Capulin (Upper Mora/Adelante CFRP)
Field Inventory Summary v 3.0 / Jan 2020
New Mexico Forest and Watershed Restoration Institute

During fall 2018 and summer 2019, the New Mexico Forest and Watershed Restoration Institute (NMFWRI) inventory and monitoring crew established monitoring plots in the Capulin Watershed in the Santa Fe National Forest Management Unit. These plots were part of the landscape assessment for the Capulin unit of the Upper Mora CFRP, hereafter referred to as "Capulin." Capulin is located in Mora County near the community of Ledoux, NM, and is part of the 21,628-acre Upper Mora NEPA Planning Project proposed by the Adelante RC&D and other collaborators as a Collaborative Forest Restoration Program project (CFRP). From this 21,000 acre landscape assessment, 5,100 acres will be selected for a NEPA assessment. The proposal document "12-16 Capulin/Walker Flats NEPA Planning Projects (Planning-Revision)" contains some background information on the entire project area.

NMFWRI was provided spatial data on the following priority areas: Walker Flats (2,282 ac), Capulin A (2774 ac), Capulin B (3,607 ac), San Jose North (686 ac), and San Jose South/Rociada (399 ac). Partway through the project, these priority areas were revised to include only Walker Flats and Capulin A. This report covers the monitoring done in the Capulin A area. See Figure 1.

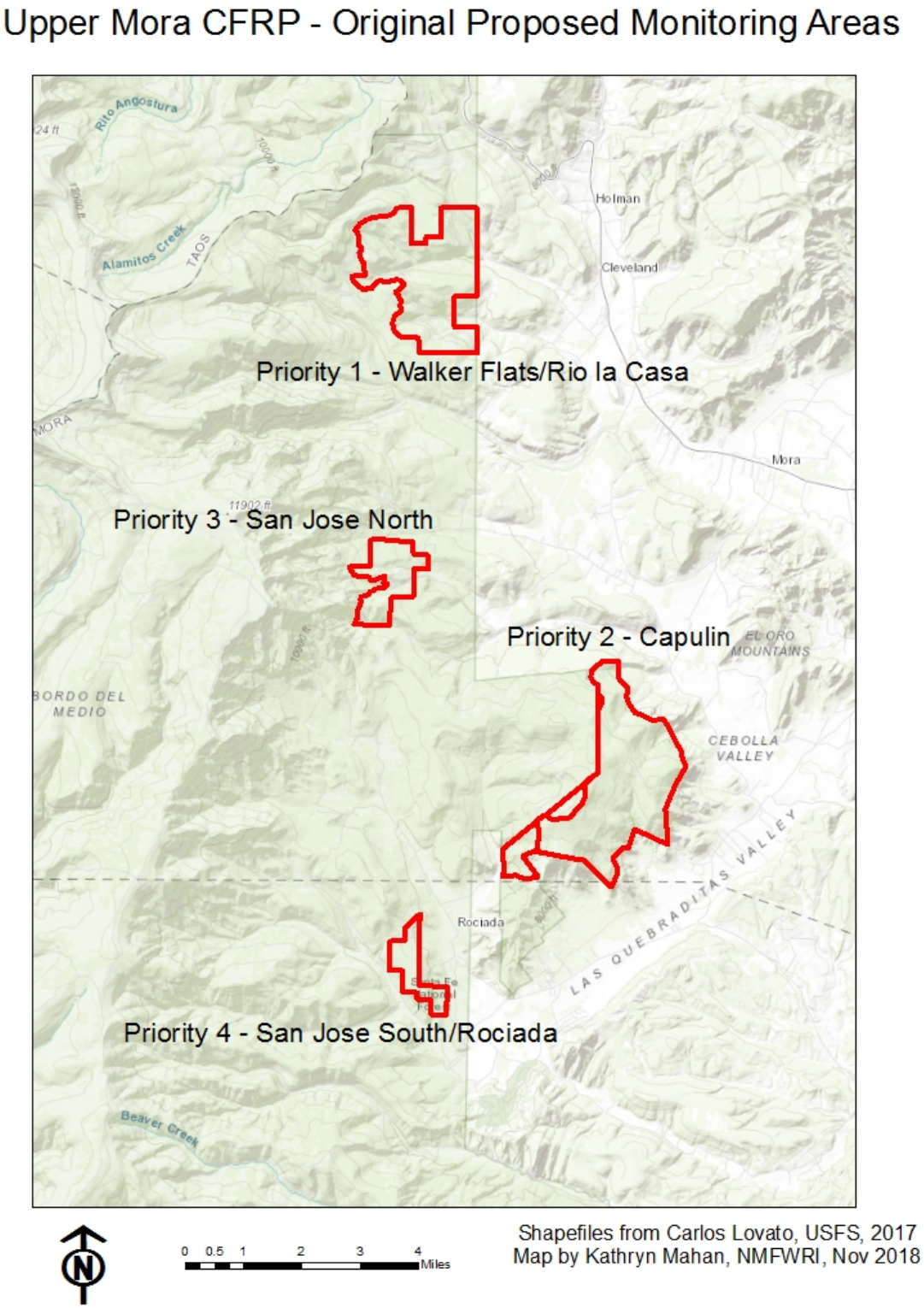


Figure 1. Upper Mora CFRP: original four monitoring units proposed to NMFWRI by the SFNF.
Note: The Capulin boundary shown in this map is the amended Capulin 2A boundary.

Within this 3,135 acre area, the NMFWRI crew monitored only 11 of 202 planned plots due to budget constraints. Monitoring used the Department of Interior's FEAT/FIREMON Integrated (FFI) sampling protocols and 1/10th acre fixed plots to assess tree size (diameter and height) and density (trees/acre). A nested sub-plot of 1/100th acre was used to estimate understory and ground cover in all years. Photo points were taken at each plot. Surface fuels were measured using Brown's transects. More detail on the monitoring protocol used can be found in the NMFWRI-provided report for the Walker Flats area on the NMFWRI website (nmfwri.org), or upon request. The location of the plots was based on a stratified random sampling design which is discussed further in a subsequent section.

Because budget and time constraints did not allow the NMFWRI crew to complete the number of planned plots, a crew from the Pecos-Las Vegas Ranger District of the Santa Fe National Forest (hereafter abbreviated as "USFS crew") provided assistance and monitored 111 plots using variable-radius plot protocols with a 20 basal area factor prism.

Under both protocols, only trees 5" dbh and over were analyzed.

See Figure 2 for planned plots, Figure 3 for plots completed, and Figure 4 for an overlay of both.

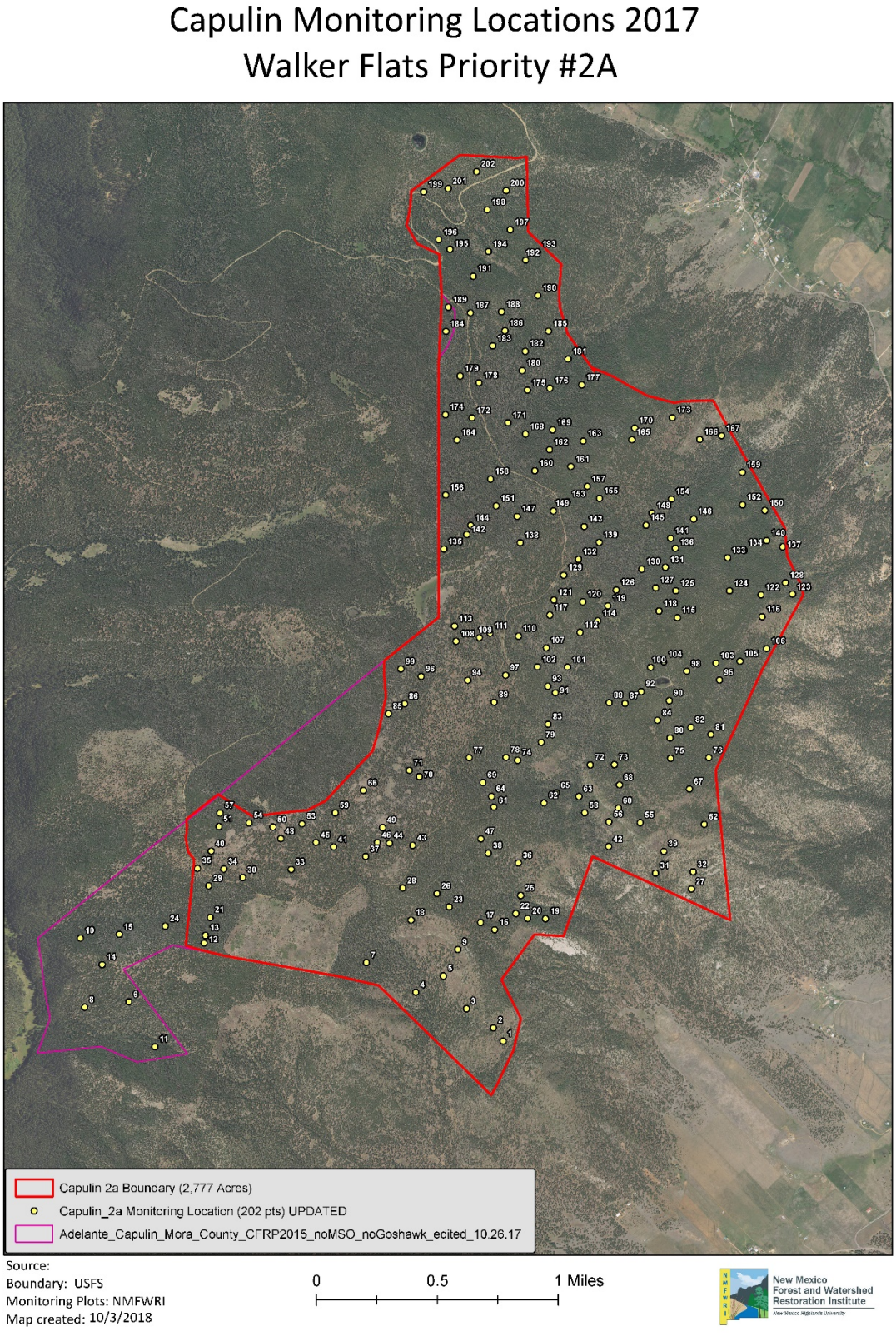


Figure 2. Planned plots in Capulin Area 2A.

