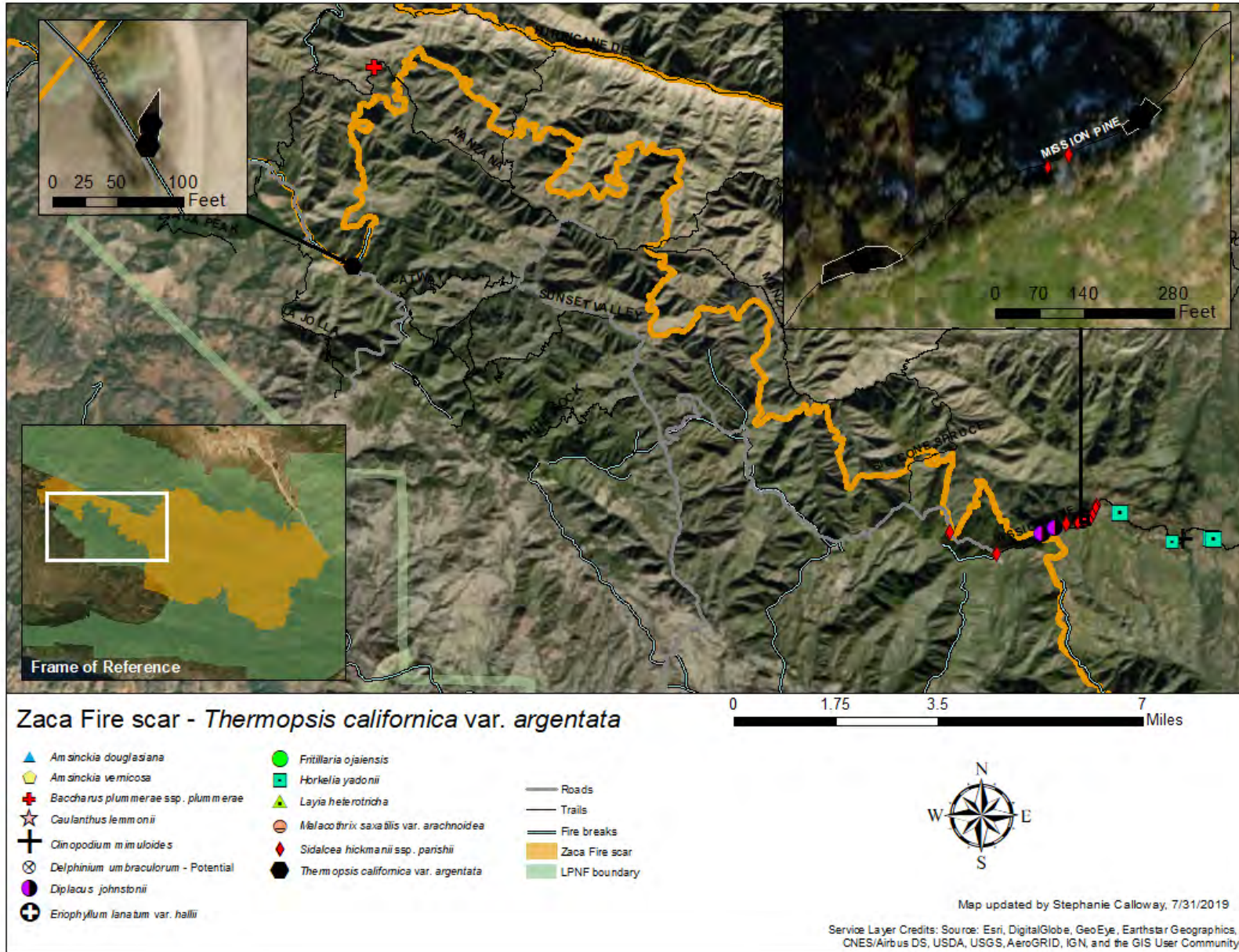
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| <i>Am sinckia douglasiana</i>                    | <i>Fritillaria ojaiensis</i>                         | Roads          |
| <i>Am sinckia vermicosa</i>                      | <i>Horkelia yadonii</i>                              | Trails         |
| <i>Baccharis plummerae</i> ssp. <i>plummerae</i> | <i>Layia heterotricha</i>                            | Fire breaks    |
| <i>Caulanthus lemmonii</i>                       | <i>Melacothrix saxatilis</i> var. <i>arachnoidea</i> | Zaca Fire scar |
| <i>Clinopodium mimuloide</i>                     | <i>Sidalcea hickmanii</i> ssp. <i>parishii</i>       | LPNF boundary  |
| <i>Delphinium umbracolorum</i> - Potential       | <i>Thermopsis californica</i> var. <i>argentata</i>  |                |
| <i>Diplacus johnstonii</i>                       |  |                |
| <i>Eriophyllum lanatum</i> var. <i>hallii</i>    |  |                |

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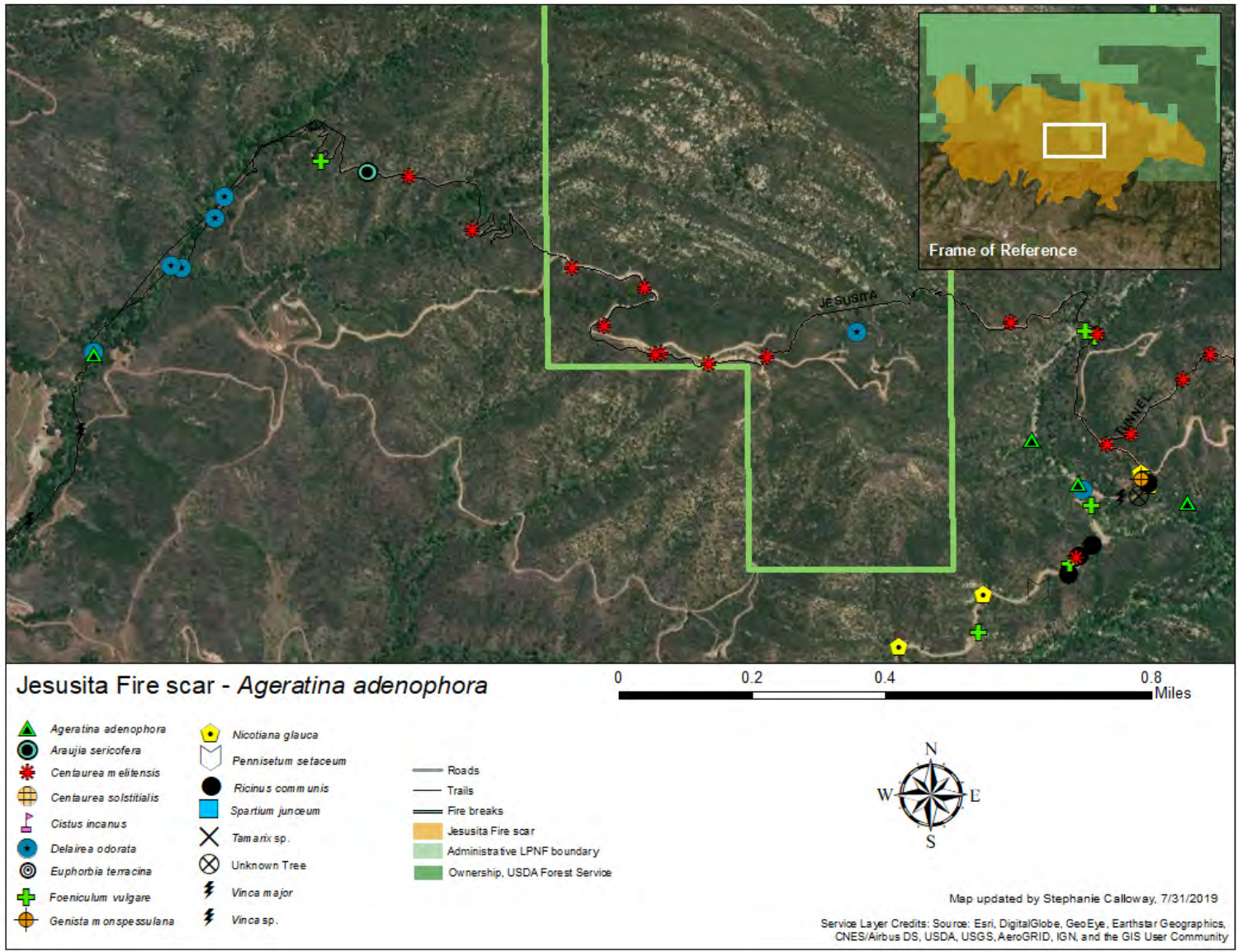


