

# **Basic Map & Compass Skills**

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Interior photos courtesy of Mike Masek.

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## The Basics of Map & Compass

The ability to navigate with a handheld compass and a topographic map is a hallmark outdoor skill. It will enable the wilderness explorer to not only stay found but locate water sources, road junctions, and the best routes through challenging terrain.

There are three areas to focus on when learning to put these time-tested navigation tools together:

- 1) Topographic Map Use without a Compass
- 2) Following a Compass Bearing without a Map
- 3) Using Map & Compass Together

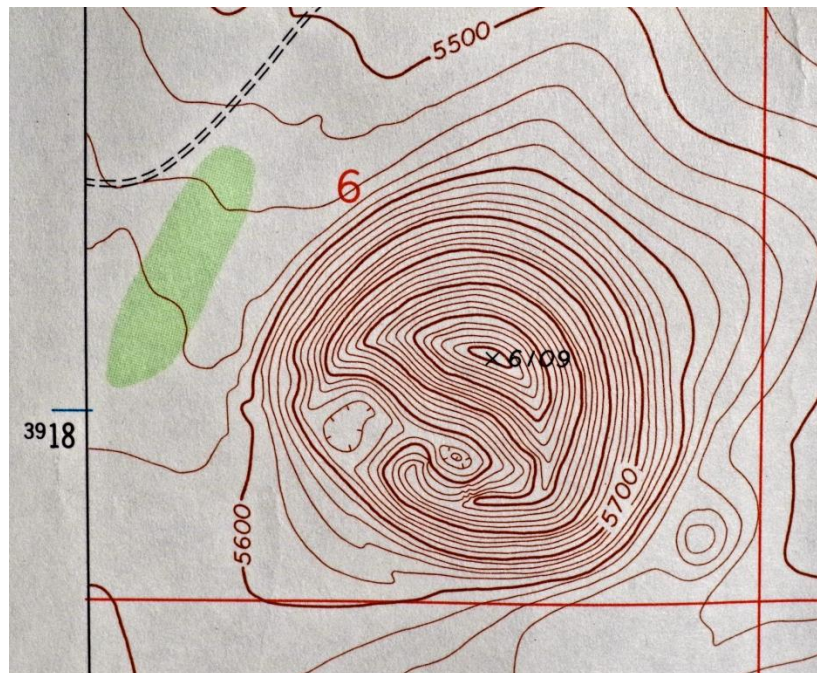
Each of these has its place and is partly dependent on the terrain and your end goals. For instance if I am in the desert with ninety-mile visibility, I may just pull out my topo map and use the easily identified peaks, canyons, and mesas to pinpoint my general whereabouts. I do this a lot where I live as our incredible vistas make triangulating my position relatively easy. If I need to reach an exact location such as a small spring, then I will use a compass in conjunction with my map. However, when I am in the jungle or forest, a map and compass are always used together and are critical to arriving at my destination.

The only time I use a compass by itself is if I am given a set of pre-determined bearings to follow such as in a sport-orienteeing event or if a friend has provided bearings to his basecamp. Having a compass dangling around your neck does little good unless you have a topo map to go with it or already have known bearings.

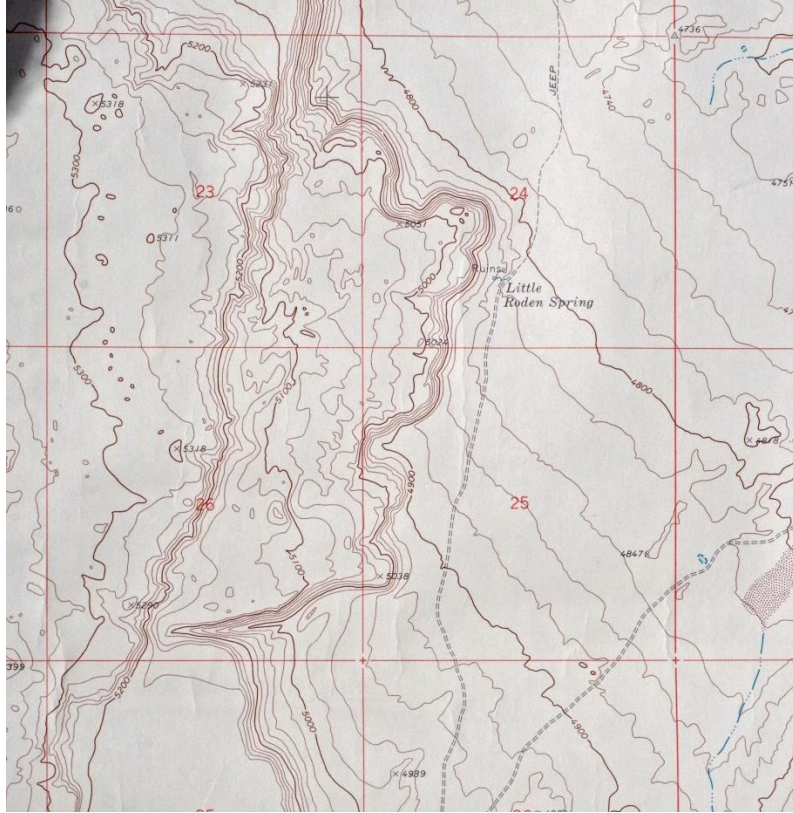
## Understanding the Terrain with a Topographic Map