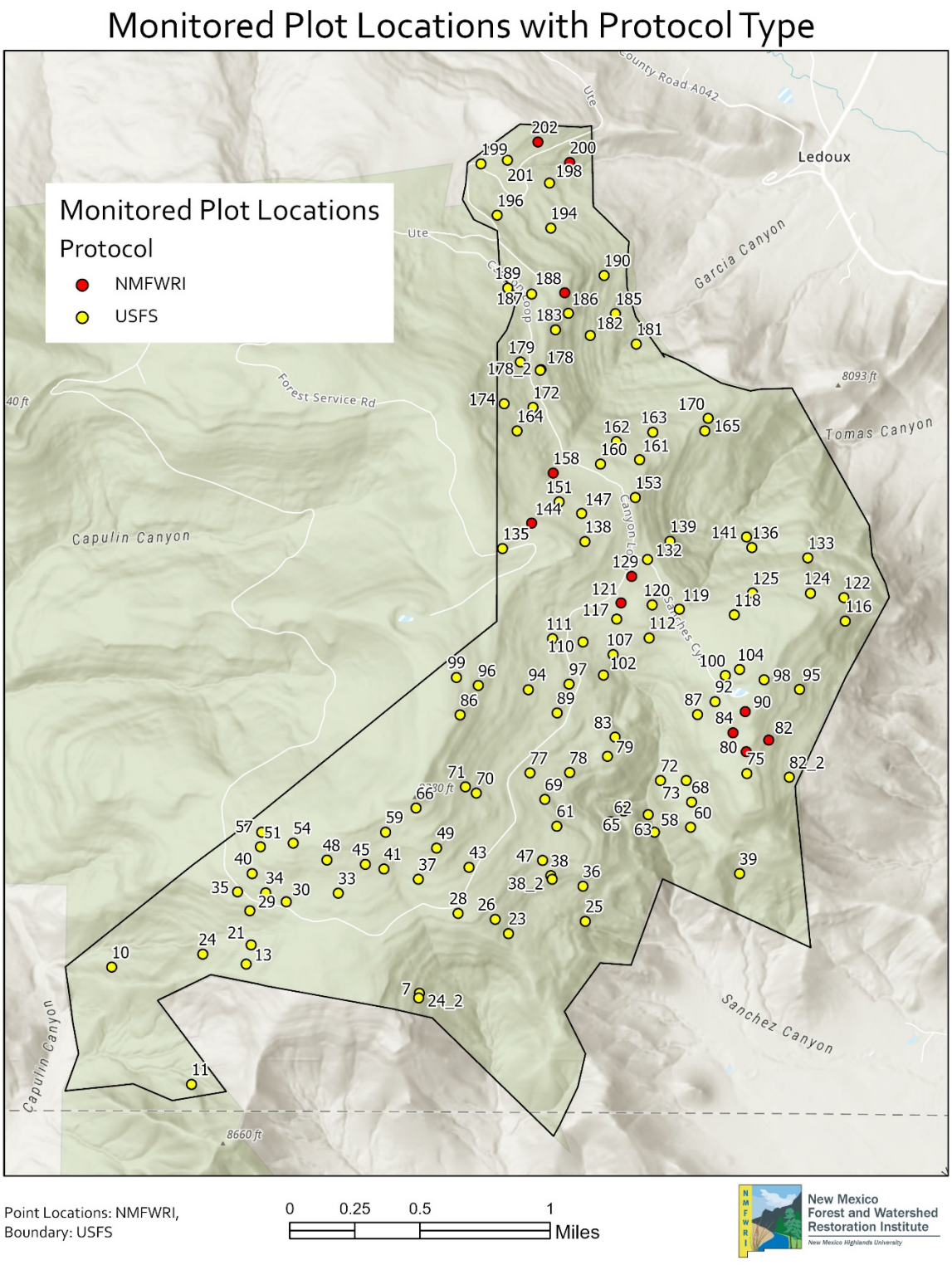


Figure 3. Plots at Capulin completed by USFS and FWRI crews.

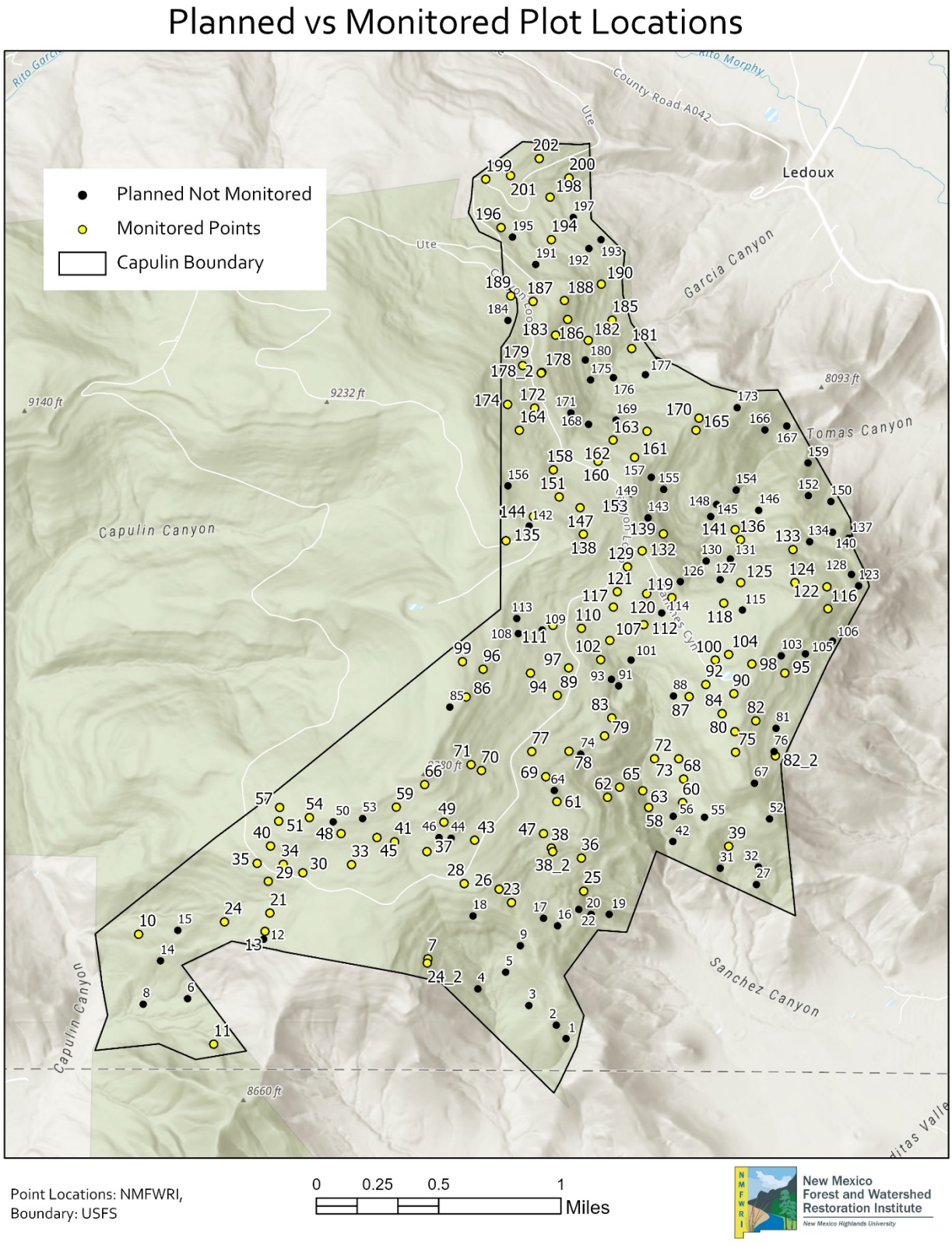


Figure 4. Planned and completed plots at Capulin.