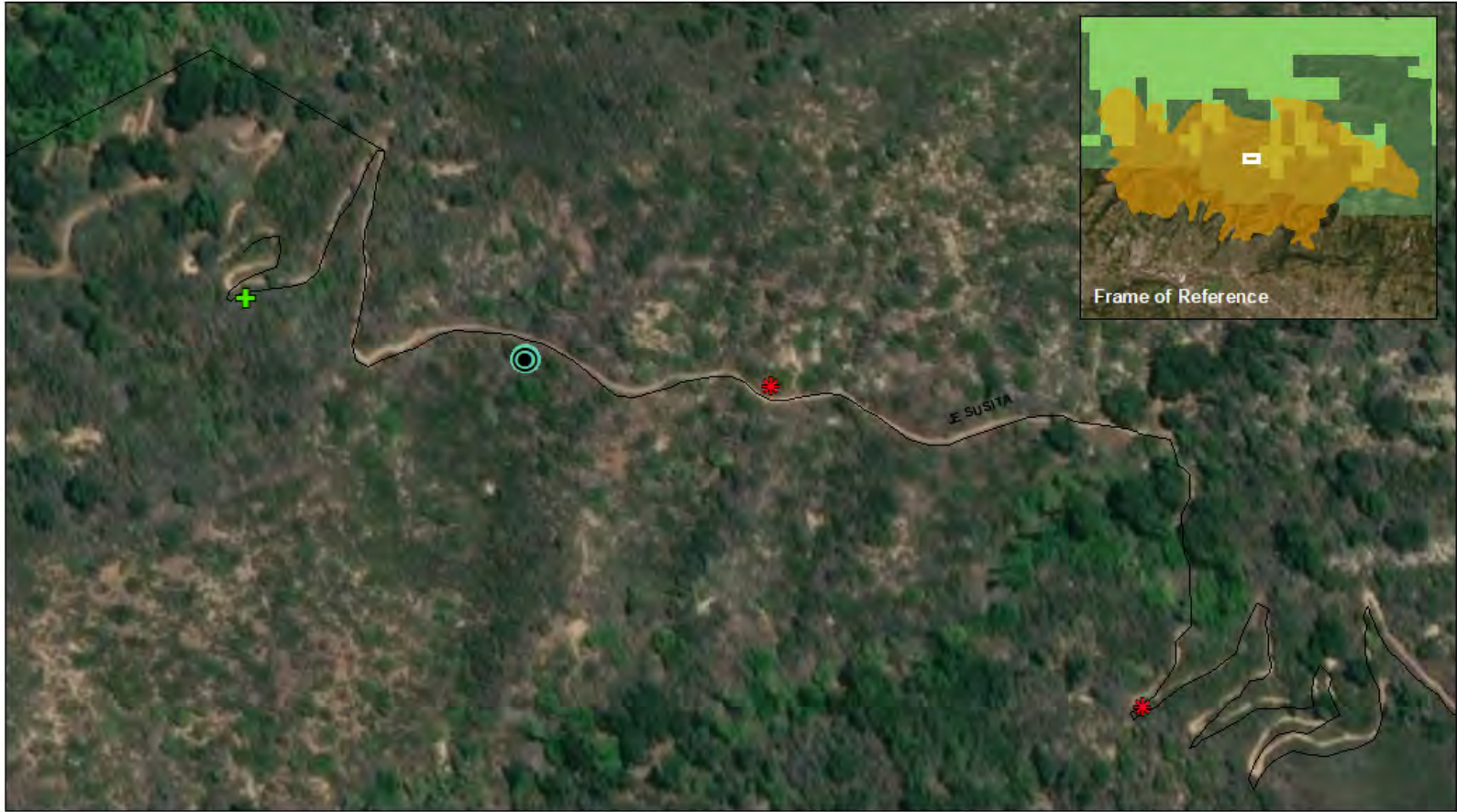
Map updated by Stephanie Calloway, 7/31/2019

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

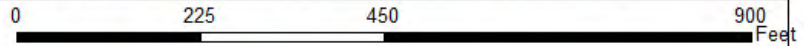


Appendix C. Invasive plants mapped within the Jesusita Fire scar as part of SBBG's Botanical Blackholes project





