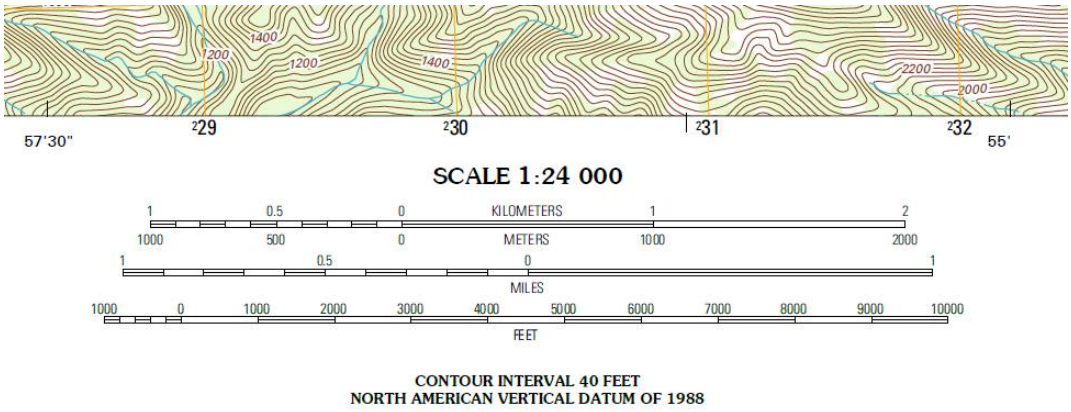
Geography 80-20
80% of what there is to know, for 20% of the sweat

Basic Map Skills for the Outdoors

Map Scale



Map source: US Geological Survey

Four ways to indicate map scale:

- Representative fraction — 1: 24 000
- Graphical/bar scale
- Verbal scale — "an inch to 2000 feet"
- Coordinate grid on the map

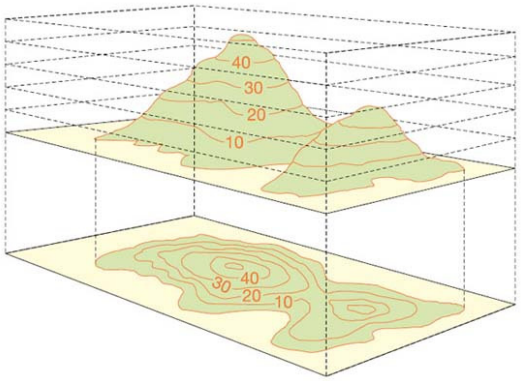
Which of these will remain valid when the map is magnified or reduced in size?

Measuring distance on a map

Distance as the crow flies can be measured using the scale. But distance along a road/stream cannot be validly measured from a map by following the line with a string or "map measurer," as sometimes taught. Maps don't show every bend in a feature, so you will under-measure distance significantly. Instead, look for distance tags, usually delimited by dots or arrowheads. Bryan Conant's wilderness maps, for example, include these, making them useful for trip planning.

Map sources: Rand McNally, BryanConant.com

Contours



A contour line joins places that have the same elevation.

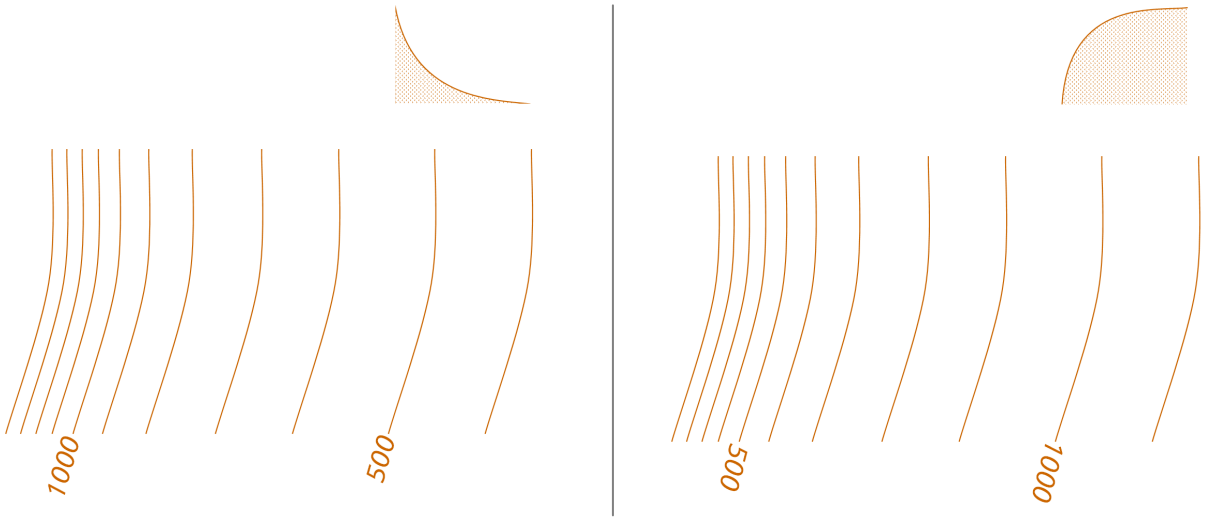
Spot heights indicate elevation at points. Benchmarks (BM) are surveyor-certified reference points. The ground markers should never be disturbed.