Disclaimer

NMFWRI provides this report and the data collected with the disclaimer that the information contained in these data is dynamic and may change over time. The data are not better than the original sources from which they were derived. It is the responsibility of the data user to use the data appropriately and within the limitations of monitoring data in general, and these data in particular. NMFWRI gives no warranty, expressed or implied, as to the accuracy, reliability, or completeness of these data. These data and related graphics are not legal documents and are not intended to be used as such. This includes but is not limited to using these data as the primary basis for the development of thinning prescriptions or timber sales. NMFWRI shall not be held liable for improper or incorrect use of the data described and/or contained in this report.

The same warnings apply to the data collected by the USFS monitoring crew. In addition, twelve collected USFS plots had duplicate labels. NMFWRI worked with USFS to successfully correct six duplicates based on the spatial data (latitude and longitude); a log of corrections is available upon request. Information on the other six duplicates (for which tree data is included in analysis but spatial data is unconfirmed) can be found in Appendix I.

Analysis was also done according to our standard protocols. Note that the values reported in the tables are expressed on a per acre basis, but represent only area actually sampled. We do not scale up these values to calculate volume of wood over the project area, and warn readers of this report that they are not intended for that purpose. The accompanying tables show summaries of our data, and some differences are discussed below; however, differences that seem apparent here may not stand up to rigorous statistical tests. For some estimates, the standard deviation exceeds the mean (i.e., the coefficient of variation is greater than 100 percent), and sampling errors for some estimates exceed 100 percent. Therefore, data should be used and results interpreted with appropriate caution.

As noted above, the Forest Service crew assisted in plot measurements because time and budget did not allow NMFWRI to complete the number of plots planned. The USFS crew's standard protocol differs from the standard NMFWRI protocol, so the two plot groups are kept separate in analysis. To test for a potential major impact of using two different protocols to assess the same project, we used the LANDFIRE Existing Vegetation Type to model the plots in order to check whether the dominant forest types could be expected to be different for each group of plots. This model showed that NMFWRI-monitored plots and USFS-monitored plots could be expected to be similar. On-the-ground data from both protocols produced averages (pg 19, Summary table) that are similar, suggesting that the protocol used had no major impact on data. The predictable exception here is regeneration measurements which are typically underestimated in variable-radius plot protocols. For more details on the LANDFIRE data, see Appendix II.

Plot Distribution Rationale

Plots were established using a random point location with project-specific boundaries e.g. stand boundaries, treatment areas, vegetation types, etc. For the Upper Mora CFRP Project, the following distribution rationale (detailed rationale provided to USFS) was used based on stand boundaries provided by the USFS:

For Stands 1-50 acres, 1 plot per 10 acres (USFS standard)
For Stands 51+ acres:
51-70 ac --- 5 plots
71-90 ac --- 6 plots
91-110 ac --- 7 plots
111-200 ac --- 8-9 plots
201-400 ac --- 10 plots

Within the Capulin project area, monitoring plot locations were generated using a stratified random sampling design. Stand boundaries were provided by the USFS and were used to determine the number of stands per acre. Acreages were calculated within the stand boundaries and this value was used to determine the number of monitoring plots according to the rationale above. Using the GIS software package, ESRI ArcMap, a specified number of random points were generated based on the stand boundary acreage. The command that was used in ArcMaps was 'Create Random Points'. The stand boundary shapefile was used to constrain the location of and number of points. To prevent points from being too close together, points were generated with a minimum 100 meters distance between points.

Plot Selection Rationale

Plot selection rationale for NMFWRI-monitored plots was based on accessibility. See Figure 5 and Figure 6 for road and slope maps for the project area. As the photos below document, travel to and within the unit was a challenge during and after wet weather and wind events.

Selection rationale for the subset of plots monitored by USFS is not known.

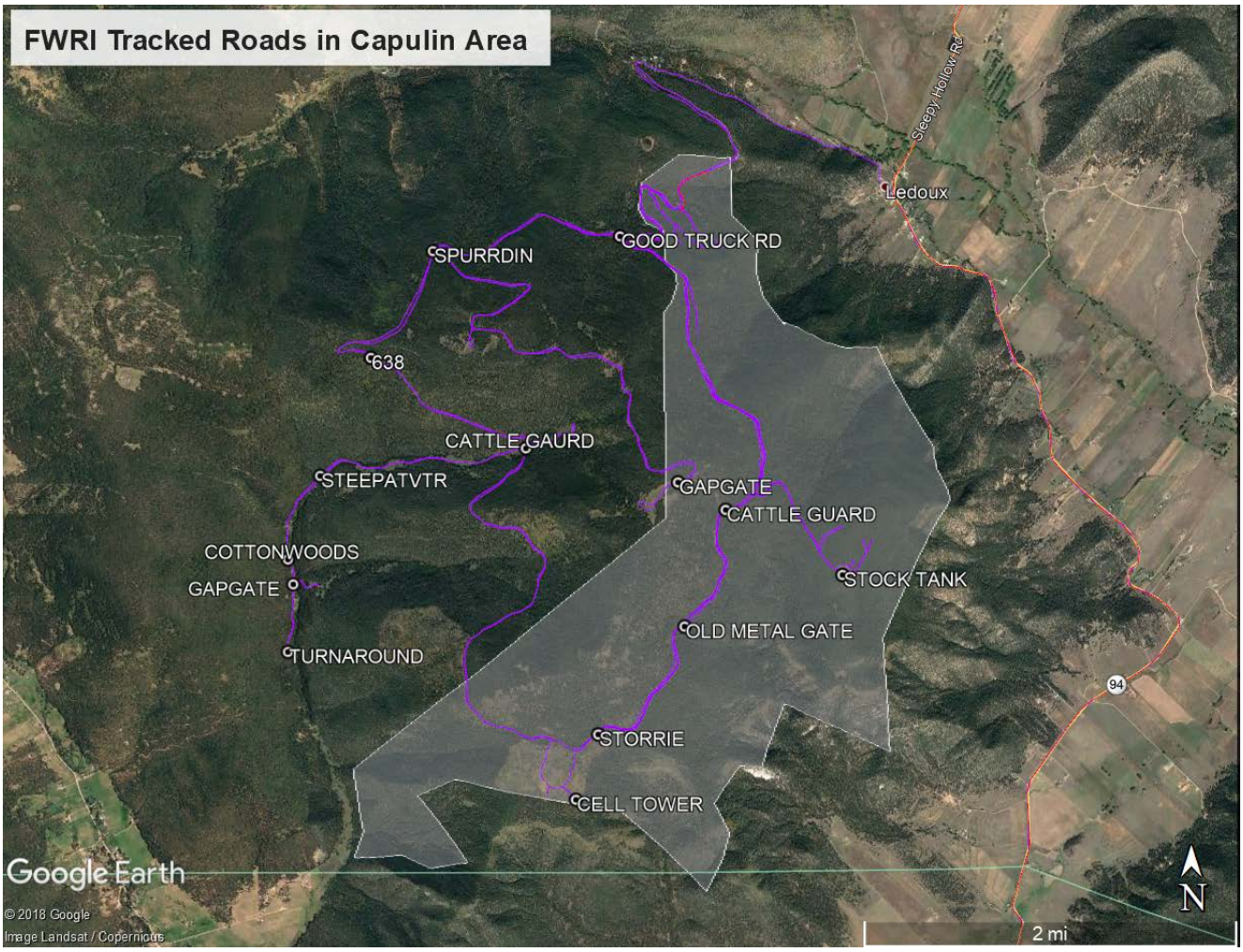


Figure 5. Roads in Capulin project area.

