

Navigation Techniques for Adventure Racing

A Navigation Primer

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Comments/Suggestions are Welcome

Introduction

The purpose of this "primer" is to provide you with the basic knowledge and tools to competently plot a course using given coordinates, selecting a reasonable route, and to successfully navigate a course to completion.

It should be noted that the most valuable navigation tool you possess is your brain. Using your head, and the insight of others with you, is your best asset in successful navigation. Map and compass merely augment brainpower, and hours of navigation practice are essential in becoming competent in this skill.

Please use this primer in conjunction with a map and compass book for general reference. The goal here is to focus on specific information that relates directly to Adventure Racing.

Topographical maps

A topo map is your best friend, and often your worst enemy. Maps are updated infrequently, and are often wrong. Learn to develop and follow your instincts.

Maps are merely a 2 dimensional view of a 3 dimensional world. You're required to use your brain to visualize how this all appears to your eyes. Think of a road map, and what it tells you, but more importantly, what it doesn't tell you (does a highway go uphill or downhill?) A topo map can tell you many of the same things as a road map, but adds contour lines to give you an idea of how the terrain will flow.

What to look for on a topographical map

Scale

One of the first things to look for is the scale of the map, this will help you plot coordinates correctly and give you an idea of how much territory is covered. The most common scale in the United States is the 1:24,000 or 1:50,000. This literally means that 1 inch or foot equals 24,000 inches or feet. A smaller number typically means more detail.

You should also find a scale of miles or kilometers on the map for your reference. Racers will often use the scale and compare 1 mile to the length of their finger or a spread hand for easy reference in calculating approximate distances. One measurement is to use the distance between your index and pinky finger. On a 1:24,000 map this is close to a mile for most hand sizes.

Also check the contour interval, the spacing between each contour line. This is an important navigation tool.

Publication Dates/Names

Check for the name of the map and the date published. On a USGS topo these should be in the lower right hand corner. Any photo revisions that have not been field checked will show up in purple. The date will give you a rough idea of how current the map is, and you should keep this in mind as an un-maintained trail or road can become quite overgrown in just a few years!

Adjoining maps

Then names of maps that adjoin your map are usually found on each side of the map, and on each corner. On newer USGS quads, a grid on the bottom of the map will detail adjoining quads. Use these when marking your maps and route choice.

Contour lines

These lines will give you a rough idea of what the terrain should look like. In general, the more widely spaced the contour lines are, the more gentle the terrain. Contour lines that are very close together indicate steeper, hillier terrain. Reference contours are typically marked with a BOLD brown line; interval contours are lighter brown. Count up and down using the reference contours as your starting point.

This is where the contour interval comes into play, if the interval is small, say 20 ft, and the lines are very close together, this may indicate a cliff and could be impassable. However, if the contour interval is 100 ft, it may slope up sharply, but be perfectly passable.

It's very possible that a contour interval of 40 ft could "hide" a 25ft cliff that isn't on the map, and may prove to be a challenge to get up or down, so use your brain and carefully evaluate your surroundings before making a route choice.

Declination

The earth is not perfect and magnetic north is a moving target. It does shift by varying degrees each year. Your topo map should indicate the declination for that area and you should adjust accordingly. If a map is very dated, say more than a few years, then you should try to find out the true declination from local sources or on the web. Often you can find out from the race director.

The best method to deal with declination is to purchase a compass that has adjustable declination (typically a small screw on the back of the face plate). For a westerly declination, you add. For an Easterly declination, you subtract. An easy way to remember this is to "Add Whiskey". If your compass has an adjustable declination, set it for your race and forget it.

Universal Transverse Mercator (UTM) marks

Along with Latitude and Longitude, USGS quads are marked with UTM coordinates. This system divides the map into 1-kilometer grids (for a 1:24000 map) and helps you pinpoint your location.

Look on either edge of the topo and notice the small blue tick marks marked with a number like ³⁹16 or ⁴⁸32^{000m}E. You will use these numbers to plot your checkpoints. It is typical that the easting is reported first, followed by the northing. Remember the phrase "read right up" to help you remember to read the easting left to right, followed by the northing from the bottom up.

Typically UTM's are given as a string of 6 digits (³⁹1634 or 391634). If there is an extra digit at the end, don't worry about it. It typically means that the CP was verified using a GPS, which displays 7 digits. You can't really plot to the extra digit anyway.

