Mapping the Sandias

Jamey Browning

FOSM Board Member - Maps and Signage Chair Volunteer Agreement with Cibola NF – Work with Julie Padilla in SRD Recreation OpenStreetMap US Volunteer – Trails Stewardship Initiative in the Sandia Mountain Area









Updated 6/03/2025

Dedicated to my hiking buddy Blizzard 2011 to 2021



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Jamey Browning

FOSM Board member, Maps and Interpretive Signage Chair

- Retired Aerospace Engineer for GE Intelligent Platforms.
- Started volunteering for Albuquerque Open Space in 2014 and developed a love for hiking the Sandia Mountains. I enjoy finding and exploring new trails.
- Joined FOSM in 2018 and have been a regular member of the Monday trail maintenance crew since 2021.
- More than 2,800 miles of wandering the Sandia Mountain and seeking out new trails.
- Always enjoyed and collected maps. Started learning mapping in 2023. Took on-line training, bought books on making maps.

Hiking the Sandias

- I started hiking the Sandias in 2014
- I searched for and collected paper maps of the Sandias to help with finding hiking trails.
- The paper maps usually showed the main trails, but each map was a little different. No map had every trail.
- Eventually, I started using Gaia GPS because it seemed to have a more complete set of trails than any map I had used.
- I keep a log of each hike, Location, Length, and Altitude
 - I have hiked around 2,800 miles in the Sandias with 111 miles of altitude gain
 - About 1,400 miles were uphill which works out to an average 8% slope



Friends of the Sandia Mountains

Hypsometric Map of the Sandia Mountains

Cartography by the Browning Workshop © 2024





Friends of the Sandia Mountains

3D Hypsometric Map of the Sandia Mountains

Cartography by the Browning Workshop © 2024





La Luz Elevation Profile with Vegetative Zones



Thematic Flow Map of La Luz area trails.

- Theme: The relationship and movement between La Luz Trailhead, Sandia Crest, the Sandia Peak Aerial Tramway upper terminal, and the Sandia Peak Aerial Tramway lower terminal.
- Flow: What are the trail travel paths to common destinations for hikers using the La Luz area trail system.



Smartphone App Map Improvements

- Trail App Map Data Sources
- OpenStreetMap Trail Updates
- Trail App Map Data Types
- Authoritative vs. Unauthoritative Data
- Trail Issues Observed when Hiking the Sandias
- Improving Trail App Map Data
- OpenStreetMap Trails Stewardship Initiative

Map Data - Data Sources

- US Census Bureau TIGER Database (Topologically Integrated Geographic Encoding and Referencing system)
 - Census Imagine that in 1920 a Census worker needed to know the route to a farmhouse in a rural location. The Census Bureau recorded the path to this farmhouse as well as every other dwelling in the US.
 - Began converting this to electronic form in the 70s. TIGER Database created for the 1990 census.
 - Can be very outdated. A path to a farmhouse in 1910 might be a city subdivision now.
- Land Managers such as the National Park Service, US Forest Service, Albuquerque Open Space, and BLM.
 - Authoritative but often outdated and inaccurate due to resource constraints.

Map Data - Data Sources

- Google Maps and MapQuest
 - In the early 2000s, TIGER's road network data formed the basis of online mapping platforms MapQuest, OpenStreetMap, and the early Google Maps.
 - Google Maps started charging for data in 2012. Expensive and doesn't really focus on trails. Google has a fleet of GPS enabled drivers helping to keep their maps current.
- OpenStreetMap.org Used by most trail apps as a data source
 - Similar to Wikipedia but focuses on map data. For the US, OSM imported TIGER roads and paths in late 2007 and have been trying to fix it since then. Has a fleet of volunteers mapping every path in the world. Grew rapidly once Google started charging for data. Open Source, free, continuous updates but often not consistent with Authoritative Data. Data ranges from excellent in urban areas with volunteers to poor in rural areas with few volunteers.
- Government and Private Satellite Imagery