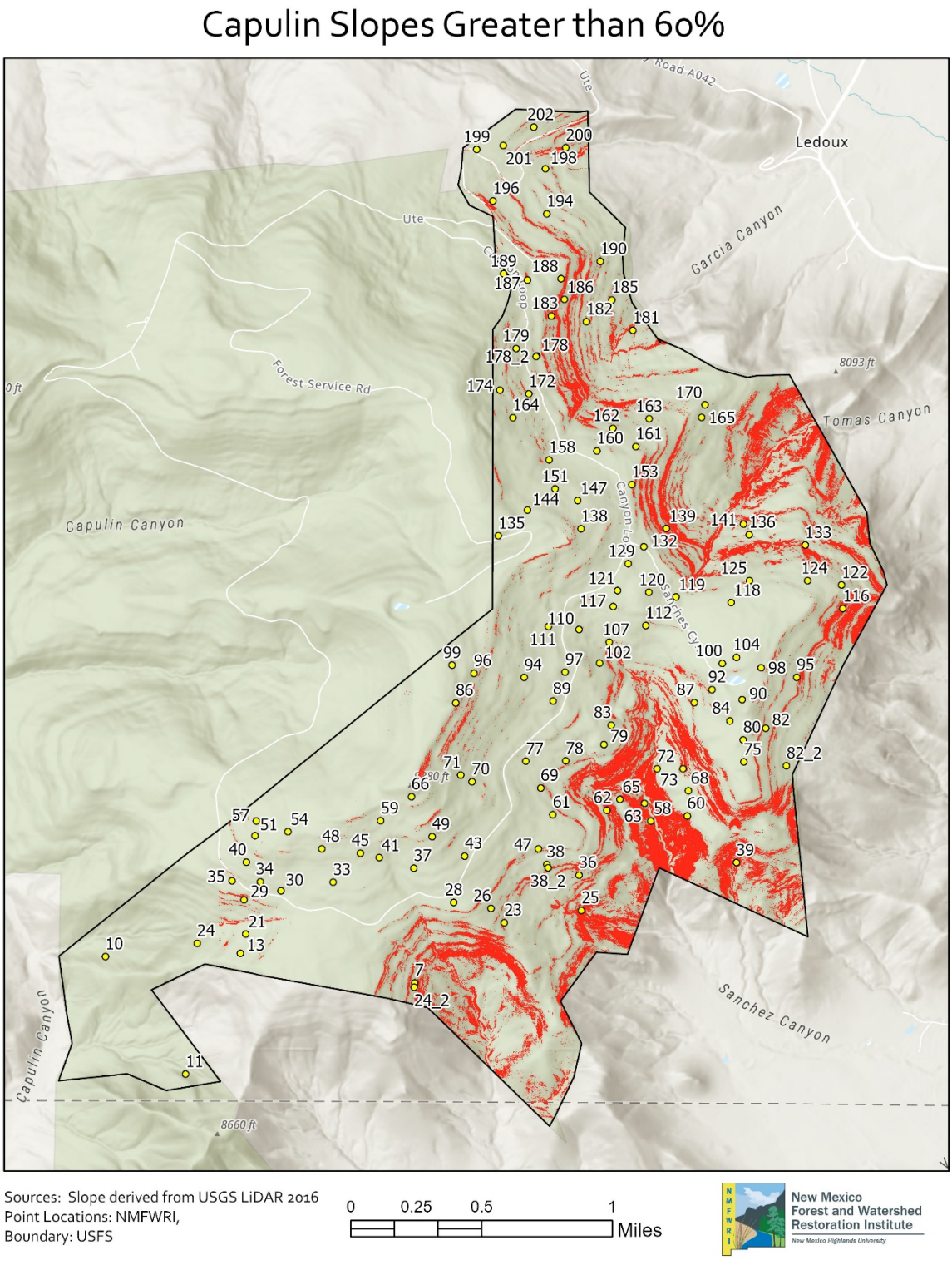


Figure 6. Slope map for Capulin project area based on LiDAR.

Monitoring Results Summary – NMFWRI Data

Of the plots collected by NMFWRI, the average slope was 22 percent, with a predominantly Southern aspect. As the slope map in Figure 6 shows, slopes in the project area may exceed 60 percent. In addition, uneven ground means both aspect and slope vary even within a plot.

Aspect (cardinal direction)		
Direction	**Count**	**Percent of plots with this aspect**
N	2	18%
E	4	36%
S	5	45%
W	0	0.0%

Slope (in %)	
Range of slope	
Max	58
Min	8.0
Mean slope	22
Median slope	20
Mode slope	15

Overstory canopy cover averaged 71 percent. Ground cover was predominantly litter.

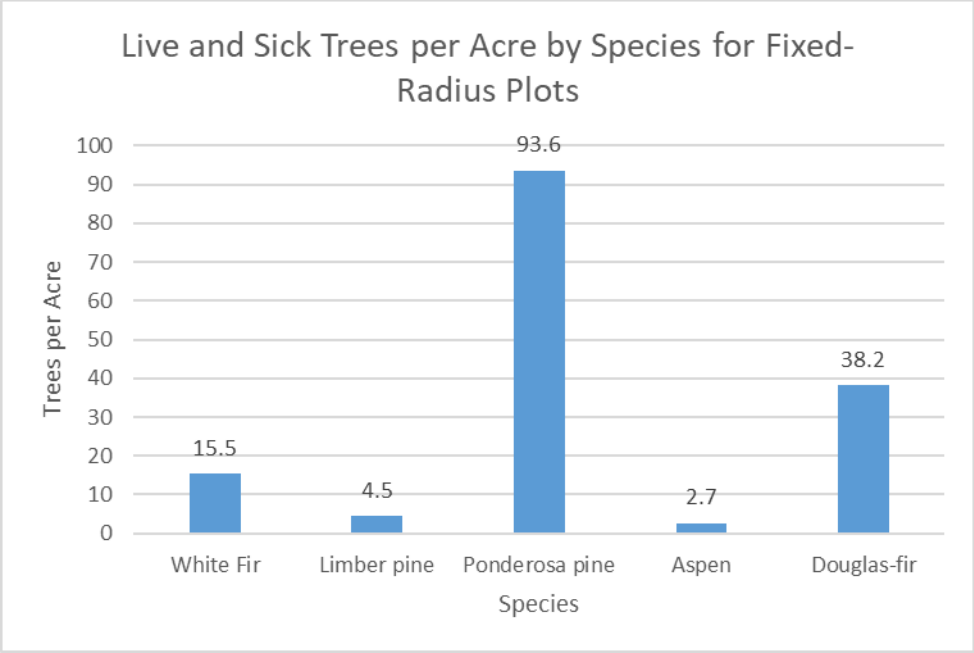
	Aerial cover			
Tree Canopy	**Seedlings/Saplings**	**Shrub cover**	**Graminoid Cover**	**Forb Cover**
71%	11%	15%	8.4%	2.7%

Ground cover					
Plant Basal	**Bole**	**Litter**	**Bare Soil**	**Rock**	**Gravel**
7.3%	4.1%	70%	1.5%	17%	0.73%

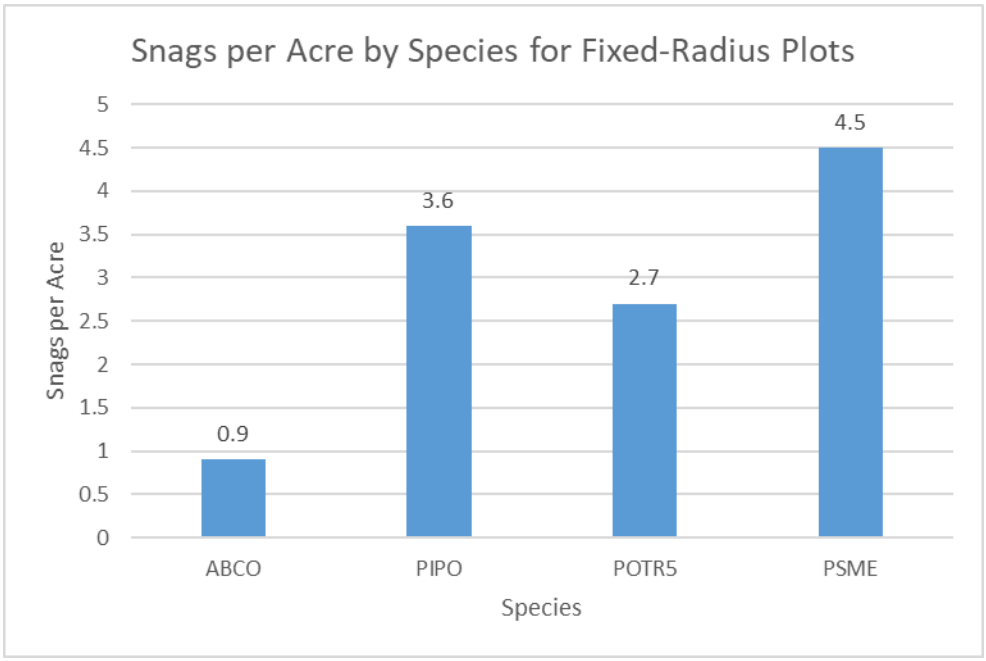
Stand characteristics are presented in the table and graphs below.

Metric for FWRI fixed-radius plots	**Value**
Trees per Acre	155 tpa
Snags per Acre	11.8 pa
Basal Area per Acre	95.9 sqft/ac
QMD	10.6 in
Height	51.2 ft
Live Crown Base Height	20.4 ft

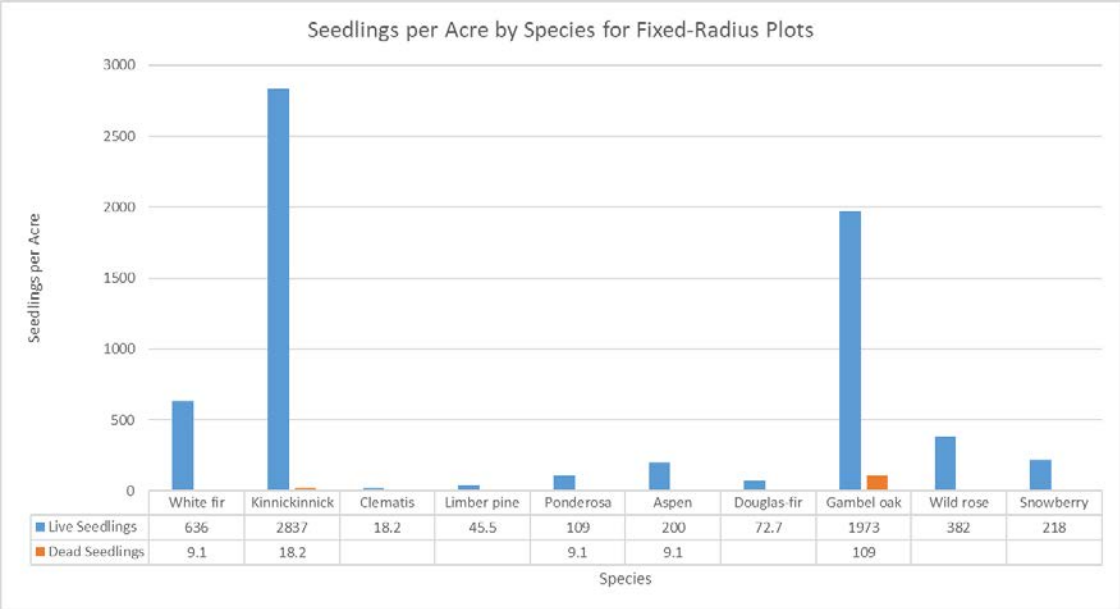
Live and sick trees per acre averaged 155. As a reminder, “trees” for these plots were individuals over 4.99 inches at DBH. Of the live trees, 60% were ponderosa pine, 25% were Douglas-fir, 10% were white fir, 2.9% were limber pine, and 1.8% aspen. The sick tree class was dominated by ponderosa pine, which were recorded as having mistletoe.