Sources: UK Ordnance Survey; US Geological Survey

Reading a landscape

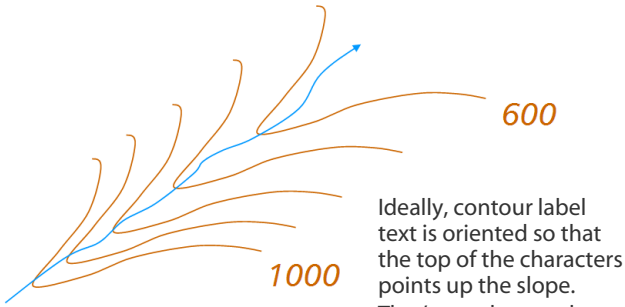
Steepness and profile

Contours are drawn at a fixed vertical interval. Contours spaced closely indicate that the elevation change occurs over a short distance, i.e. steep slope. So variations in spacing reveal a lot about the topography.

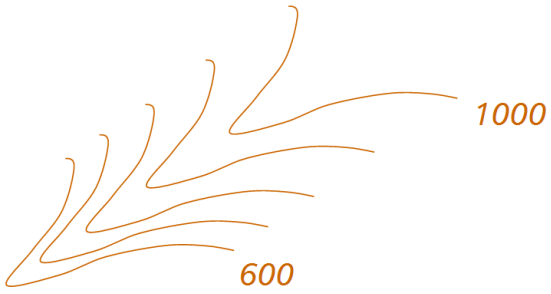


Type of feature

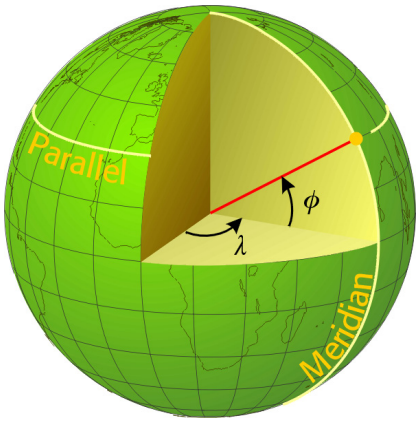
Context (e.g. streams and how they branch) can indicate the lay of the land, and whether you're looking at a valley or a spur. Or conversely, contours indicate which way the stream is flowing (always from high to low). Human activity (roads, towns) and vegetation are more likely to be in valleys (because that's where the water is) than on ridges. Using these clues it's possible to read contour maps at a glance.

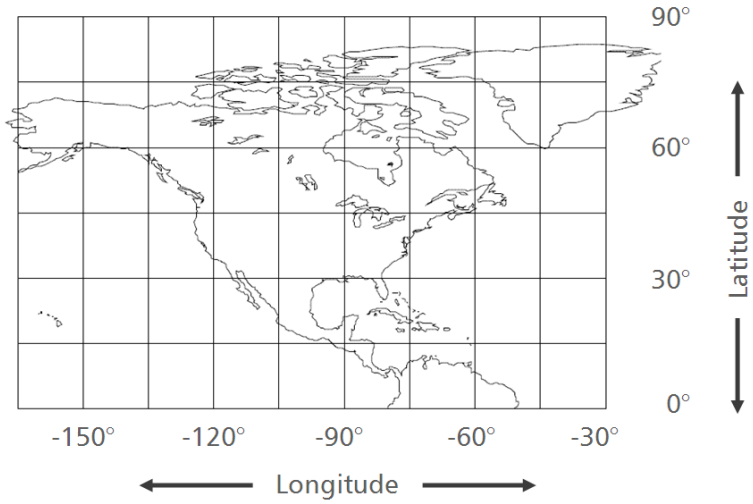


Ideally, contour label text is oriented so that the top of the characters points up the slope. That's not the case here.