**Jesusita Fire scar - *Araujia sericifera***



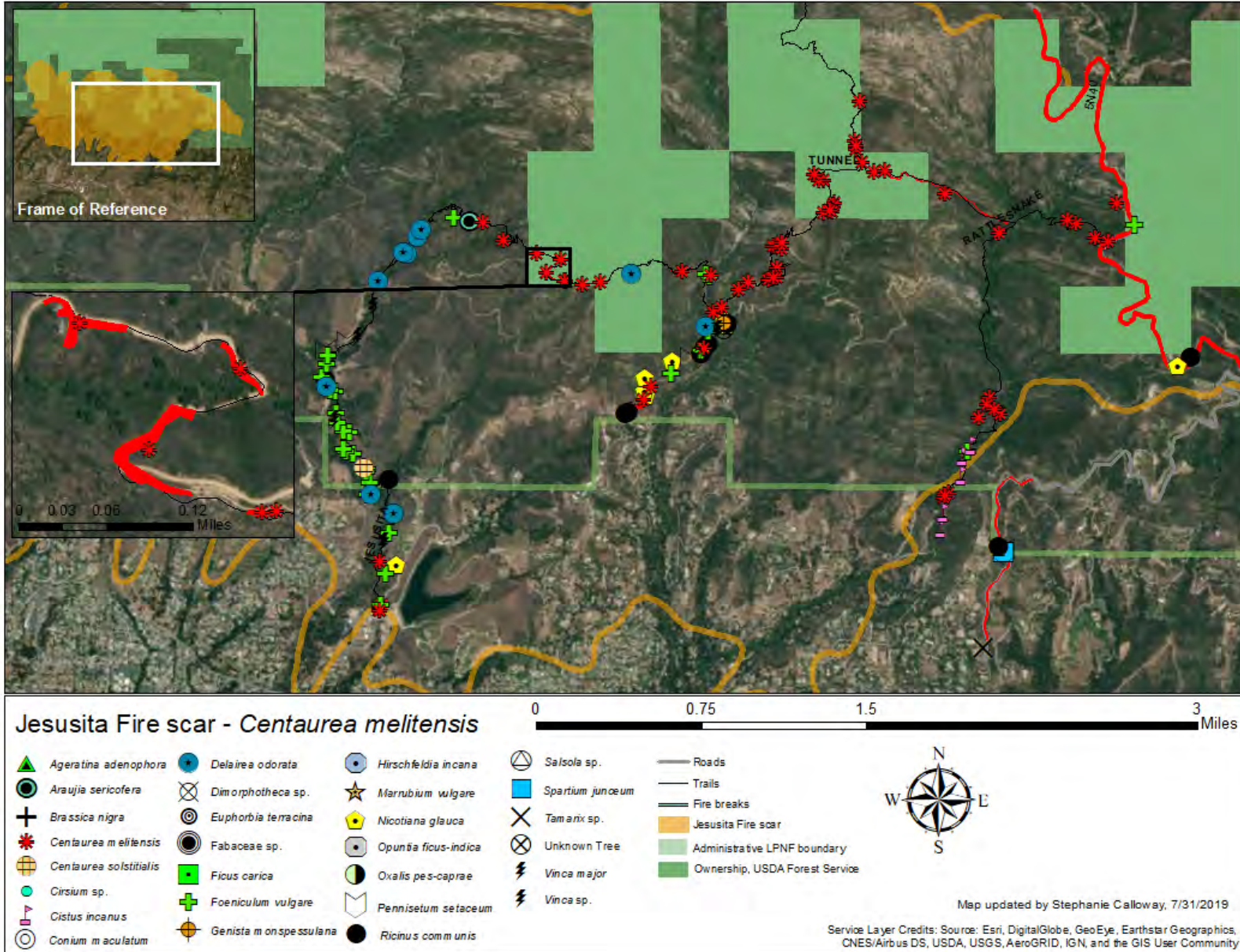
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|-------------------------------|------------------------------|-----------------------------|-------------------------|
| <i>Ageratina adenophora</i>   | <i>Delairea odorata</i>      | <i>Hirschfeldia incana</i>  | <i>Salsola</i> sp.      |
| <i>Araujia sericifera</i>     | <i>Dimorphotheca</i> sp.     | <i>Marrubium vulgare</i>    | <i>Spartium junceum</i> |
| <i>Brassica nigra</i>         | <i>Euphorbia terracina</i>   | <i>Nicotiana glauca</i>     | <i>Tamarix</i> sp.      |
| <i>Centaurea melitensis</i>   | Fabaceae sp.                 | <i>Opuntia ficus-indica</i> | Unknown Tree            |
| <i>Centaurea solstitialis</i> | <i>Ficus carica</i>          | <i>Oxalis pes-caprae</i>    | <i>Vinca major</i>      |
| <i>Cirsium</i> sp.            | <i>Foeniculum vulgare</i>    | <i>Pennisetum setaceum</i>  | <i>Vinca</i> sp.        |
| <i>Cistus incanus</i>         | <i>Genista monspessulana</i> | <i>Ricinus communis</i>     |                         |
| <i>Conium maculatum</i>       |                              |                             |                         |