Snags were recorded at an incidence of 12 per acre. These were dominated by Douglas-fir, ponderosa pine and aspen. A stock table is presented on page 15, followed by sample plot photos.

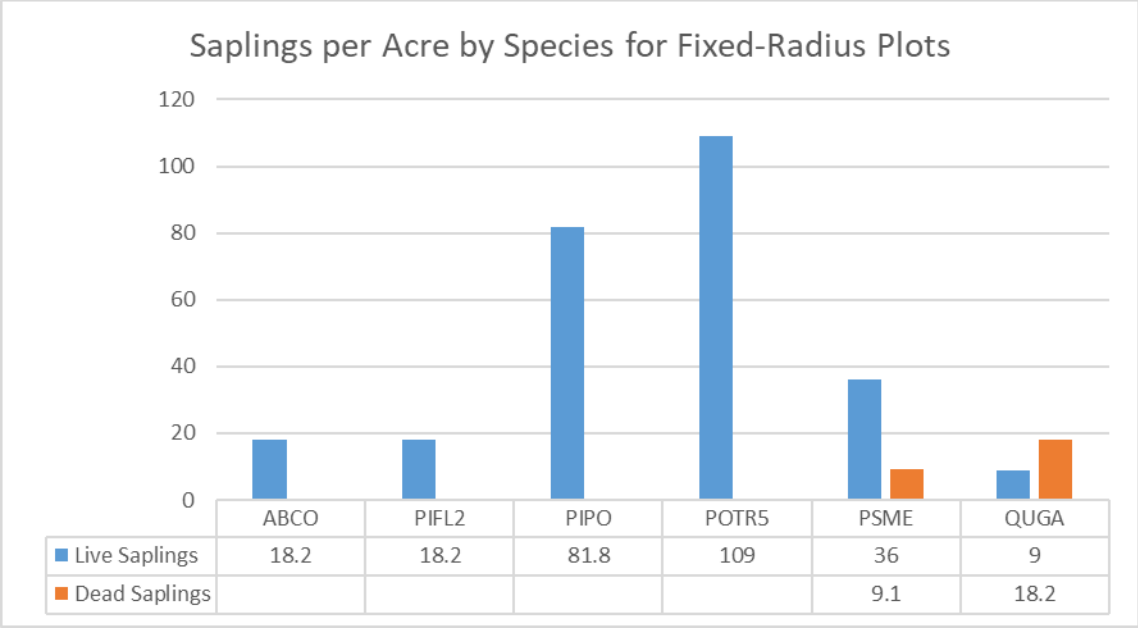


6400 live seedlings, 155 dead seedlings, 270 live saplings and 14 dead saplings per acre were recorded on these plots. Seedlings were dominated by kinnickinnick, Gambel oak, white fir, wild rose, snowberry and aspen.



	White fir	Kinnickinnick	Clematis	Limber pine	Ponderosa	Aspen	Douglas-fir	Gambel oak	Wild rose	Snowberry
Live Seedlings	636	2837	18.2	45.5	109	200	72.7	1973	382	218
Dead Seedlings	9.1	18.2			9.1	9.1		109		

Saplings were dominated by aspen, ponderosa pine, Douglas-fir, white fir and limber pine.



	ABCO	PIFL2	PIPO	POTR5	PSME	QUGA
Live Saplings	18.2	18.2	81.8	109	36	9
Dead Saplings					9.1	18.2

Surface fuels were also recorded on these plots with the following results:

Metric	Value
1-hour	0.08 tons/ac
10-hour	1.1 tons/ac
100-hour	1.8 tons/ac
All fine woody debris (1 to 100 hr)	**2.98 tons/ac**
1000-hour sound (class 1, 2, 3)	2.93 tons/ac
1000-hour rotten (class 4, 5)	4.05 tons/ac
All down woody debris (1 to 1000 hr)	**9.96 tons/ac**
Duff	9.76 tons/ac
Duff depth	0.98 inches deep
Litter	7.26 tons/ac
Litter depth	1.45 inches deep
Total fuelbed depth	**2.43 inches**
Total fuelbed	**17.02 tons/ac**
Total surface fuels	**26.98 tons/ac**

Table 1. Stand table from NMFWRI-Monitored Plots at Capulin.

Capulin		Saplings			Pole			Mature Trees						***Total by Species & Covertype***	***%Species for all G-Stock***
Diameter Class		***0***	***2***	***4***	***6***	***8***	***10***	***12***	***14***	***16***	***18***	***20***	***22***		
ABCO White fir	COUNT	0	0	0	4	5	2	3	1	0	2	0	0	***17.00***	
	TPA	0.00	0.00	0.00	3.64	4.55	1.82	2.73	0.91	0.00	1.82	0.00	0.00	***15.45***	***10.00%***
	BA/AC	0.00	0.00	0.00	0.72	1.75	1.05	1.99	0.84	0.00	3.14	0.00	0.00	***9.49***	***9.89%***
	AVE HT. (HL)	0.00	0.00	0.00	31.92	46.73	62.57	52.92	65.00	0.00	79.46	0.00	0.00		
PIPO Ponderosa pine	COUNT	0	0	0	16	23	20	24	9	8	2	1	0	***103.00***	
	TPA	0.00	0.00	0.00	14.55	20.91	18.18	21.82	8.18	7.27	1.82	0.91	0.00	***93.64***	***60.59%***
	BA/AC	0.00	0.00	0.00	2.84	7.03	9.77	16.79	8.91	9.79	2.95	1.85	0.00	***59.92***	***62.47%***
	AVE HT. (HL)	0.00	0.00	0.00	35.20	45.19	48.78	54.15	59.05	72.34	57.67	65.00	0.00		
PSME Douglas-fir	COUNT	0	0	0	12	15	1	5	2	5	0	0	2	***42.00***	
	TPA	0.00	0.00	0.00	10.91	13.64	0.91	4.55	1.82	4.55	0.00	0.00	1.82	***38.18***	***24.71%***
	BA/AC	0.00	0.00	0.00	2.03	4.87	0.41	3.69	2.03	6.28	0.00	0.00	4.69	***23.99***	***25.01%***
	AVE HT. (HL)	0.00	0.00	0.00	30.91	49.10	68.00	74.63	81.52	88.46	0.00	0.00	89.50		
PIFL2 Limber pine	COUNT	0	0	0	3	1	0	1	0	0	0	0	0	***5.00***	
	TPA	0.00	0.00	0.00	2.73	0.91	0.00	0.91	0.00	0.00	0.00	0.00	0.00	***4.55***	***2.94%***
	BA/AC	0.00	0.00	0.00	0.51	0.32	0.00	0.60	0.00	0.00	0.00	0.00	0.00	***1.43***	***1.49%***
	AVE HT. (HL)	0.00	0.00	0.00	30.79	34.00	0.00	47.00	0.00	0.00	0.00	0.00	0.00		
POTR5 Aspen	COUNT	0	0	0	1	1	1	0	0	0	0	0	0	***3.00***	
	TPA	0.00	0.00	0.00	0.91	0.91	0.91	0.00	0.00	0.00	0.00	0.00	0.00	***2.73***	***1.76%***
	BA/AC	0.00	0.00	0.00	0.20	0.29	0.59	0.00	0.00	0.00	0.00	0.00	0.00	***1.09***	***1.13%***
	AVE HT. (HL)	0.00	0.00	0.00	50.00	51.00	76.00	0.00	0.00	0.00	0.00	0.00	0.00		
Forestland Species Sub-total	***COUNT***	***0***	***0***	***0***	***36***	***45***	***24***	***33***	***12***	***13***	***4***	***1***	***2***	***170.00***	
	TPA	***0.00***	***0.00***	***0.00***	***32.73***	***40.91***	***21.82***	***30.00***	***10.91***	***11.82***	***3.64***	***0.91***	***1.82***	***154.55***	***100.00%***
	BA/AC	***0.00***	***0.00***	***0.00***	***6.30***	***14.26***	***11.81***	***23.08***	***11.77***	***16.06***	***6.09***	***1.85***	***4.69***	***95.92***	***100.00%***
	AVE HT. (HL)	***0.00***	***0.00***	***0.00***	***34***	***47***	***52***	***57***	***63***	***79***	***69***	***65***	***90***		
Summary by Size Class for Forestland Species	***TPA***		***0.00***			***95.45***				***59.09***				***154.55***	
	TPA %		***0.00%***			***61.76%***				***38.24%***				***100.00%***	
	BA/AC		***0.00***			***32.37***				***63.54***				***95.92***	
	BA/AC %		***0.00%***			***33.75%***				***66.25%***				***100.00%***	
	QUADRATIC MEAN DIA.					***7.89***				***14.04***				***10.67***	
	AVE HT. (HL)		***0.00***			***46***				***67***				***60***	