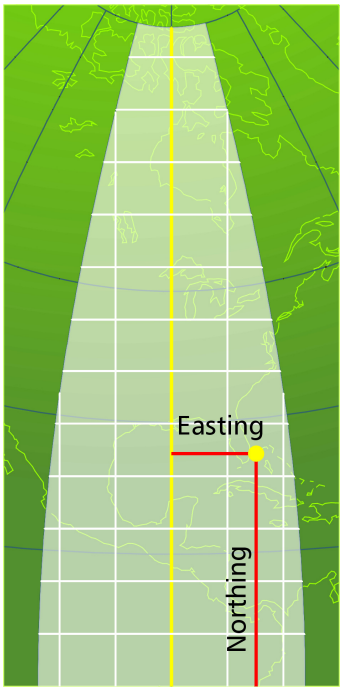
Latitude and Longitude



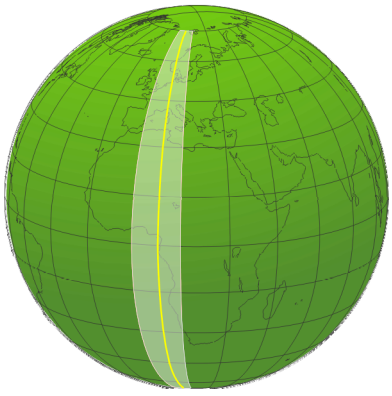


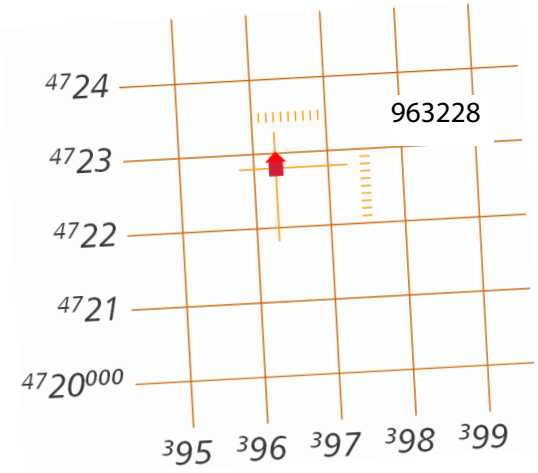
- A spherical coordinate system, but much like x and y if you accept the distortion at higher latitudes.
- Strength: Universal. South latitude and west longitude are negative. So New Orleans is "30, –90"
- Drawbacks: Hard to work with: units of measurement are angles rather than distances. 1°N is not the same distance as 1°E.
- Along Great Circles: 1°: distance driven in 1 hour (70 mi). 1′: distance driven in 1 minute (1 mi). 1″: distance driven in 1 second: 100 ft. Decimal degrees: 5th decimal (0.00001°) is about 1 meter.

Universal Transverse Mercator (UTM)



- Graph paper wrapped around meridian and trimmed to a 6° wide strip (illustrations show a 15° wide strip for clarity).
- It takes 60 strips (**zones**) to cover the earth. Zone 1: 180°-174°W. Zone 2: 174°-168°W, etc. SBA is in Zone 11: El Capitan Beach to Kingman AZ
- If two places are separated by a meridian that's a multiple of 6° (e.g. 120°W, a multiple of 6, runs between119°W and 121°W), those places are in different zones. Some cities are split into two different zones.
- Coordinate units are meters, kilometers
- Not oriented with lat-long grids except at central meridian. Hence we have a third north: true north, magnetic north, now **grid north**
- No negative coordinates. Uses an artificial origin off to the west.
- To find your way on a topo map, use a GPS that has a UTM readout, and a map that has a UTM grid.

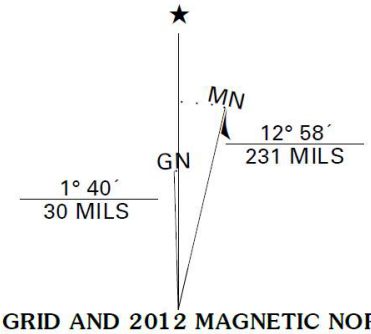




Further reading: www.digitalgeographic.com/resources/8020

Compass Bearings

The declination indicator on USGS maps shows true north (*) and magnetic north (MN). Grid north (GN) is specified when the UTM grid is overlaid. The milliradians (MILS) scale is an alternative to degrees: 6400 MILS = 360°



UTM GRID AND 2012 MAGNETIC NORTH DECLINATION AT CENTER OF SHEET

True north * points to the North Pole, which is a fixed point. Bearings are read clockwise from north: 000° is north, 090° is east, 180° is south, 270° is west, etc.