Let's look at map use first. I am going to cover only a few of the essential tips for reading a topo map. You can obtain a free interpretive handout from [USGS.gov](http://USGS.gov) or a gear shop. This will allow you to delve into further explanation of the symbols.

*Contour lines:* these lines indicate how steep or flat the terrain is. Lines that are tightly packed will indicate a steep mountainside, cliff, or deep canyon; conversely, contour lines that are widely spaced will be indicative of a relatively flat region such as a meadow or field.



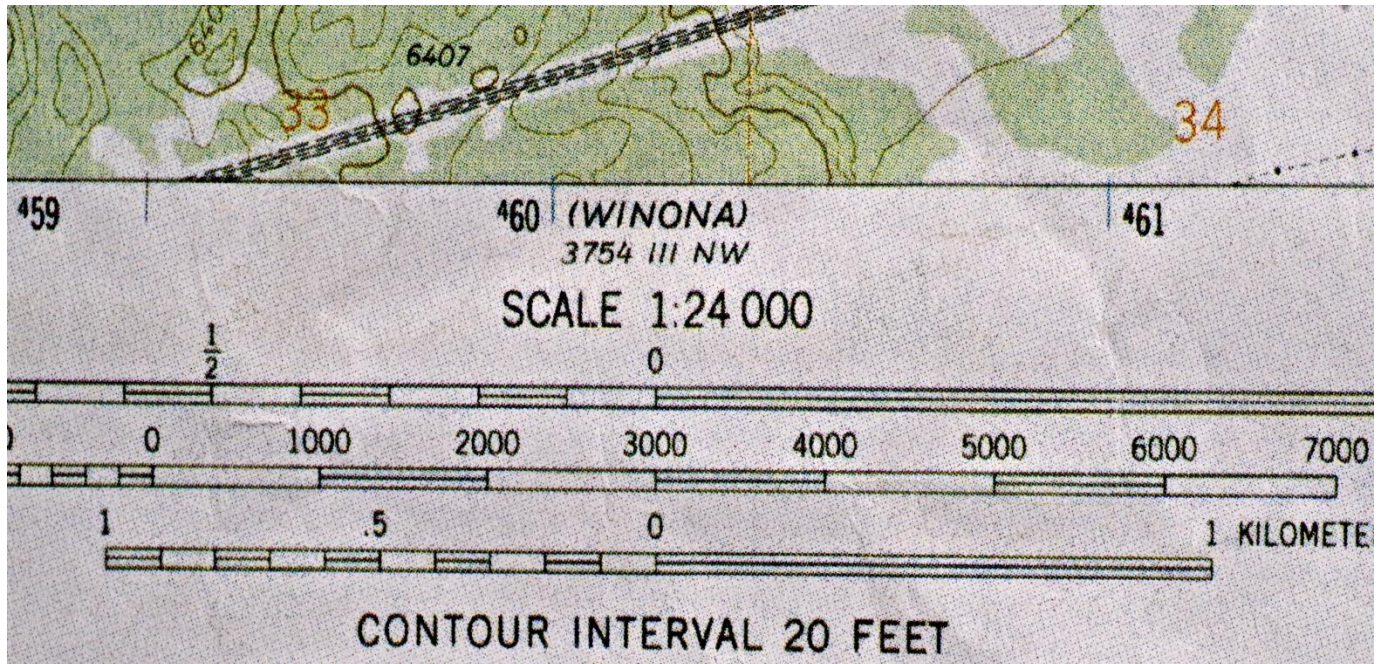
The steep sides of this crater are indicated by the tightly-grouped contour lines.