Reference:

https://successfulsocieties.princeton.edu/sites/g/files/toruqf5601/files/PN_TIGER_Land_US_FINAL_ToU_962018_0_1.pdf https://wiki.openstreetmap.org/wiki/TIGER

OpenStreetMap Trail Updates

- OpenStreetMap is similar to Wikipedia it that the data is added and maintained by volunteers throughout the world.
- Smartphone app developers such as AllTrails and Gaia GPS, periodically sync their databases to the OpenStreetMap database to obtain the latest data. If you would like to contribute, it is necessary to volunteer with OpenStreetMap.org.
- Trail App Developers don't publish an update schedule, but they appear to sync to OpenStreetMap several times throughout the year.
- A small group of OpenStreetMap volunteers regularly hike trails in the Sandias area. If issues such reroutes are observed, they log into OpenStreetMap.org and make updates to the database.

Reference: <u>https://wiki.openstreetmap.org/wiki/Major_OpenStreetMap_consumers</u> <u>https://wiki.openstreetmap.org/wiki/List_of_OSM-based_services</u>

Map Data Types

- A GIS (Geographical Information System) is a map in a database.
 - You can search the database and even merge it with other databases.
- Geographic Features
 - Features are anything on the earth's surface which can be represented on a map.
 - For making trail maps a feature we are very interested in is the positional centerline data for a trail.
- Attributes
 - Each feature has associated attributes which provide additional information about the feature.

Reference: <u>https://support.esri.com/en-us/gis-</u> <u>dictionary/feature#:~:text=Features%20can%20represent%20various%20types,objects%20like%20networ</u> <u>ks%20or%20surfaces</u>.

Map Data Types – Features and Attributes

- Geographic Feature Examples
 - Points Dimensionless; a sign, building, or a tree.
 - Polylines a road, a trail, a river.
 - Polygons (areas) Sandia Mountain Wilderness, Sandia Peak Ski Area.

A building or even a city could be represented as a point or a polygon depending on the scale of a map.

- Attribute Examples (Trails)
 - Trail Name
 - Trail Operator
 - Trail Type; terra, snow, water
 - Trail's Managed Usage
 - Trail's Allowed Usage
 - Average Incline
 - Length
 - Surface
 - Access Restrictions (closed in winter, etc.)

Map Data Types - Example USFS Terra Trail Attributes

Other trail types are snow and water trails

- The attributes below are examples of how the USFS documents a terra trail. Not all tags will apply to every trail and there are many other attributes.
 - atv = [designated/yes/no]
 - bicycle = [designated/yes/no]
 - foot = [designated/yes/no]
 - highway = [usually "path". Other tags such as track are available]
 - horse = [designated/yes/no]
 - motor_vehicle = [designated/yes/no])
 - motorcycle = [designated/yes/no]
 - name = [Name of Trail]
 - ohv = [designated/yes/no]
 - operator = United States Forest Service
 - operator:website = [webpage for the ranger district, area, or trail if there is one]
 - Ref = [Trail Number]

Map Data – Authoritative vs. Unauthoritative Data

Authoritative Data

- Data produced by an official authority which serves as the foundation for subsequent use and decision-making is considered authoritative.
- Problems with authoritative data. Due to resource constraints and other issues, the data can be outdated and can contain errors.

Map Data – Authoritative vs. Unauthoritative Data

Unauthoritative Data

- Data not produced by an official authority.
- OpenStreetMap data is crowd sourced by volunteers and is not considered authoritative.
- My observation from reviewing OSM data is that the volunteers are conscientious, and the trail centerlines are usually more current and accurate than centerlines in the authoritative data.
- However, volunteers are usually not knowledgeable about the existence of authoritative data attributes and sometimes map sensitive areas which can lead to conflicts with authorities.