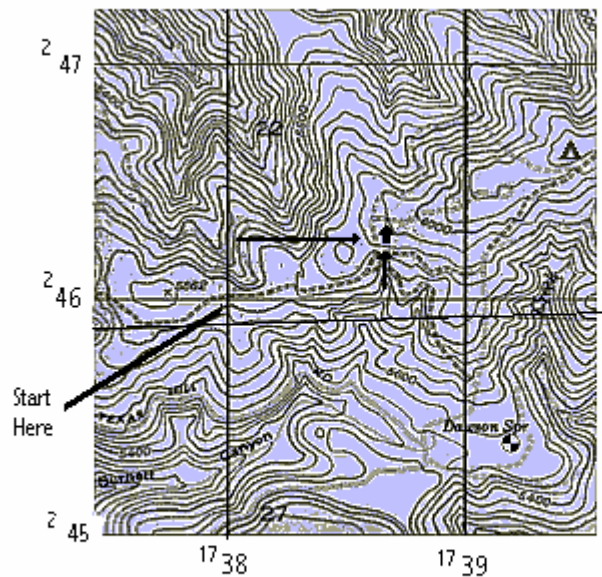
Plotting UTM coordinates

Once you understand the logic, marking the map using the UTM system is quite easy. The coordinates might be given as $^{17}3876\text{mE}$, $^{2}4631\text{mN}$

First locate the hash mark that corresponds to the first four numbers, lay your straight edge across the map taking great care to make sure that you are connecting the same marks on other side (note: your straight edge might not be parallel with the map grid). Now draw about a 6 inch line with a pencil making sure to cross the other UTM coordinate. Now repeat the process with the other number, and again draw about a 6 inch line with your pencil, so that both lines intersect.

Take your UTM plotting grid (double check that your using the correct scale), and use the intersection of the two pencil marks as your starting point. Carefully slide your grid to the right for the Easterly coordinate and up for the Northerly coordinate. When you've found the point, make a small circle (about $1/8'' - 1/4''$ diameter) around the checkpoint.

Look at the following example, the black arrow is located at approximately $^{17}3876\text{mE}$, $^{2}4631\text{mN}$. Now, try and determine where the Campground is using UTM coordinates.



Compasses and Compass Work

There are several types of compasses available on the market. Your best choice is a baseplate style compass with a rotating, liquid filled dial. It should have graduations of at least 2 degrees, and adjustable declination scale, and be easy for you to read. It may be helpful to purchase one with a sighting mirror if you expect open terrain with few trees to block your view.

If you plan to race outside of North America, consider purchasing a compass with a "global needle" that will work in all 5 magnetic zones on our planet. Don't assume your compass will work correctly outside of North America; check your owners manual or model number and compare.

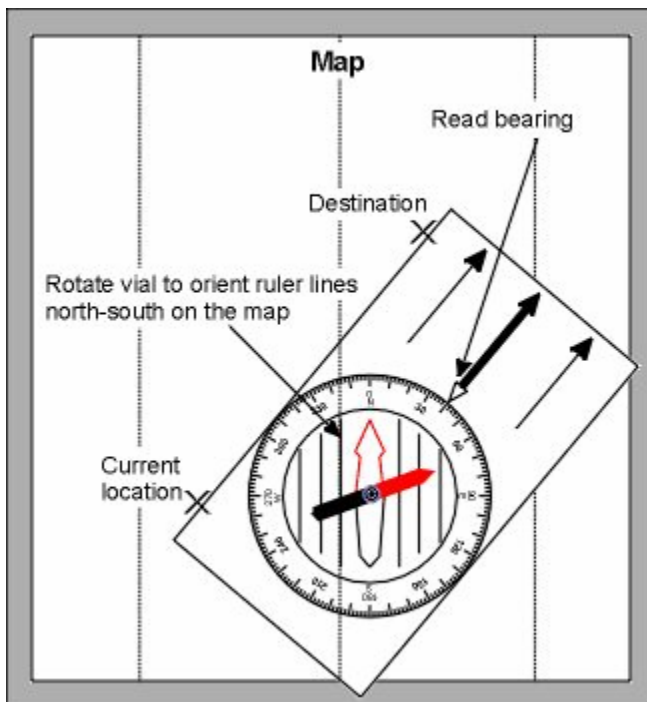
The team navigator should have a back-up compass and each teammate should carry a compass with them. Be careful of things that can throw off a compass such as power lines, large metal objects, mining quarries, etc.

Taking a bearing

Each compass usually has an arrow that points right through the top of the baseplate, this is your "direction of travel" arrow.