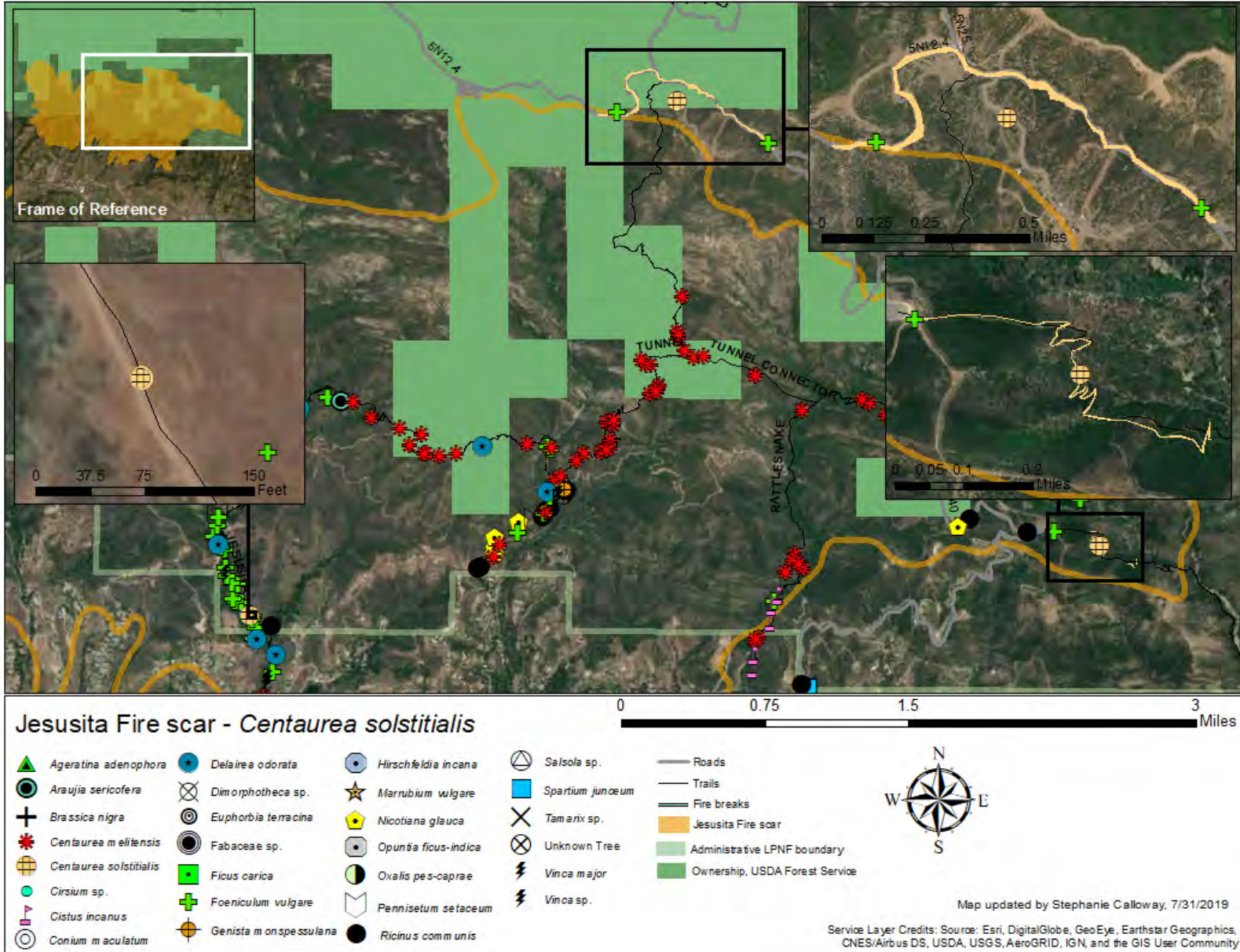


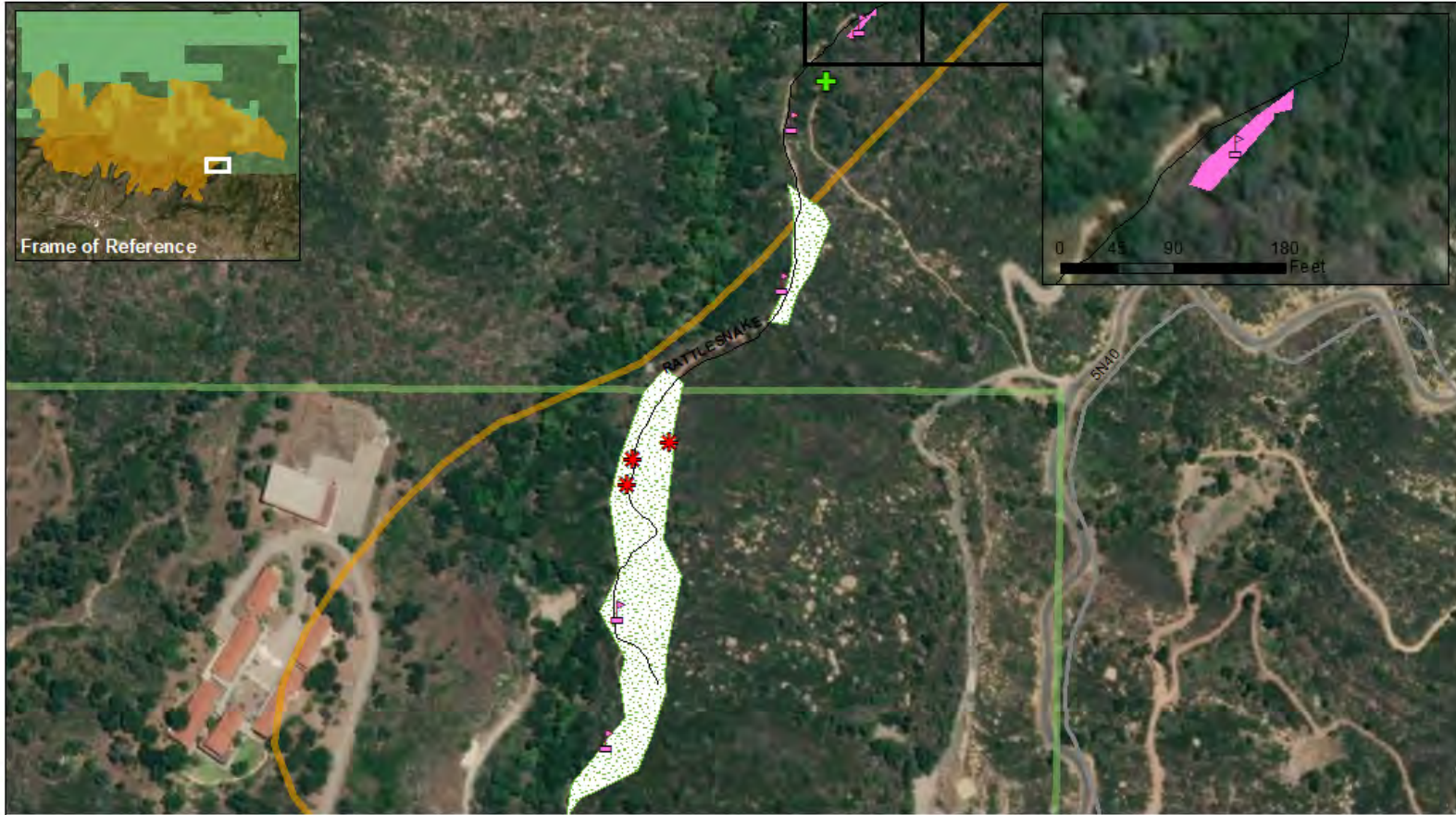
- Roads
- Trails
- Fire breaks
- Jesusita Fire scar
- Administrative LPNF boundary
- Ownership, USDA Forest Service

Map updated by Stephanie Calloway, 7/31/2019

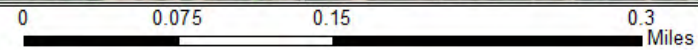
Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community