Trail Issues Observed While Hiking the Sandias

• Smartphone Map Apps

- Encountered missing trails and non-existent trails in hiking app maps
- Little to no information about the trails in hiking app maps
 - Sometimes just a dashed line.
 - No info on: Managed trail, user trail, hike trail, bike trail, etc.
 - Can't differentiate between an official trail and a user trail.
- USFS Trails
 - Missing Trail Signs
 - Errors in the authoritative Forest Service trails database
 - Forest Service kiosk maps usually show the entire forest. Would like to see hiking maps showing trails in smaller areas such as the foothills area or the Crest area.

Issues - US Park Service and OpenStreetMap

- On September 22, 2021, Keri Nelson, a backcountry coordinator for the US Park Service presented an OSM "Mappy Hour" presentation titled "Trails in OpenStreetMap".
- The presentation described the damages that have resulted from visitors hiking through backcountry areas and sensitive sites outside of designated hiking trails.
- Backcountry enthusiasts have used maps and apps sourced from OpenStreetMap data to find and navigate trails in US national parks and public lands that are not designated as part of the park's managed trail system and not listed on official maps.

Trails Stewardship Initiative

US Park Service representatives cited the following issues:

- Closed/unmarked trails rendering the same as or more strongly than official/managed trails
- Trails marked in locations where there is no trail
- Social trails mapped to posted dangerous areas or off-limits sensitive sites with illegal access

To address these issues, OpenStreetMap US established the <u>Trails Stewardship Initiative</u> and the <u>United States/Trail</u> <u>Access Project</u>.

Improving App Map Data - OpenStreetMap and the Trails Stewardship Initiative

- In 2021, OpenStreetMap launched the US Trails Stewardship Initiative to address issues brought up by the Park Service.
- The Trails Stewardship Initiative is a community effort to ensure responsible mapping of trails on recreational lands in the United States. This project is a collaboration between the OpenStreetMap US mapping community, US land management agencies at the federal, state and local levels, and developers of popular outdoor navigation apps that use OSM data. The USFS participates in the Initiative.

Reference: <u>https://openstreetmap.us/our-work/trails/</u>

Trails Stewardship Initiative

- In 2019 I joined OpenStreetMap as a volunteer and began making additions and corrections to the trail system in the Sandias.
- Including myself, there is a small group of regular OpenStreetMap volunteers who update trails in the area.
- In 2023 my focus changed, and I undertook a project to update all the trails in the Sandia Ranger District and surrounding open space areas using the criterial defined in the Trails Stewardship Initiative.
- In 2024, I undertook a project to update the Manzanitas trail system.
- Every trail in the Sandias and Manzanitas that I have been able find has been reviewed and updated for centerlines and the attributes have been made consistent with authoritative databases.

Trails Stewardship Initiative

- The Forest Service Southwest Region (R3) is aware of this work and believes that it is beneficial.
- At their request, I have given presentations to the Southwest Region on the OpenStreetMap and the Trails Stewardship Initiative.
- At Kerry Wood's request I recently provided OpenStreetMap training to volunteers associated with Red Rock Ranger District of the Coconino NF in Sedona.
- After Sandia Ranger District, Red Rock is the second District in the Southwest Region to work with OpenStreetMap volunteers to update area trails.

Sandia and Manzanitas Area Trails

- 174 SRD Trails (Sandias 113, Manzanitas 61), around 286 miles
 - 21 Foothills Open Space trails
 - 6 Bernalillo Open Space trails (Carlito Springs)
 - 25 Sandia Mountain Natural History Center trails
 - 88 Named user trails (includes 16 decommissioned USFS Trails)
- 314 Total

Plus, there are around 597 unnamed user trail segments in the area.

These were accurate last year– the count changes over time as new trails are added and old trails decommissioned.

Trails Stewardship Initiative

- I downloaded relevant government authoritative trail data and merged it into the OpenStreetMap database for all managed trails in the Sandias and Manzanitas.
- Attributes for all trails that I could find have been updated to indicate the official Open Space or USFS name, number, managed usage, allowed usage, and other appropriate attributes.
- I also strive to mark all unmanaged informal user trails as "informal" so that app developers can recognize and render them as unmanaged user trails.