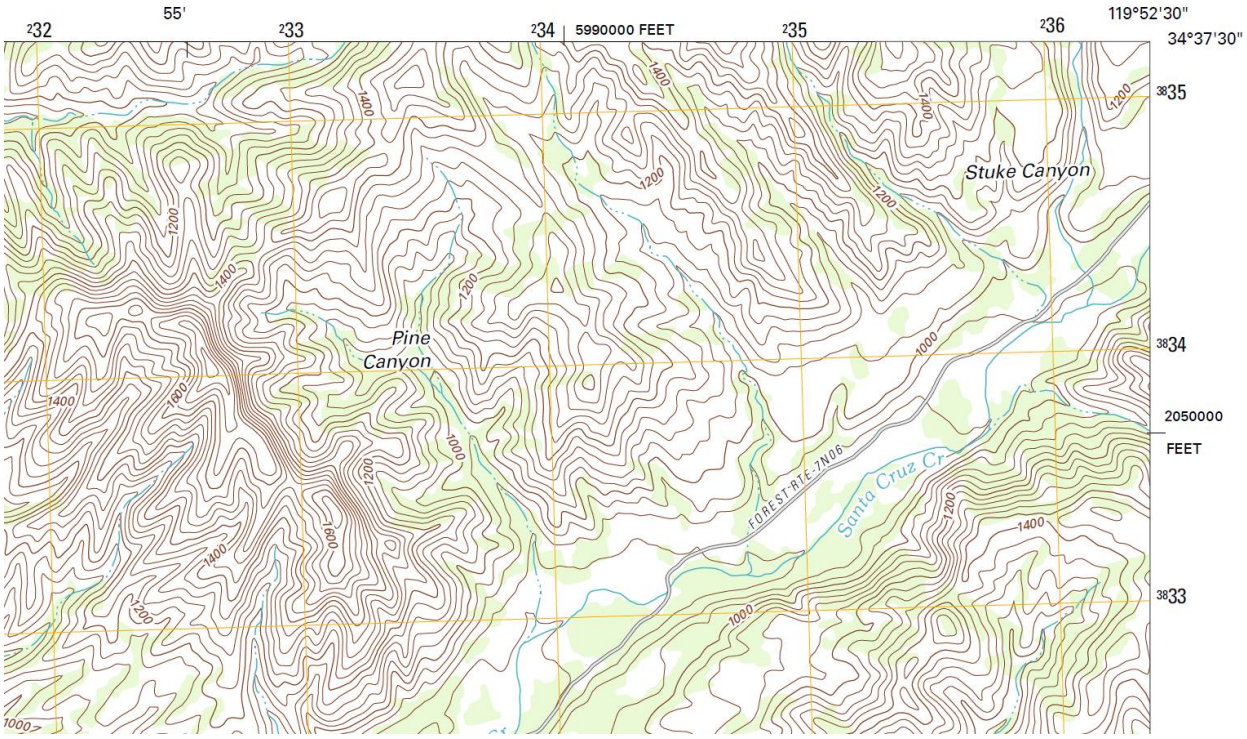
Magnetic north (MN) is near true north. It drifts over time, so check the map date to make sure it's current. MN varies from place to place based on the alignment and density of material in the earth's interior, but over the extent of a topo sheet, we take it to be constant. To orient a map with your surroundings, align the north needle on your compass with MN, not *.

Magnetic declination is the angle between true north and MN, at a particular place and time. It may be east or west of true north. When you're given a bearing, always ask: is this relative to true north or MN? If it's relative to true north, which is often the case, add east or west declination to your compass reading to compensate — a bezel on your compass may make this easier. To find the declination for a given place on a given date, ask the government: *www.ngdc.noaa.gov/geomag-web*

Some GPS instruments incorporate an electronic compass. Others present compass-like graphics, but infer direction from your movement; they can be misleading when you're stationary. Know your equipment.