Sample Plot Photos from NMFWRI-monitored plots at Capulin

CAP_84_S (south from center)

CAP_82_W (west from center)

CAP_90_N (north from center)

CAP_129_C (south from 75 ft north of center)

CAP_158_E (east from center)

CAP_200_S (south from center)

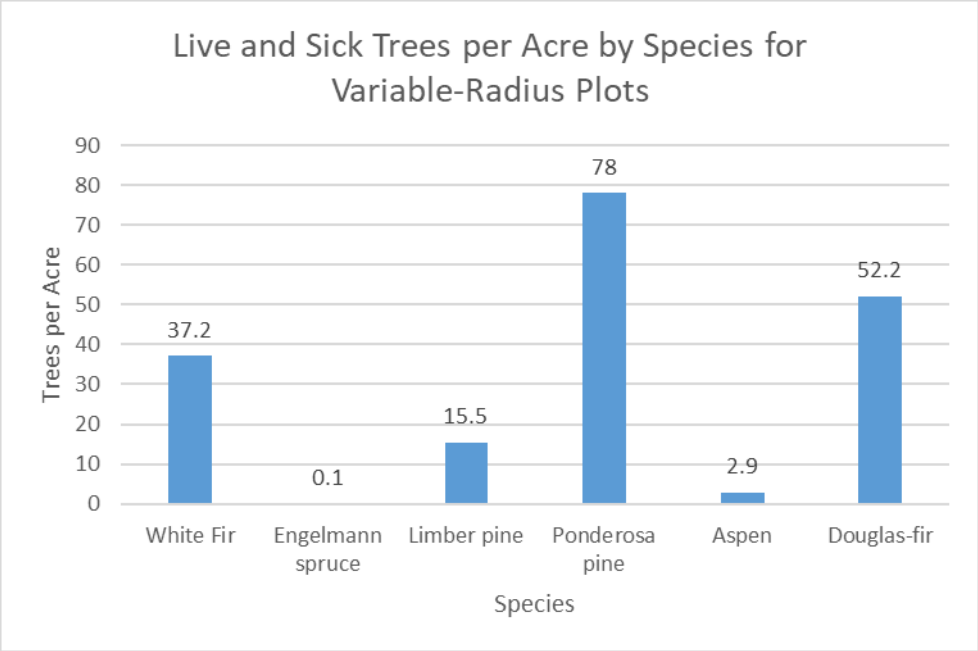
Monitoring Results Summary – USFS Data

Slope and aspect were not recorded on USFS plots. Overstory canopy cover averaged 51.5%; ground cover was not recorded.

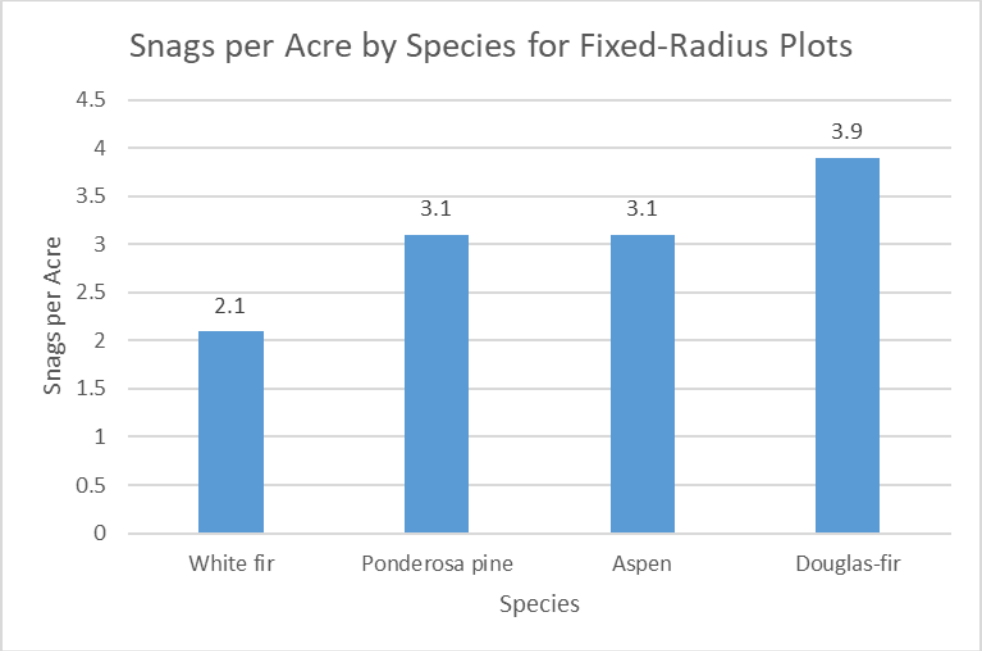
Stand characteristics are presented in the table and charts below.

Metric for USFS 20 BAF plots	Value
Trees per Acre	185.9 tpa
Snags per Acre	12.2 pa
Basal Area per Acre	100 sqft/ac
QMD	11.2 in
Height	59.3 ft
Live Crown Base Height	26.5 ft

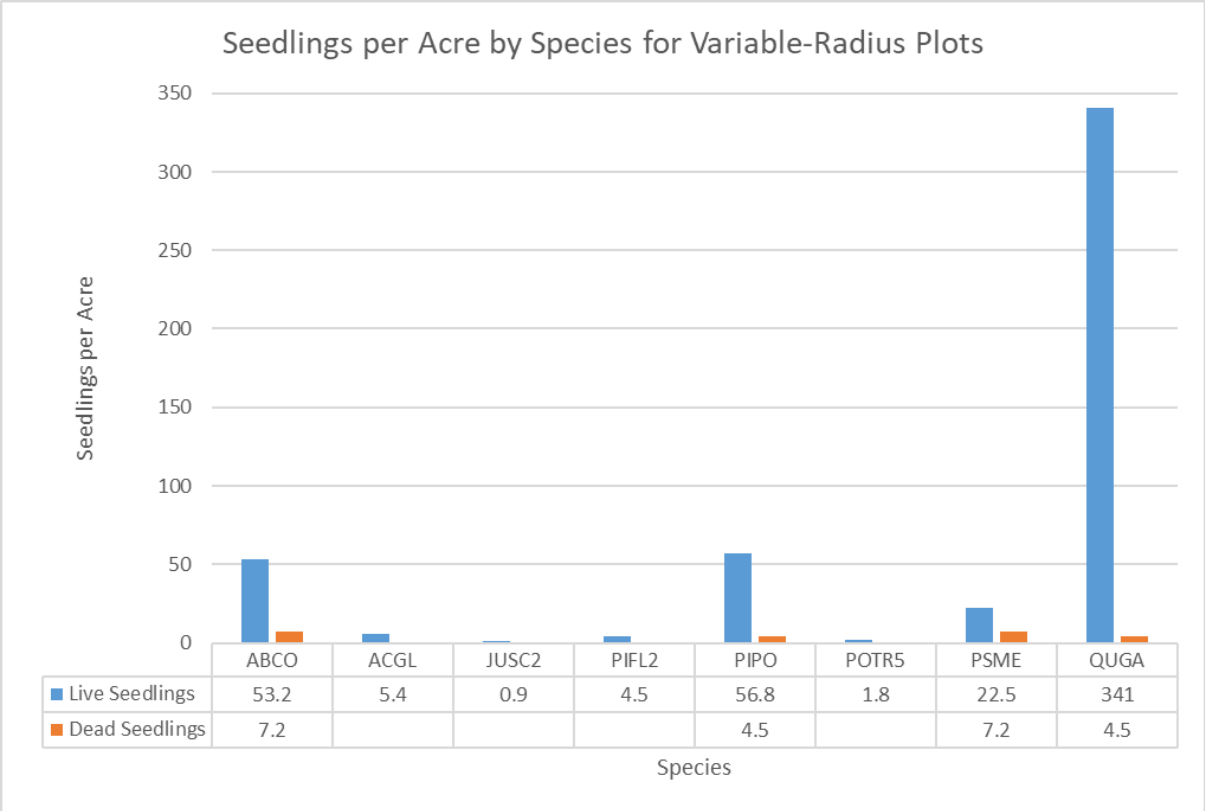
The average trees per acre on these plots was 186 as well as 12 snags per acre. Of the live and sick trees, 44% were ponderosa pine, 29% were Douglas-fir, 21% were white fir, and 9% limber pine. The sick tree class was dominated by ponderosa pine, which were recorded as having mistletoe.



The on-plot snags were dominated by Douglas-fir, ponderosa pine, aspen and white fir.



500 live seedlings and 24 dead seedlings per acre were recorded on these plots. Seedlings were dominated by Gambel oak, ponderosa pine, white fir and Douglas-fir.



No saplings were found on plots.
Surface fuels were not recorded.