Jesusita Fire scar - *Cistus incanus* and *Quercus dumosa*

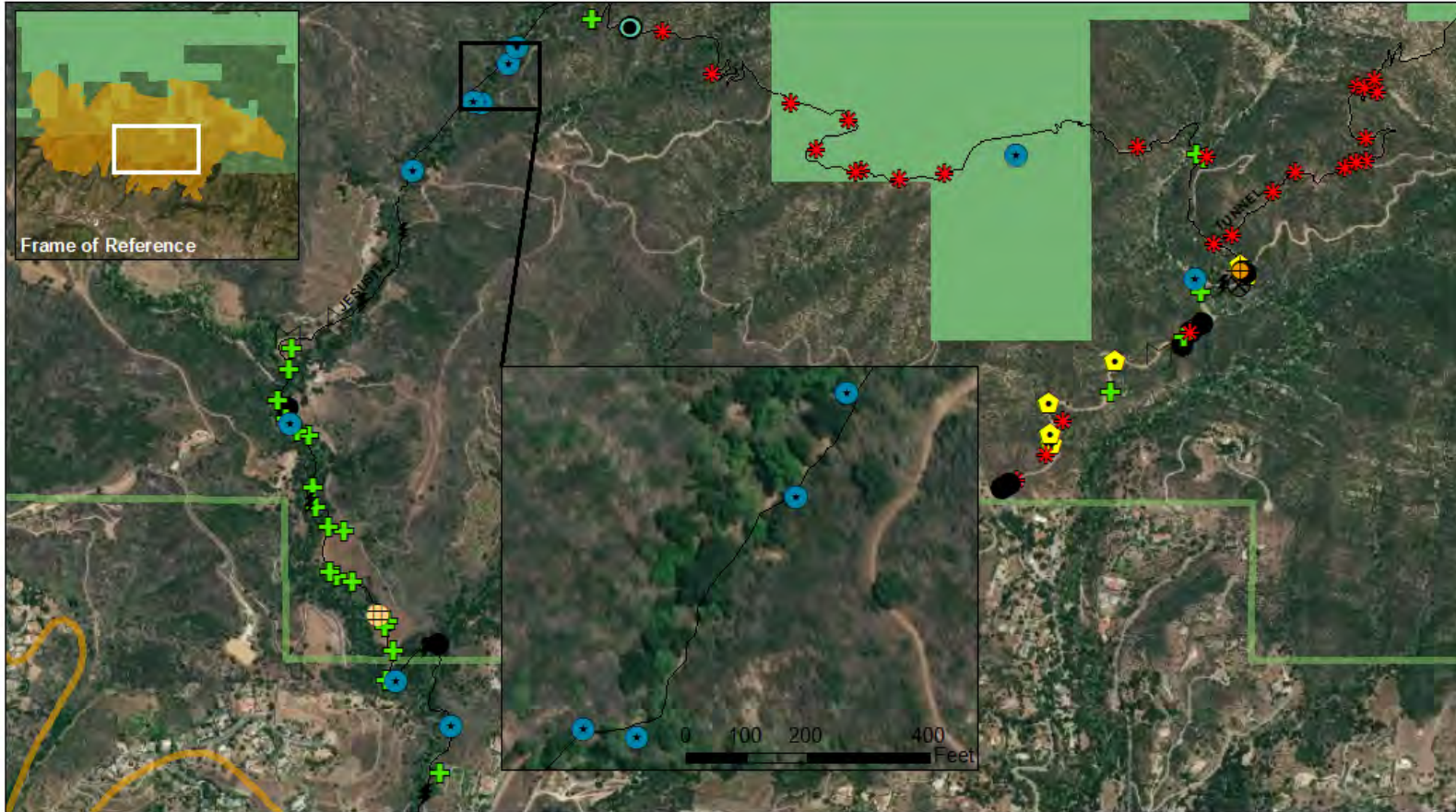


- |                               |                              |                             |                         |
|-------------------------------|------------------------------|-----------------------------|-------------------------|
| <i>Ageratina adenophora</i>   | <i>Delairea odorata</i>      | <i>Hirschfeldia incana</i>  | <i>Salsola</i> sp.      |
| <i>Araujia sericifera</i>     | <i>Dimorphotheca</i> sp.     | <i>Marrubium vulgare</i>    | <i>Spartium junceum</i> |
| <i>Brassica nigra</i>         | <i>Euphorbia terracina</i>   | <i>Nicotiana glauca</i>     | <i>Tamarix</i> sp.      |
| <i>Centaurea melitensis</i>   | Fabaceae sp.                 | <i>Opuntia ficus-indica</i> | Unknown Tree            |
| <i>Centaurea solstitialis</i> | <i>Ficus carica</i>          | <i>Oxalis pes-caprae</i>    | <i>Vinca major</i>      |
| <i>Cirsium</i> sp.            | <i>Foeniculum vulgare</i>    | <i>Pennisetum setaceum</i>  | <i>Vinca</i> sp.        |
| <i>Cistus incanus</i>         | <i>Genista monspessulana</i> | <i>Ricinus communis</i>     | <i>Quercus dumosa</i>   |
| <i>Conium maculatum</i>       |                              |                             |                         |



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



Jesusita Fire scar - *Delairea odorata*

- |                               |                              |                             |                         |
|-------------------------------|------------------------------|-----------------------------|-------------------------|
| <i>Ageratina adenophora</i>   | <i>Delairea odorata</i>      | <i>Hirschfeldia incana</i>  | <i>Salsola</i> sp.      |
| <i>Araujia sericifera</i>     | <i>Dimorphotheca</i> sp.     | <i>Marrubium vulgare</i>    | <i>Spartium junceum</i> |
| <i>Brassica nigra</i>         | <i>Euphorbia terracina</i>   | <i>Nicotiana glauca</i>     | <i>Tamarix</i> sp.      |
| <i>Centaurea melitensis</i>   | Fabaceae sp.                 | <i>Opuntia ficus-indica</i> | Unknown Tree            |
| <i>Centaurea solstitialis</i> | <i>Ficus carica</i>          | <i>Oxalis pes-caprae</i>    | <i>Vinca major</i>      |
| <i>Cirsium</i> sp.            | <i>Foeniculum vulgare</i>    | <i>Pennisetum setaceum</i>  | <i>Vinca</i> sp.        |
| <i>Cistus incanus</i>         | <i>Genista monspessulana</i> | <i>Ricinus communis</i>     |                         |
| <i>Conium maculatum</i>       |                              |                             |                         |

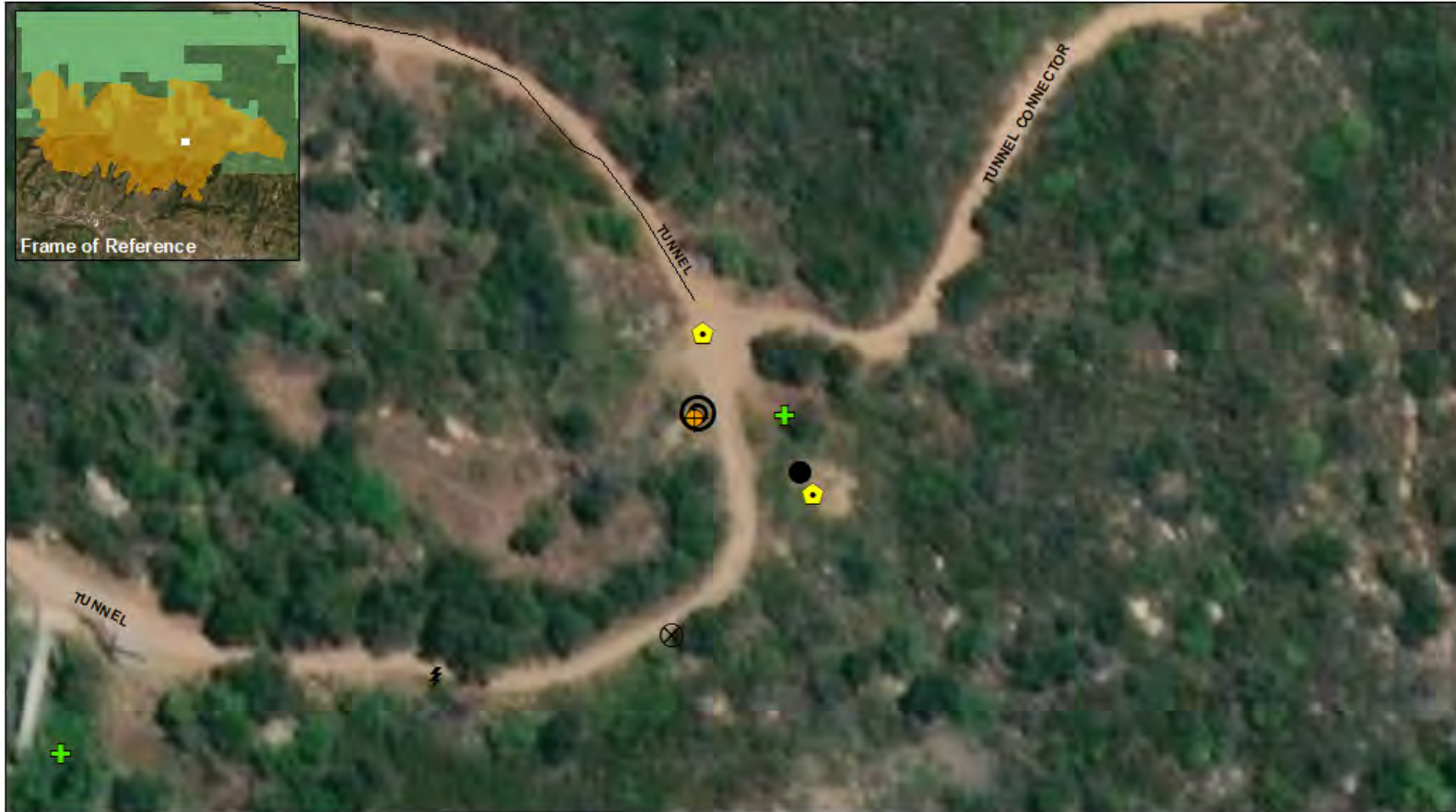


0 0.25 0.5 1 Miles

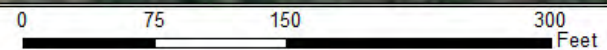
Map updated by Stephanie Calloway, 7/31/2019