Putting it all together

Here's a sample USGS topo sheet, with UTM grid, latitude and longitude coordinates in the corners, and contours showing valleys and peaks, steep and gentle slopes, and a forest road. Can you interpret all the features and fine print well enough to find your way around the area with a compass or GPS? Relating a contour map to reality takes practice: we see more detail on the ground than there is on the map. There's a plus-or-minus on the placement of everything on a map, and plus-or-minus on the GPS. So things don't line up 100%.



How to get around with this knowledge

It takes theoretical knowledge, equipment, common sense and creativity. Also good maps, and a feel for what they show and don't show. TIP: USGS top maps can be downloaded free at *store.usgs.gov* The older editions have better detail, hiking trails, more place names. The newer editions have the UTM grid.

Scenario 1

Given a coordinate pair: "34.4, -119.7" (34.4°N latitude, 119.7°W longitude), where on earth is it? Enter that string into a search engine (Bing, Google, Mapquest, OpenStreetMap) just as it is, and the system will do the hard work and plot it on a map for you.

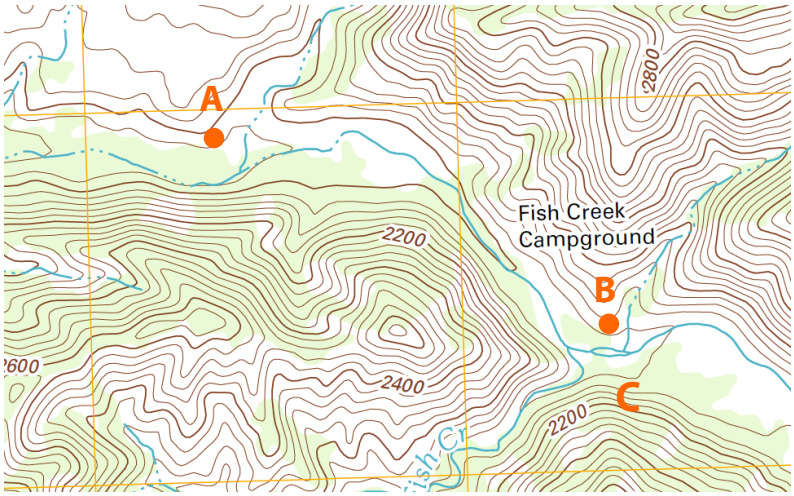
Scenario 2

The converse problem: On a web mapping system, you've zoomed in on a place, say a campground. How to get its latitude and longitude? (1) Travel there with a GPS ☺ or (2) While sitting at your desk: Bing Maps (bing.com/maps) is best for this. Right-click on the point, and from the menu, choose "Add a pushpin." The latitude and longitude are displayed.

Scenario 3

Bill: "I remember we cross the river somewhere around here to get to the campground. Here's the river to our right, but I don't recall if this is where we cross."

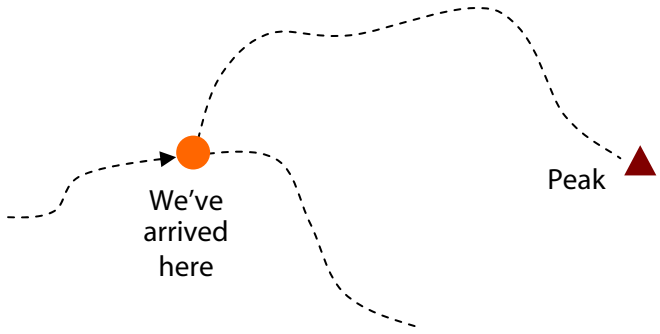
Solution: Use GPS to find your position on the map (probably in UTM if you have that grid on the map), and see if you're across from the campground. Contrary to what this map shows, Fish Creek campground is on the south bank of the stream, at C. If your current location turns out to be A, that's not the crossing point. If you're at B, roll up your pant cuffs.



Scenario 4

There are two paths leading out from here. Which one do we take to the peak?

The peak is at 090°, due east. That doesn't mean that the eastbound path will get there. If we store the peak as a waypoint in a GPS and let the instrument navigate us there, it would be misleading in this scenario, as it would direct us down the eastbound path with confidence. Having a map saves the day.



When taking a compass bearing on a peak or other feature, whether on a map or in reality, you want to be accurate (taking declination into account) because there are often multiple peaks on the horizon. But when choosing a trail, compass precision is not critical because trails are usually at least 60° apart. You do want to know your orientation: where's north?

Rev: 2015-08. This document is online: *www.digitalgeographic.com/resources/8020*