Mapping Trails the DCR Way

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This document describes the method used by DCR GIS staff to map forest and park trails using GPS (Global Positioning System).

After several years of experience mapping our agency's trail networks, we have developed a methodology that lets us obtain accurate, useful trail data. It requires a fairly high-quality GPS unit that can take point and line features with complex attributes. We have used Trimble GPS units (GeoExplorer II, GeoExplorer3 and 3c, ProXR, and more recently the GeoXM and GeoXT with ArcPad and GPScorrect software). This document does not cover a specific GPS unit; the information should be applicable to any GPS unit of adequate specifications.

The principle concept we use for mapping trails is that of a topological network. In simpler terms, the trails are individual lines that meet at trail intersection points. Lines begin and end where they meet other trails; a single line does not continue through an intersection. This approach has two major benefits: it allows the lines that meet at an intersection to be snapped to an accurate point, and it provides a measure of quality control because the intersection points are coded with an attribute showing how many trails meet there. If the GPS user doesn't map one of the trails that should come into an intersection, it is easy to tell that a trail is missing because the numbers won't match.

Features and Attributes

The GPS unit should be set up to collect point and line features, each of which has several attribute fields. With the Trimble units we have used, some use a file called a "Data Dictionary" which contains information on the types of features that can be collected and what attributes are needed for each, and some collect data into a shapefile, which can be customized to have a form where the user can enter in similar attribute information. In both cases some of the attributes can be chosen from a picklist (which limits the possible attribute values and ensures consistent spelling). For both feature types the current date and time are collected as attributes, and some other GPS information may be collected depending on the hardware and software.

For lines, the attributes collected are:

Type: Trail, Road, or Other
Condition: Good, Fair, or Poor
Surface: Natural, Paved, Gravel, or Other
Width: 0-5', 5-10', or 10'+
Comments: a text field that the user can type anything into

For points, the attributes collected are:

Type: Trail Intersection, Road Intersection, Trail/Paved Rd., Trail/Unpaved Rd., Paved/Unpaved Rd., Trailhead, Dead End, [those first seven are intersection types] Parking Area, Gate, Bridge, Stream Xing, Campsite, Scenic/View, Utility Lines, Wetland, Vernal Pool, or Other
Num: 0, 1, 2, 3, 4, 5, or 6+
Comments: a text field that the user can type anything into
Photo Taken: True/False – whether the user took a photo at this point (default is false)
Photo ID: If they took a photo, the number of the photo
Field Note: If they wrote a note (on paper) about this point, the number of the note

It is important to familiarize yourself with the possible attribute values (especially the many values for point Type) so that you will be on the lookout for these features in the field. For instance, you need to be aware that if you cross a stream or bridge, you should take a point there.

Field Work

Typically your day will start at a parking lot. This is a good opportunity to take your first point of the day – Type should be Parking Area. This will also help you get back to your vehicle at the end of the day! If you start at a point that is not a parking lot, it may be a Trailhead. After taking this first point, start your first line. Walk along this line until you get to the first intersection (an intersection is anywhere that the trail splits or hits another trail or road). When you get to the intersection, stop your line and enter its attributes. These attributes apply to the entire line. If a section of trail changes dramatically at some point other than an intersection (for instance, if it goes from being gravel to dirt, or from being 15 feet wide to 4 feet wide, etc.) then you'll need to end the line at that point, enter the attributes, and then start a new line. This way the attributes will be accurate for the line they are associated with.

Now you are at an intersection. Take a point at the intersection, giving it a Type of Trail Intersection (or Road Intersection, Trail/Paved Rd. or Trail/Unpaved Rd. or Paved/Unpaved Rd. as the case may be) and then enter the number of trails that meet at this intersection into the Num field. IMPORTANT: this number includes all the possible ways you can go from the intersection, including the trail you came in on. A trail that splits has a value of 3; a place where two trails cross has a value of 4 (see images below). Entering this number correctly is essential.