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Jesusita Fire scar - *Euphorbia terracina* and *Genista monspessulana*



- |                               |                              |                             |
|-------------------------------|------------------------------|-----------------------------|
| <i>Ageratina adenophora</i>   | <i>Delairea odorata</i>      | <i>Hirschfeldia incana</i>  |
| <i>Araujia sericifera</i>     | <i>Dimorphotheca</i> sp.     | <i>Marrubium vulgare</i>    |
| <i>Brassica nigra</i>         | <i>Euphorbia terracina</i>   | <i>Nicotiana glauca</i>     |
| <i>Centaurea melioides</i>    | Fabaceae sp.                 | <i>Opuntia ficus-indica</i> |
| <i>Centaurea solstitialis</i> | <i>Ficus carica</i>          | <i>Oxalis pes-caprae</i>    |
| <i>Cirsium</i> sp.            | <i>Foeniculum vulgare</i>    | <i>Pennisetum setaceum</i>  |
| <i>Cistus incanus</i>         | <i>Genista monspessulana</i> | <i>Ricinus communis</i>     |
| <i>Conium maculatum</i>       |                              |                             |

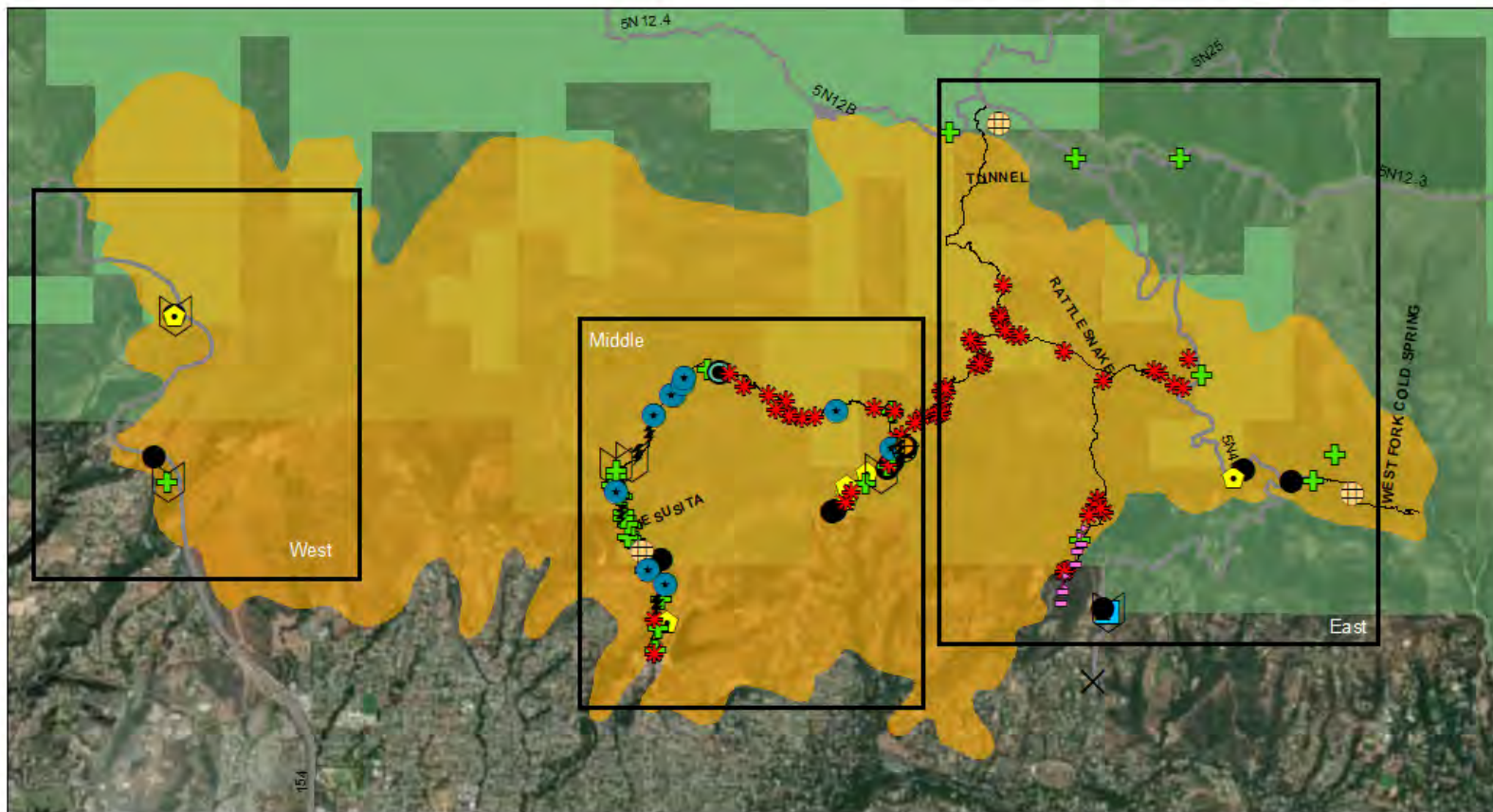
- |                    |                         |
|--------------------|-------------------------|
| <i>Salsola</i> sp. | <i>Spartium junceum</i> |
| <i>Tamarix</i> sp. | Unknown Tree            |
| <i>Vinca major</i> | <i>Vinca</i> sp.        |

- |                                |
|--------------------------------|
| Roads                          |
| Trails                         |
| Fire breaks                    |
| Jesusita Fire scar             |
| Administrative LPNF boundary   |
| Ownership, USDA Forest Service |