Ref:

https://wiki.openstreetmap.org/wiki/United_States/Trails_Stewardship_Initiative#Suggested_Tagging

Example: Gravel Pit Trail Attributes

bicycle=designated check_date=2025-05-01 description=Sandia Crest Area Trail Trails dog=yes foot=designated highway=path horse=designated motor_vehicle=no name=Gravel Pit Trail (339) operator=United States Forest Service operator:website=https://www.fs.usda.gov/re carea/cibola/recreation/recarea/?recid=8212

6&actid=50

piste:grooming=no piste:type=nordic ref=339 sac_scale=mountain_hiking ski=designated snowshoe=designated source=survey;gnss surface=ground trail_visibility=excellent trailblazed=yes (trail signs)

OpenStreetMap uses a different set of attributes than the USFS. USFS attributes must be translated to OSM attributes.

Example: Klaus XC Ski Trail Attributes

bicycle=no

dog=yes

foot=no

highway=path

horse=no

name=Klaus Groomed XC Ski Trail

operator=Sandia Nordic Ski Club

operator:website=https://www.san dianordic.org/

piste:difficulty=easy

piste:grooming=classic+skating piste:lit=no piste:oneway=no piste:type=nordic ref=14 ski=designated snowshoe=yes source=survey;GNSS trail_visibility=excellent

Smartphone and Computer Map Rendering

- Apps render map features based on the attributes associated with each feature.
- Hiking, bike, horse, ski, and motorized trails may be rendered uniquely by each app.
- Some examples follow:

Rendering - In the context of computer graphics, "rendering" refers to the process of generating an image from data, such as 3D models, using a computer program.

Gaia App Trail Rendering

- In Gaia GPS, all hike/horse trails are rendered in green. Trails which allow bikes are rendered in red.
- Note that bikes are not allowed in the Wilderness area west of Cienega TH



Attribute: Hike/Horse=designated Bike=no

Attribute: Hike/bike/horse=designated

Gaia App Trail Rendering

 In the Manzanitas Oak Flat area, motorcycle trails are rendered in purple, unmaintained trails in light gray, and a bike trail in red.

Attribute: motorcycle=designated Attribute: Hike/bike/horse=designated

Attribute: Informal=yes



Attribute: highway=tertiary motor_vehicle=designated

Waymarked Trails Winter Trails Rendering



TRAILFORKS – Mountain Bike Trail Rendering

Trailforks Map Legend

Trails

- Trail supports current activity type and is one of the primary uses of the trail.
- ----- Trail supports current activity type but is not it's primary activity or intended use (dashed).
- ----- Trail does not support the current activity type (greyed out).
- A planned trail or access to the trail is restricted (thin).
- Trail is permanetly closed (thin & opaque).
- ----- Trail is hidden, you have special permission to view and keep secret (dashed & thin).



Openskimap.org - Ski Trail Rendering



Updating Trail Centerlines

- GPS (Global Positioning System), GNSS (Global Navigation Satellite System), or Remote Satellite imagery may be used to update trail centerlines.
- In some cases, a combination may be used.
- It may be necessary to hike a trail using trail signs as guidance of what is the current routing of an official trail as well as user trails.
- Trail centerline can be adjusted using high resolution satellite imagery in open areas.
- In areas with canopy, GPS or GNSS must be relied upon.

GPS – The USA Navigation System (6-11 visible at any given moment) GNSS – The Navigation Systems operated by the USA, EU, Russia, & China (40-60 visible)

Updating Trail Centerlines using GNSS & Imagery

- Upper La Luz SE near Crest Spur Junction
- Using a combination of imagery and GNSS track to set centerline in OSM.