Summary

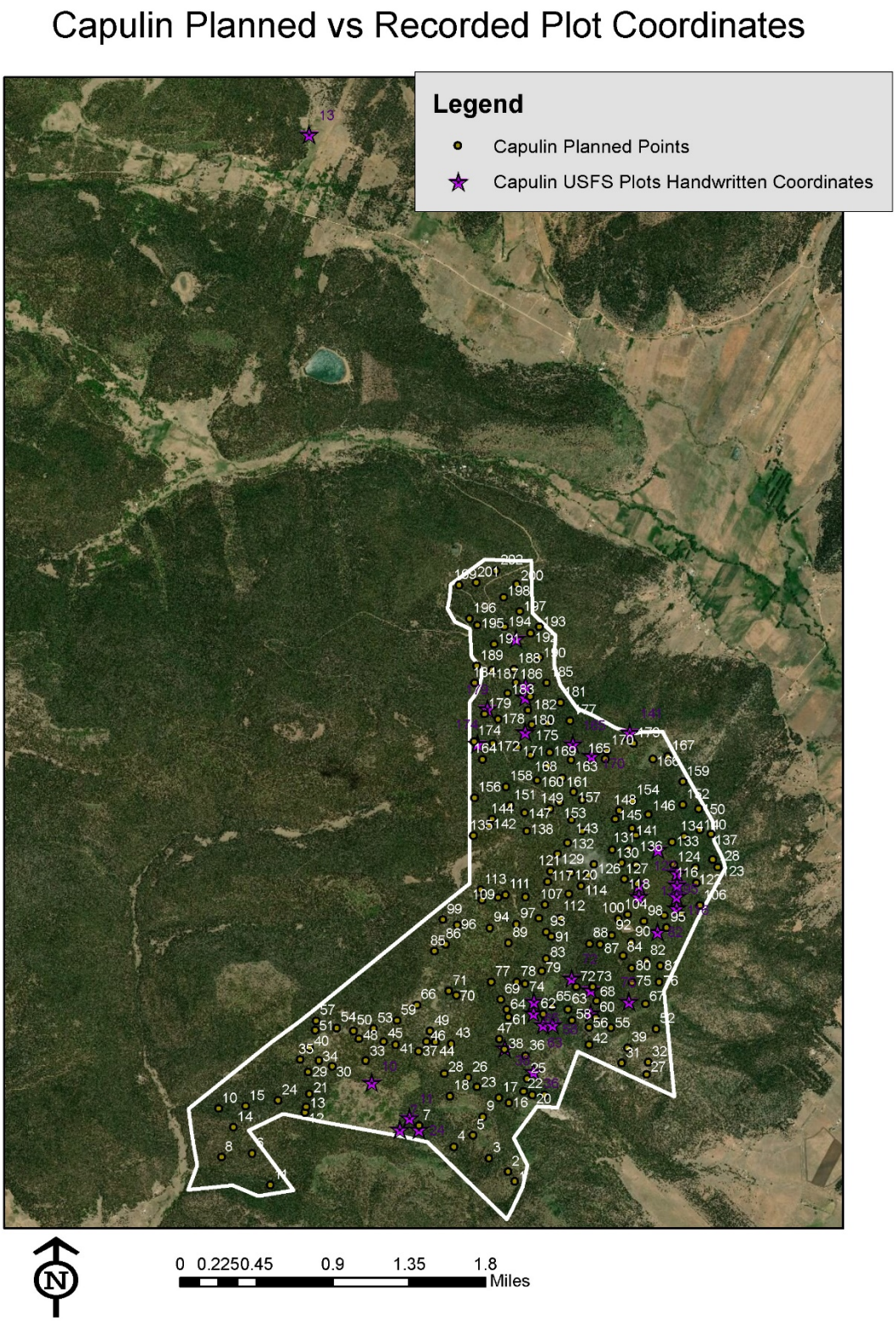
Because the monitoring methods used by NMFWRI and USFS crews were different, the results are kept separate in the summary table, below.

Metric	NMFWRI Plots	USFS Plots
Overstory Canopy	71%	52%
TPA	155	186
Seedlings	6500	490
Saplings	270	n/a
Snags	12	12
Basal Area per Acre	96	100
QMD	10.6	11.2
Average Height	51	59
Live Crown Base Height	20	27

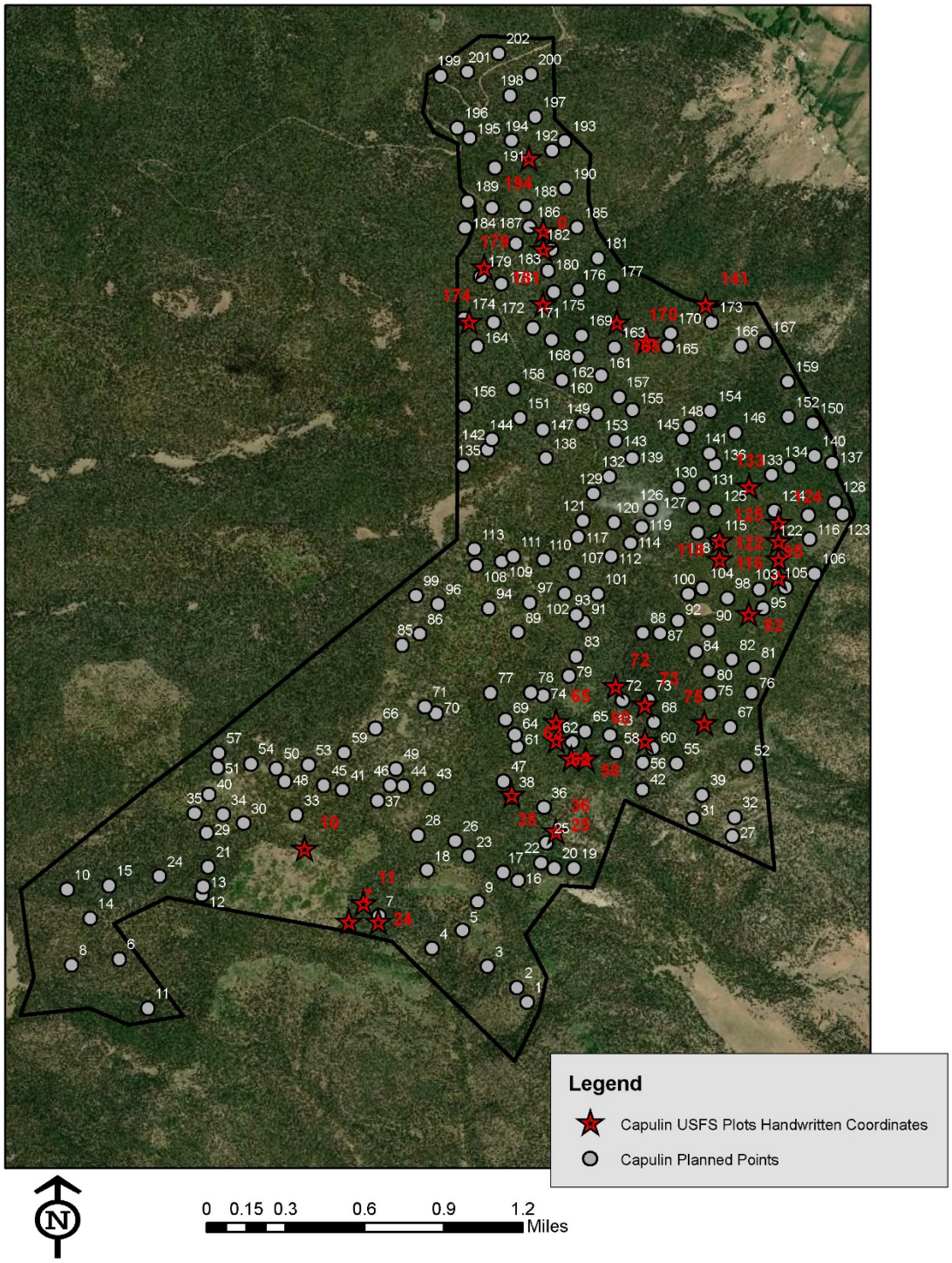
Values differed somewhat between NMFWRI and USFS plots, in particular for seedlings per acre. As mentioned earlier, variable-radius plots are known to underestimate regeneration. Other explanations for the differences could include a combination of the different monitoring protocols used by the crews, small sample size, and/or sampling errors. That said, the differences found are likely not significant for most metrics.

Overall basal area needs to be reduced. Developing and implementing restoration prescriptions for the Capulin unit should be possible. NMFWRI encourages the residual stand be left with groups and openings.