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



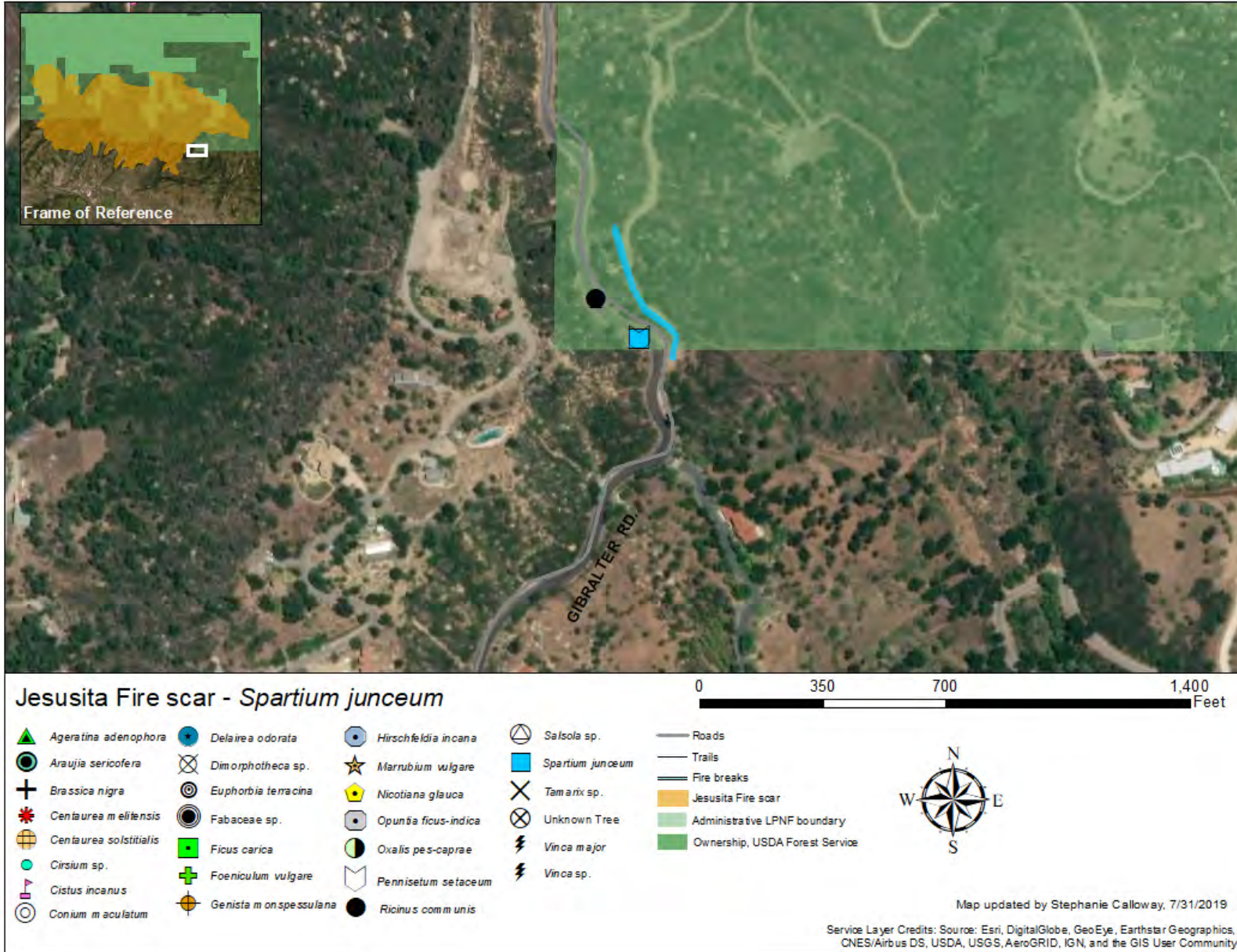
Jesusita Fire scar - *Foeniculum vulgare*, *Pennisetum setaceum*, *Ricinus communis* and *Nicotiana glauca*

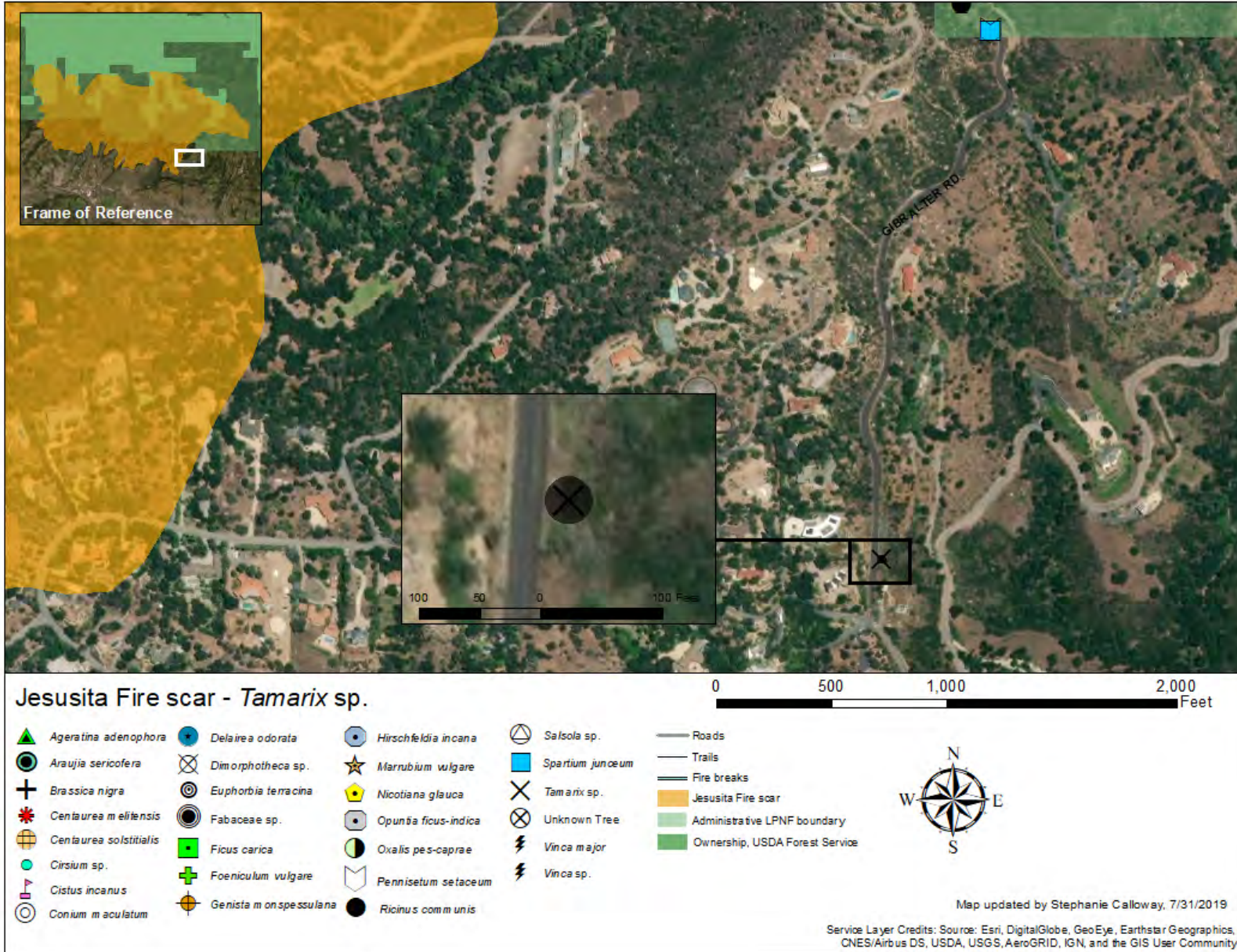
- |                               |                              |                             |                         |                                |
|-------------------------------|------------------------------|-----------------------------|-------------------------|--------------------------------|
| <i>Ageratina adenophora</i>   | <i>Delairea odorata</i>      | <i>Hirschfeldia incana</i>  | <i>Salsola</i> sp.      | Roads                          |
| <i>Araujia sericifera</i>     | <i>Dimorphotheca</i> sp.     | <i>Marrubium vulgare</i>    | <i>Spartium junceum</i> | Trails                         |
| <i>Brassica nigra</i>         | <i>Euphorbia terracina</i>   | <i>Nicotiana glauca</i>     | <i>Tamarix</i> sp.      | Fire breaks                    |
| <i>Centaurea melitensis</i>   | Fabaceae sp.                 | <i>Opuntia ficus-indica</i> | Unknown Tree            | Jesusita Fire scar             |
| <i>Centaurea solstitialis</i> | <i>Ficus carica</i>          | <i>Oxalis pes-caprae</i>    | <i>Vinca major</i>      | Administrative LPNF boundary   |
| <i>Cirsium</i> sp.            | <i>Foeniculum vulgare</i>    | <i>Pennisetum setaceum</i>  | <i>Vinca</i> sp.        | Ownership, USDA Forest Service |
| <i>Cistus incanus</i>         | <i>Genista monspessulana</i> | <i>Ricinus communis</i>     |                         |                                |
| <i>Conium maculatum</i>       |                              |                             |                         |                                |