Updating Trail Centerlines Using Satellite Imagery

OpenStreetMap

Right - Chalk Dust Trail Reroute Centerline Updated in OSM using Remote Imagery

Esri World Imagery Maxar Satellite Vintage: Mar 28, 2024 Source: Bernalillo County2024 Description: MRCOG-NM, BHI, BernCo GIS Resolution:0.1524 m (6 inches) Accuracy:0.37 m (1.2 Feet)



Maxar Satellite Imagery – Chalk Dust Trail Reroute

Esri World Imagery Maxar Satellite Vintage: Mar 28, 2024 Source: Bernalillo County 2024 Description: MRCOG-NM, BHI, BernCo GIS Resolution:0.1524 m (6 inches) Accuracy:0.37 m (1.2 Feet)



End of Main Presentation about the Smartphone Map Improvement Project

Additional Information

- USFS Volunteer Agreement with Cibola NF
 - Trail Sign Improvements
 - Kiosks Improvements
 - Trail Centerline Improvements
- Work with other Sandia area organizations and agencies
- Maps

Forest Service Database Improvement

- When making Forest Service maps it is a requirement to use the official Forest Service trails database.
- However, a systematic study of the information showed that there are at least 50 significant errors in the database.
- There are many reroutes which are not in the database. In some cases, the data is quite old from pre-GPS days and is 100s of meters off. The oldest data is from the first Sandias USGS 24K Quad released in 1954.
- Before Sandia maps can be made, the database requires improvement.
- The Forest Service recognizes that now that everyone has access to a GPS in their smartphone, the Forest Service database needs improvement.

Trail Errors - Crest Trail Travertine Falls Area

S Crest at Travertine Falls Reroute



Forest Service Database Improvement

- There are three grades of GPS receivers:
 - Recreational (~7 meters),
 - Mapping (~1 meter), and
 - Survey (~1 cm) grade.

- Smart phones have historically not been as accurate as recreational grade GPS's.
- FOSM purchased two mapping grade Bad Elf Flex Mini GNSS units, and I bought one for myself. The Cibola NF approved the usage of this unit.
- Canyon, Jen, and I are busy collecting centerline data to update the USFS database for the SRD. So far, I have collected centerline data for all foothills trails between the Tram and I40. Canyon has collected all of the Placitas area tails, and Jen has started on some of the longer more remote trails such as Embudito (from the TH to Crest Trail).
- The Supervisors Office updates the trails database quarterly so our new centerline data should start to make its way into the database soon.
- As the data is being collected, I have also been using it to update the OpenStreetMap database trail centerline data.



Forest Service Kiosk Maps

SRD Kiosk Project

- A map format has been created and is being reviewed by the Cibola Supervisors Office.
- SRD is also working on correcting errors and improving the centerline trail data for SRD.
- Once these two items are complete, it should be possible to move forward with releasing custom maps for each SRD kiosk.

Map created for the La Luz Trail Head Kiosk

Created as part of the La Luz safety project.









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Trail 365 and Trail 401 are highlighted for clarity

USDA is an equal opportunity provider, employer, and lender.

Cartography by the Browning Workshop

This product is reproduced from geospatial information prepared by the USDA Forest Service. Geospatial information and GIS product accuracy may very. Using GIS products for purposes other than those for which they were created may yield inaccurate or misleading results. USDA Forest Service reserves the right to correct, update, modify, or replace this geospatial information without notification.

Works With:

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VEHICLES WHICH ARE PROHIBITED ON

NON-MOTORIZED TRAILS.







Sandia Ranger District Trail Signs

- While hiking in the Sandias I noticed that there were a noticeable number of trail junctions without trail signs. I offered to help Sandia Ranger District with making trail signs.
- So far, some 21 new trail signs have been provided to SRD. FOSM pays for the material, and I can make sign replacements quickly – often within a few days.
- A few examples follow. HDPE Plastic signs are used in the Sandias in non-wilderness areas. White oak trail signs are usually used in the Sandia Mountain Wilderness. White oak is weather resistant. The signs are made according to the USFS sign specification.