Point this arrow at your intended landmark or direction of travel, now turn your compass dial so that the needle and the "north arrow" inside compass are aligned (match red to red), and simply read your bearing from the bottom of the direction of travel arrow.

To follow this bearing, follow your "direction of travel" arrow while keeping the north needle aligned with the "north arrow" inside. Sounds easy, doesn't it? Not so fast, most people can't walk a straight line for very long (go outside and try it).



The best method to keep on course is to choose 2 or 3 landmarks (trees, powerlines, rock cairns, etc) in the distance that match your intended direction of travel, walk carefully towards those landmarks and choose more as you get to each one. Keep checking your bearing! This is still not foolproof, but it is helpful.

Remember: always, always, orient the map! (Hold the map horizontally, place the compass on the map, then rotate the map until the north lines on the map align with magnetic north).

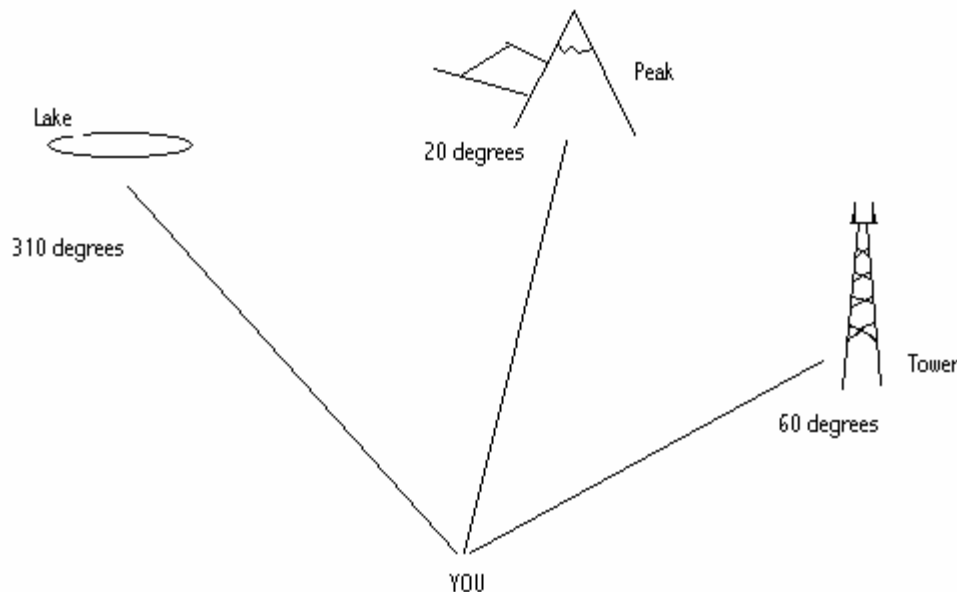
Determining your position (Triangulation)

By taking a bearing off 2 or more distant landmarks, you can often pinpoint your location to a reasonable certainty. Try to find landmarks that are close to right angles with each other from where you are standing.

Take a bearing from the first landmark, now place the compass on your map with the landmark at the top of the compass and draw a line straight back. Now repeat the process with the second landmark. Where the lines intersect, should be your approximate position.

Adding a third landmark is most valuable, and will help provide the most accurate position. This can also help prevent any errors you might make by using only 2 landmarks, call it a "safety check".

Obviously this technique works best with a clear line of site to prominent landmarks.



Navigating with no Landmarks

The time may come when you are trying to navigate in a dense forest, or the area is shrouded in fog. In this case your travel will have to be slower and deliberate. Use one of your teammates and "leapfrog" by having your teammate walk out in front just till they're almost invisible, then have them turn around. Make sure they appear to be on the correct bearing (point them left or right as needed), then walk towards them and repeat the process.

Night Navigation

Navigation at Night takes on a whole new meaning. Because your field of vision is limited, distances become deceiving and finding trail and road intersections becomes even trickier.

Try very hard to "not get lost" while traveling at night, this means purposely slowing your pace while traveling at night and purposely "over" navigating. Plan to check your bearing and position every 10-15 minutes at night!

It's recommended that you have a high power halogen beam for the night leg of a race and bring plenty of extra batteries. Many racers prefer a combination LED/Halogen lighting system to conserve battery life, since many people don't need the high power beam for just walking, but turn it on for when the extra lighting is required.

It's very important that you learn to keep track of your pace, and that you make allowances for a slightly slower pace at night. If you haven't practiced pacing, you'll need to get out and gain some experience.