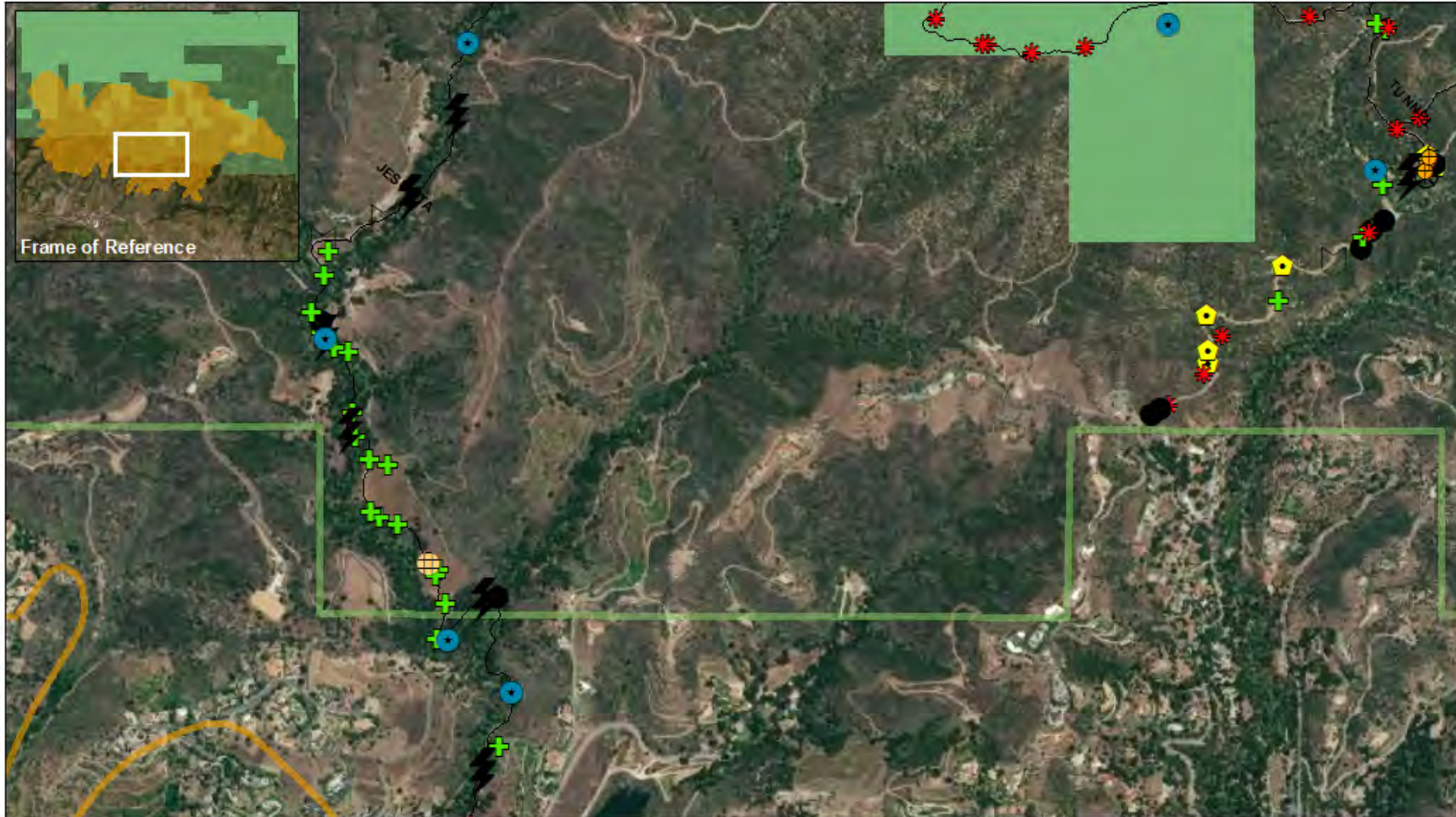


Map updated by Stephanie Calloway, 7/31/2019

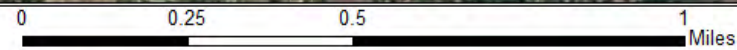
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### Jesusita Fire scar - *Vinca* sp.



- |                               |                              |                             |                         |
|-------------------------------|------------------------------|-----------------------------|-------------------------|
| <i>Ageratina adenophora</i>   | <i>Delairea odorata</i>      | <i>Hirschfeldia incana</i>  | <i>Salsola</i> sp.      |
| <i>Araujia sericifera</i>     | <i>Dimorphotheca</i> sp.     | <i>Marrubium vulgare</i>    | <i>Spartium junceum</i> |
| <i>Brassica nigra</i>         | <i>Euphorbia terracina</i>   | <i>Nicotiana glauca</i>     | <i>Tamarix</i> sp.      |
| <i>Centaurea melitensis</i>   | Fabaceae sp.                 | <i>Opuntia ficus-indica</i> | Unknown Tree            |
| <i>Centaurea solstitialis</i> | <i>Ficus carica</i>          | <i>Oxalis pes-caprae</i>    | <i>Vinca major</i>      |
| <i>Cirsium</i> sp.            | <i>Foeniculum vulgare</i>    | <i>Pennisetum setaceum</i>  | <i>Vinca</i> sp.        |
| <i>Cistus incanus</i>         | <i>Genista monspessulana</i> | <i>Ricinus communis</i>     |                         |
| <i>Conium maculatum</i>       |                              |                             |                         |



Map updated by Stephanie Calloway, 7/31/2019

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