Appendix I: Duplicates



Capulin Planned vs Recorded Plot Coordinates (excluding plot 13)



Details on unresolved duplicate USFS plots with data included in silvicultural analysis:

CP_036	There were two CP_036s, **relabeled one as CP_039 but am not positive**
CP_082	Based on tree sheets, the plot 82 sent in the packet on 11.18.19 is not the same as the previous plot 82….**could be plot 95, or 103, or 98?**
CP_013	Based on tree sheets, the plot 13 sent in the packet on 11.18.19 IS the same as the previous plot 13, but the handwritten coordinates put it outside project boundaries
CP_024	Based on tree sheets, the plot 24 sent in the packet on 11.18.19 is not the same as the previous plot 24…**this is nearest to planned plot 7, but there is another plot 7 in the datasheet scans, so the correct ID is unknown**
CP_038	Based on tree sheets, the plot 38 sent in the packet on 11.18.19 is not the same as the previous plot 38 **It is closest to planned plot 38, but there was another plot 38 with correct coordinates and a different tree sheet; there are also plots 47 and 36**
CP_179	There are two plots 179 in the 11.18.19 packet, they are not the same based on tree sheets; **one is most likely plot 179 and the other is most likely plot 174, but not positive**

Appendix II: LANDFIRE Model for Collected Plots

To test for a potential major impact of using two different protocols to assess the same project, NMFWRI used the LANDFIRE Existing Vegetation Type to model the plots in order to check whether the dominant forest types could be expected to be different for each group of plots. Note that it is not appropriate to say that the LANDFIRE model for the NMFWRI plots was White Fir and the on-the-ground data shows something else. Rather, what's helpful is to note that the LANDFIRE model of the NMFWRI plots and the LANDFIRE model of the USFS plots were not radically different, suggesting that NMFWRI-monitored plots and USFS-monitored on-the-ground plots could be expected to be similar.

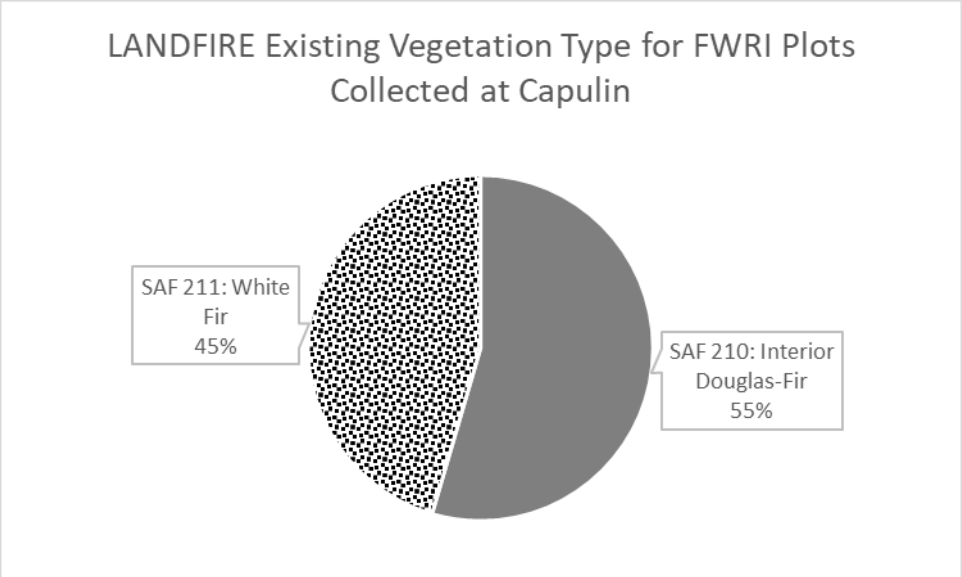


Figure 7. LANDFIRE Existing Vegetation Type for NMFWRI-monitored plots.

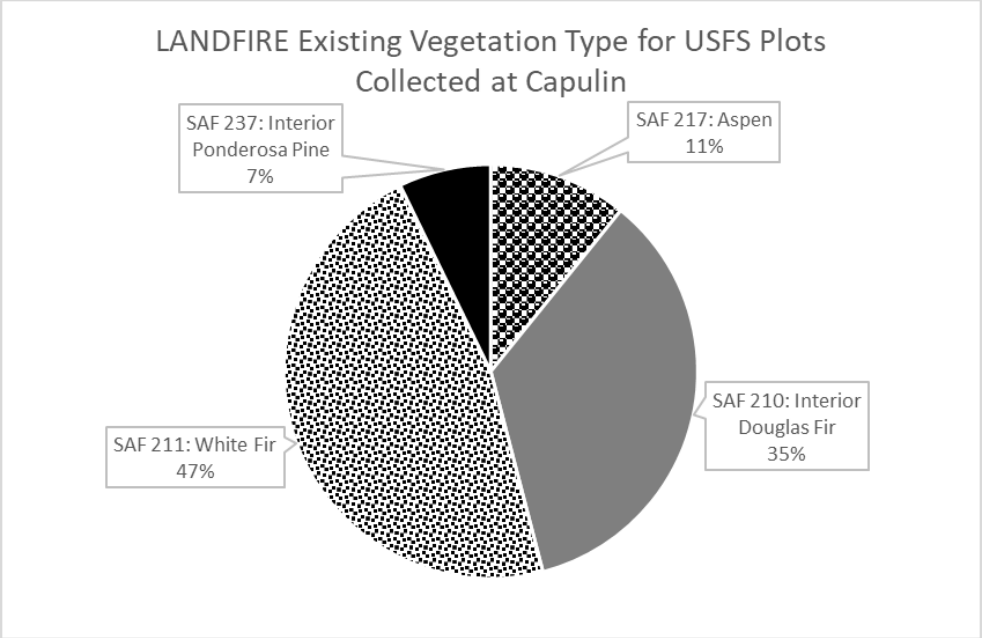


Figure 8. LANDFIRE Existing Vegetation Type for USFS-monitored plots.

2014 Landfire Existing Vegetation Type

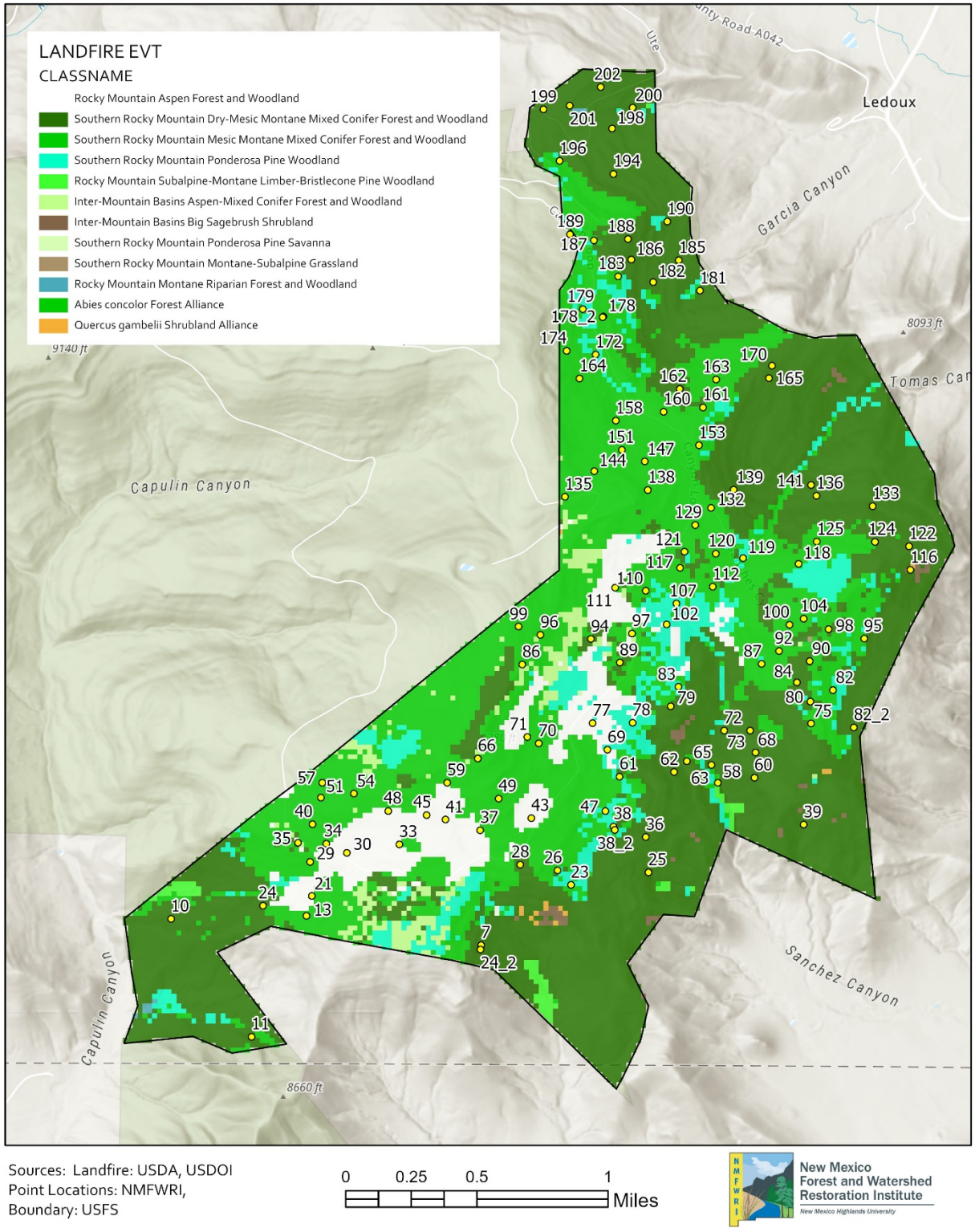


Figure 9. LANDFIRE Existing Vegetation Type for Capulin project area.