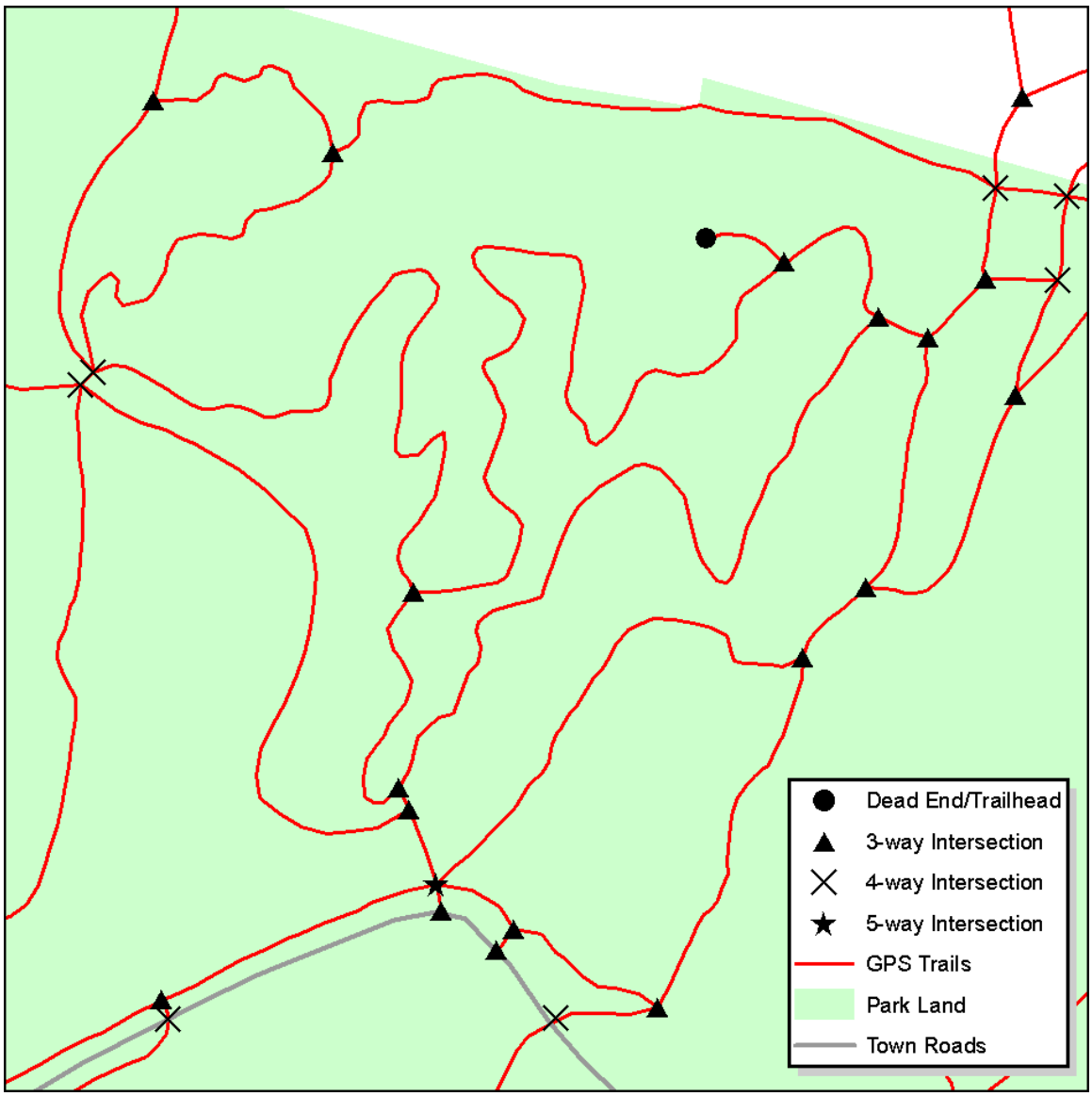
 A three-way intersection (red dot is intersection point)