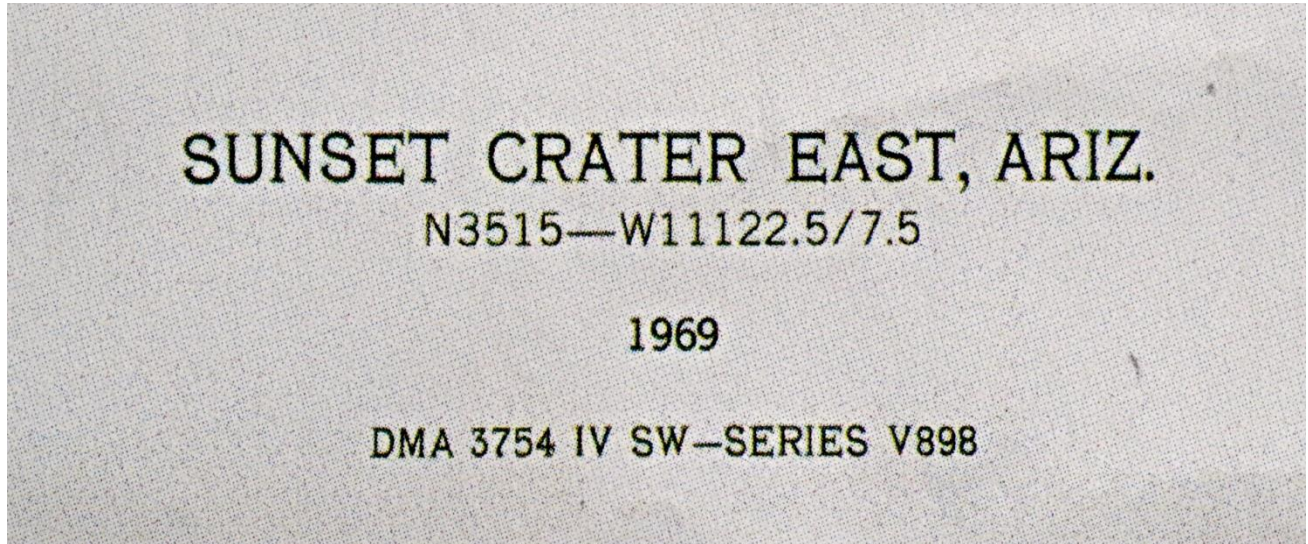
By contrast, the space between the contour lines to the right of the spring indicates flat terrain.



*Contour interval:* The spacing of those contour lines will give you a feel for the difficulty of a region you may be traversing but each map's contour lines vary. This information is located in the center margin at the bottom of the topo map. I have some maps that have contour intervals listed as 10, 20, and 40 feet. This can make a huge difference when trying to obtain water from a canyon. A 10 foot drop might be doable but a 40 foot drop is going to turn into a technical rock-climb. Always be sure to take note of the contour interval when pouring over your map.