Sandia Ranger District Trail Signs





Maps For Other Sandia Organizations & Agencies

- La Luz Safety Project, FOSM, Cibola Search and Rescue, USFS
- FOSM Sandia Snowshoe Classic
- Sandia Nordic Ski Club
- Sandia Mountain Natural History Center
- PLIAA
- Sandia Peak Aerial Tramway
- FOSM Interpretive Panel Maps

FOSM / Cibola S&R / Cibola S&R Collaboration

- In August of 2023, Cibola Search & Rescue gave a presentation on their work in the Sandias.
- After the meeting, I chatted with the presenters and learned that they were very interested in trying to proactively reduce S&R incidents in the Sandias, especially La Luz Trail. In the past 11 years (as of early 2023) there had been 81 S&R incidents on La Luz.
- Cibola, FOSM, and the USFS worked together to better understand the incidents; why, when, and where they to occur.

La Luz Hike Smart Safety Project

- FOSM, USFS, and Cibola Search & Rescue created the La Luz Hike Smart Safety Project in an effort to reduce S&R incidents on La Luz.
- FOSM created a La Luz tab on our website with Winter and Summer hiking safety write-ups to provide information on the kinds of conditions present on La Luz in various seasons.
- The Forest Service and Cibola S&R began hiking La Luz at regular intervals over the winter to provide reports on the current conditions.
- The Sandia Peak Tramway has been providing regular safety bulletins on their Facebook page as well as on their website and also provides links to our website.
- <u>https://friendsofthesandias.org/la-luz-trail-temp/</u>

Cibola Search & Rescue Incident and Heat Maps









Sandia Snowshoe Classic Map Created with Gaia and Graphic SW



Map Based Created with ArcGIS Pro



Sandia Nordic Ski Club Map



Sandia Mountain Natural History Center Maps



Sandia Mountain Natural History Center Maps





Maps for PLIAA

Public Lands Interpretive Association

BLM Valley of Fires Example



Sandia Peak Aerial Tramway

Tails, Trails & Treats Event Handout & Map

HIKING WITH YOUR FOUR-LEGGED FRIEND

Water: There is no drinkable water on nearby trails. The American Hiking Society recommends at least 8 ounces of water for your dog per hour of hiking. Carrying a collapsible bowl will make it easy to give your dog food and water. Water is available at the Tram lower terminal.

Leash: Dogs are required to be on-leash when on the Tram Terminal grounds. Leashes are also required in Albuquerque Open Space. We encourage always using a leash as wild animals such as deer and squirrels are often encountered in the area and your dog can quickly become lost chasing after them.

Condition: Consider your dog's condition. Start off with shorter hikes and gradually work up to longer hikes.

Paws: Prepare your dog's feet to go the distance - trails in the Sandia foothills are very rocky and can be hard on your dog's paws. Starting with shorter hikes and working up to longer hikes will allow an opportunity to toughen up your dog's paws. You can also get hiking booties for dogs.

Courtesy: When encountering others, it's common courtesy to step off the trail with your dog at your side to let people pass safely.

Keep Trails Clean: Remember to bring along dog waste bags and clean up after your dog.

Weather: Area temperature can vary considerably from day to day. A doggie jacket may be needed on cooler days. Bring extra water on hot days.

Restrooms: Available at the Tram terminal.

PAW-SOME DOG FRIENDLY HIKES ACCESSIBLE FROM THE TRAM LOWER TERMINAL

Tramway Trail (82)

Tramway Trail runs north from the Tram and is 2.6 miles long with 929' of elevation gain. Hikers can take a shorter 1.6 mile hike over to the La Cueva picnic area or continue all the way to the junction with La Luz trail. From here, hikers can go another 7 miles to the Tram upper terminal but remember that only service dogs are allowed on the Tram. Be aware that upper La Luz can be impassable with up to five feet of snow in the winter.

Foothills Trail (365)

Heading south from the Tram, Foothills Trail is the gateway to the Albuquerque foothills hiking system with over 3,500 acres of hiking trails. The trail is 13.3 miles long and weaves in and out of Cibola National Forest, Albuquerque Open Space and residential areas.

Foothills Trail connects with many popular area trails including Domingo Baca Trail, Pino Trail, and Embudito Trail which are also paw-friendly but can be more challenging.



Sandia Peak Tramway Paw-some Map





L Original **R** Update (In Process)



Sandia Mountains

Questions