 A four-way intersection

 A five-way intersection

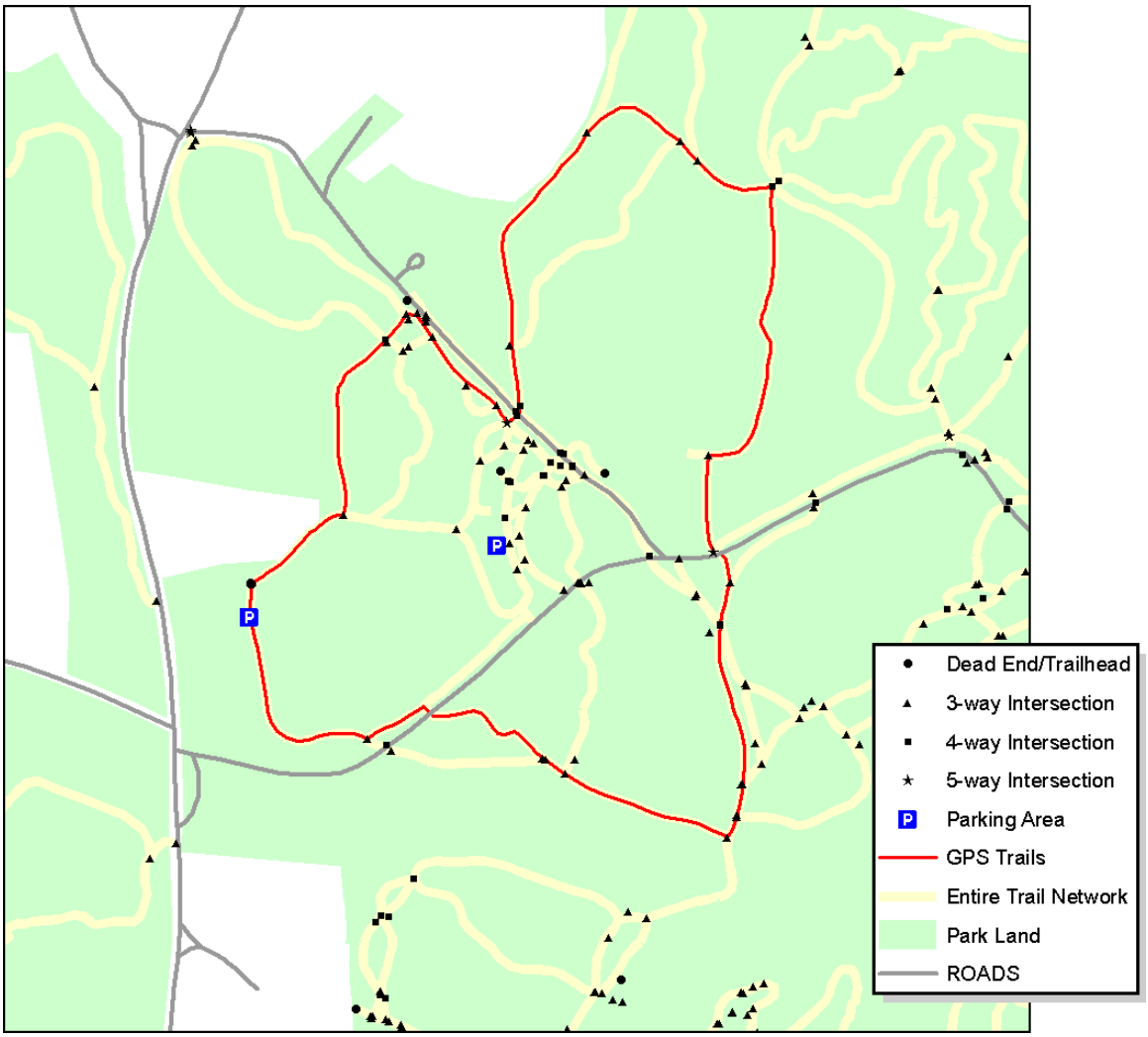
 A two-way “intersection” is just a point along a trail (not actually an intersection!)

 A one-way “intersection” is a dead end or trailhead or parking lot (there is only one way you can go)