Pacing

It's very important that you are able to keep track of your pace during a race. This helps you judge how much distance you've covered in a given amount of time. Each team may have a slightly different pace, but in general you can expect the following:

Trail running at a moderate pace (at elevation)	5-7 mph
Trail running at a moderate pace (level ground)	6-8 mph
Hiking at a brisk pace	4-5 mph
Hiking/Bushwacking (level ground)	1-2 mph
Bushwacking (uphill)	.5-1 mph

Altimeters

In an adventure race with significant terrain, the use of an altimeter is highly recommended. It's wise to make sure at least one other teammate has one as a backup. By comparing your altitude, you can select the appropriate contour line on your map, and better pinpoint your position.

There are many types of altimeters available that can be worn on the wrist like a watch, and most tell time too. The important thing to remember is to re-set the altitude at known points every chance you get. While useful tools, the changing barometric pressure can cause variations in the altimeter readings, so always compare yours to your teammates' reading.

You may also want to use your contour references and "write in" the altitude of each CP or TA for easy reference when you arrive and do the same for any peaks, lakes, etc. that you will encounter to make this process quicker.

Route Choice

The business of choosing a route for navigation is as much art as science. Logic will tell you that flat terrain with a well-marked trail is often the fastest way to travel. It may prove that you'll expend less energy by going around a steep hill rather than climb over it, so make your choices carefully. Sometimes the flat way is miles out of your way, so you have no choice.

When deciding on a route, look for lines that indicate a trail or dirt road. You may encounter unmarked trails and roads, so always keep an eye on your direction of travel. Trails may twist and turn, but as long as you're generally heading in the correct direction (ex. North-Northwest), you may be fine.

It is also helpful to use "baselines" when navigating or choosing your route. A baseline is typically a major line or axis that is easily identifiable on the map, such as a river, paved road, ridgeline, etc. Use baselines as boundaries to keep you heading in the correct direction, or to stop you if you travel too far.

You may also want to use a "point of attack". By choosing something obvious on the map that you know you can find navigate to, such as the intersection of 2 rivers, a bridge, or a very steep cliff, then use this as a jumping off point to find your checkpoint.

Often your route choice will change in the middle of the race, which is fine. You should always be adaptable and be equipped to change your route due to weather, terrain or the race directors' discretion.

You may find in some mountainous areas that the north side of a slope will have thicker vegetation than the southern side. Also, while streams are definitely nice landmarks to use, they may also be choked with heavy vegetation, so consider an adjoining ridge line or spur if the terrain allows.

Check local sunrise and sunset times and make a note of them. These will be helpful as you make choices about pace and any possible dark zones where travel is suspended for the night.

Marking your map for a race

You're at an adventure race and you've just been given your maps and instructions, what now?

Some steps to follow:

1. Count the number of maps and compare to the number required on your race instructions. Then number each map in the upper left hand corner and mark the number on the race instructions where the map is named. This makes it easy to find the correct map in a hurry.
2. Plot all of the UTM coordinates on the maps, using only the coordinate intersections required. Use a pencil for this pass. Ask a teammate to follow along or double-check your work, mistakes are easy to make in the heat of a race.
3. Circle each UTM point in red or blue ink and name it appropriately (CP1, CP2, TA1, etc). Felt tip pens seem to work best.
4. Read the instructions and select a possible route from one checkpoint to the next. Keep in mind the discipline involved and any travel restrictions.
5. Use a highlighter to mark this route(Orange is a good choice for visibility). It may change as the race progresses.
6. Note items such as such as cut-off times, route restrictions, or special instructions in the margins of the maps for easy reference.
7. Carefully fold your maps showing as much as the your first legs as possible and slide them into your map case. Double check the seal!

You may also wish to consider waterproofing your maps. A quick method is clear packing tape, or if the time allows, a waterproof sealant.

Always take your UTM plotter along, as well as your highlighter, pen and pencil in case you need to re-plot a point or mark an alternate course of travel. Many racers buy an extra UTM grid and cut out only the portion they need for the scale of map they are using for that race.

Make sure the CP's follow a somewhat logical course. Mistakes can easily be made by yourself or race organizers. Unless you're expecting it, a CP in the middle of lake with no apparent land might be a simple UTM typo. Try to switch the numbers or ask the race organizers if you are unsure!

Avoid these critical and classic race mistakes...

- Not reading the race instructions completely and accurately!
- Not making a note of any cut-off times!
- Traveling on a banned road or trail!
- Not turning around and going to a known position when you are unsure of where you are. Don't keep going forward!
- Incorrect plotting of UTM coordinates! Double, or even triple check these.

Now, go out and do it, but remember to enjoy the experience!

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