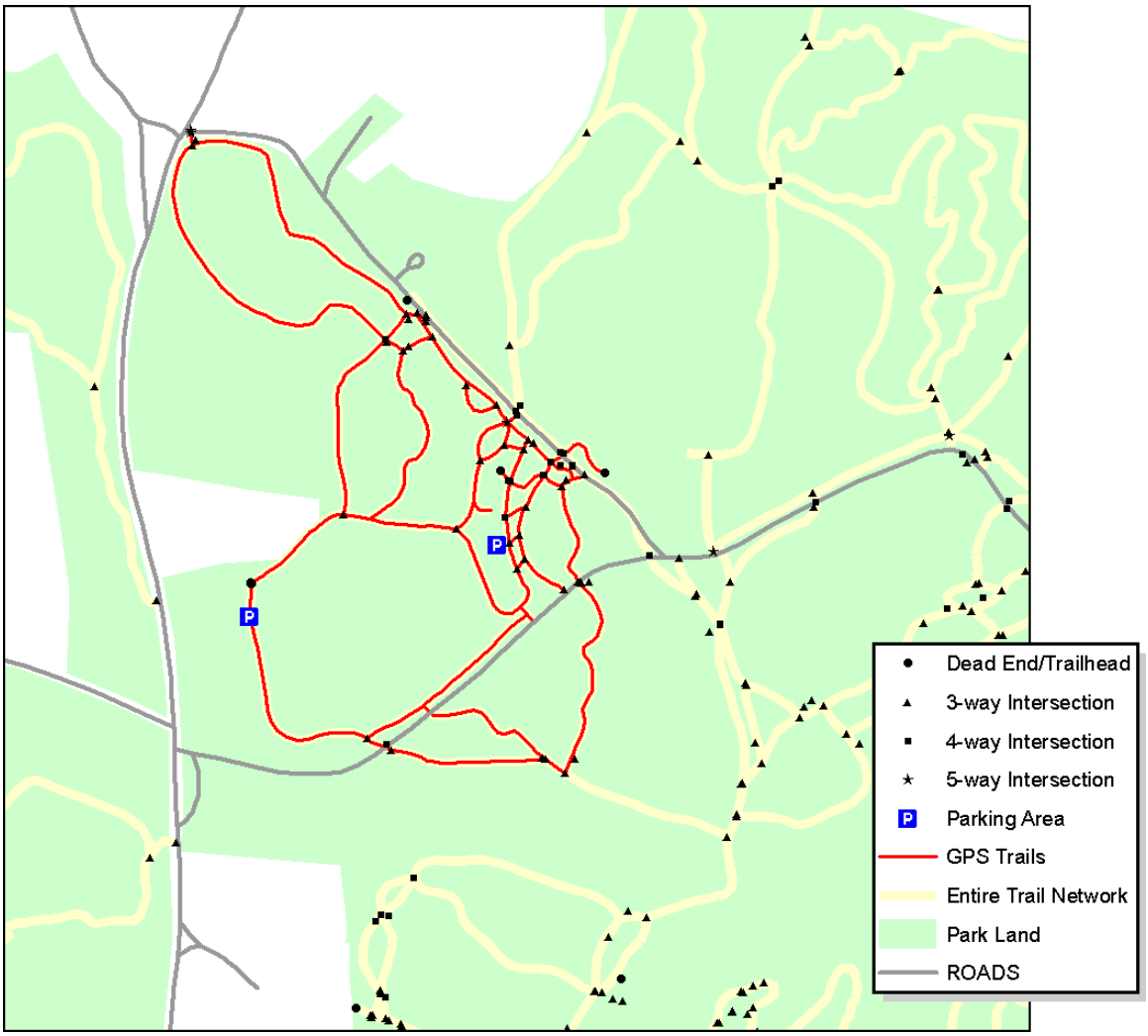


Here’s an example of part of a trail map showing trail intersection points symbolized by the number of trails that meet at that intersection.

Now you need to choose which way to go next. The way you walk when GPSing trails is very different from the way you walk when you're out for a pleasant walk in the woods. If you walk a long loop on a trail through the forest, you will miss all the side trails and you'll have to go back for them later. It is best to try to walk every side trail in a section of the park or forest before moving on to another section. This way you won't have to go back to get that one piece of trail you missed. Inevitably you will end up backtracking quite a bit to get to every trail section. Avoid the instinct to just keep walking on the main trail.



This is a bad example of how to walk when GPSing trails. The user walked a large loop, but will have to go back and GPS all the side trails he missed. This was basically a complete waste of time, since he'll end up walking almost all these trails again to get to the missed trails.



This is a good example of how to walk. The user chose a small area of the park to concentrate on and GPSed every side trail in that area. Now that part of the park is done and the next day she can start on a new area.

Continue walking trail sections and collecting intersection points (and other points like bridges, gates, stream crossings, etc.). Eventually you will build up a connected network of intersection points and trail sections that will fill the whole park. For all but the smallest parks, this will take more than one day. If you have time between fieldwork days, make a map of your progress, symbolizing the intersection points by how many trails are supposed to meet there. This will help you see which areas you need to return to (if you see a four-way intersection with only three trails sticking out of it, you'll need to return to get that missing trail). If the park is segmented by paved town roads (like in the image above), try not moving to a new section across a road until you are sure you have gotten every trail in the section you are in. Remember, you are collecting data, and if you only collect 90% of the trails in the park, your dataset is worse than useless: it is misleading.

Sometimes park users create their own trails that are not considered official by the park management. It is a good idea to GPS these trails anyway, even if they are clearly unofficial. This way the park managers can have a clear record of where the trails are so they can decide what to do about them (either block them off, ignore them, or make them into an official trail). They can be removed from the trail data later, but if you don't GPS them, no one will ever know about them. If you think a trail is unofficial, put a note in the Comments attribute field.

GPS techniques

For points, the GPS unit should be set up to average several position readings to get a more accurate point. We have generally used 30 position readings, one per second. It is important not to move away from the point while taking these positions.

For lines we generally set the GPS unit to take a reading (vertex) every 4 seconds if on foot; if the user is riding a bike, car, or other vehicle, set it to take a reading more often. When walking a line it is important to be aware of the GPS status—if your GPS unit stops receiving positions you need to slow down or stop until it resumes collecting vertices. If you keep walking your line will have long straight segments that will not accurately reflect the trail shape. This is especially important if the trail has sharp turns; make sure you slow down and collect a position (vertex) at any sharp corner in the trail. Some GPS units beep with every vertex collected; some will make a sound if they stop getting readings, and some may indicate GPS status visually.