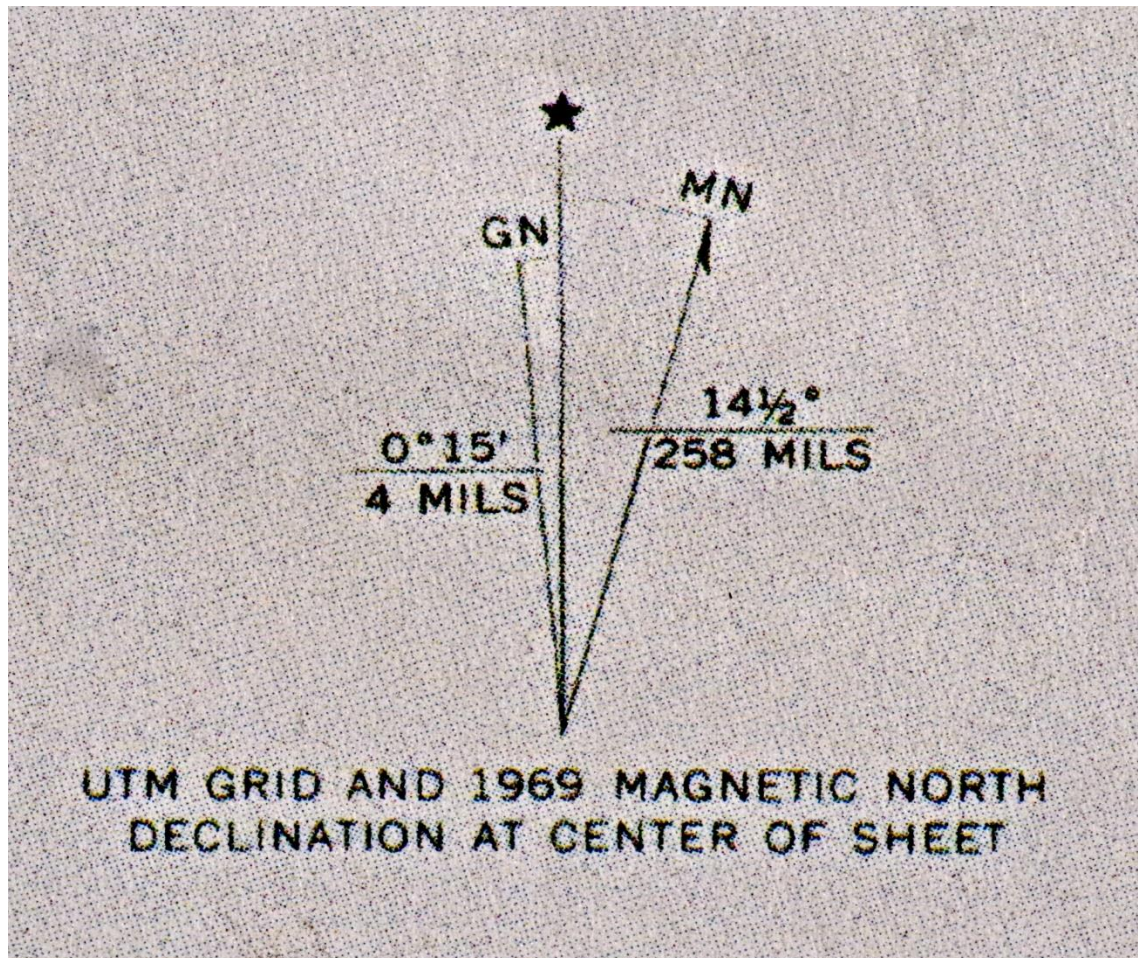


*Date the map was made:* you will find the publication date in the bottom right corner. Why is this important? Because a large portion of printed topo maps were done in the 1960s and while the large-scale features (mountains, canyons, rivers) haven't changed much, the roads, springs, and manmade structures may be different. On one survival course, we did a land navigation exercise to a "water tank" listed on our topo map, knowing it was dated 1956. We trekked cross-country and arrived, four miles later, at the water source which turned out to be a rusty steel water barrel turned on its side with shotgun holes in it! Always check the publication date and then call the local Forest Service/State office to obtain the location of current roads, backcountry water sources, and private property.





*Magnetic declination figure:* On most maps, this will be a cluster of three arrows pointing north and located in the bottom margin on the left side. One will indicate MN, which is Magnetic North; another will read, GN, which is Grid North. The third is usually a star, which refers to True North. The latter lines up with Polaris, the North Star, and is totally separate from Magnetic North. MN, or the direction a compass needle points, is hundreds of miles to the south (as of this writing) in the Arctic Ocean. The direction and strength of this magnetic field continually changes and creeps around 20+ miles each year in relation to movement in the Earth's core.



MN and TN are the two you will use to adjust for declination. Without adjusting for magnetic declination, a map and compass is useless and will result in you getting way off course, if not lost. Keep in mind that declination is different for each state (and even within states) and changes slightly each year. The number listed on your map is not going to be accurate if it was from the 1960s. I call the USGS office each year or look online and get the current magnetic declination for my home state.



## Using a Compass

Now, put aside the topo map for a few minutes as we delve into the anatomy of a compass. I like the standard baseplate compasses made by *Silva* or *Suunto*. I am going to be referring to bearings when mentioning the numbers on the compass housing but this means the same as the term “azimuth” as used by the military.

On your compass, you will see three arrows. One of these is inscribed on the baseplate, outside of the liquid-filled round housing. The other two arrows are inside the housing. One of these is red and free-floating. The other two are imprinted and resemble a red shed.



A \$12 Silva or Suunto baseplate compass is a good model to begin with. Each tick-mark is 2 degrees.

1. Magnetic North is the red arrow (see photo below). This red arrow can be affected by power lines, iron-ore deposits in the ground, the metal of your vehicle, a metal zipper in your jacket (or a neck knife as one guy found out!), and other external factors in your environment. Again, MN points towards a physical location in the Arctic Ocean and is not connected with True North.

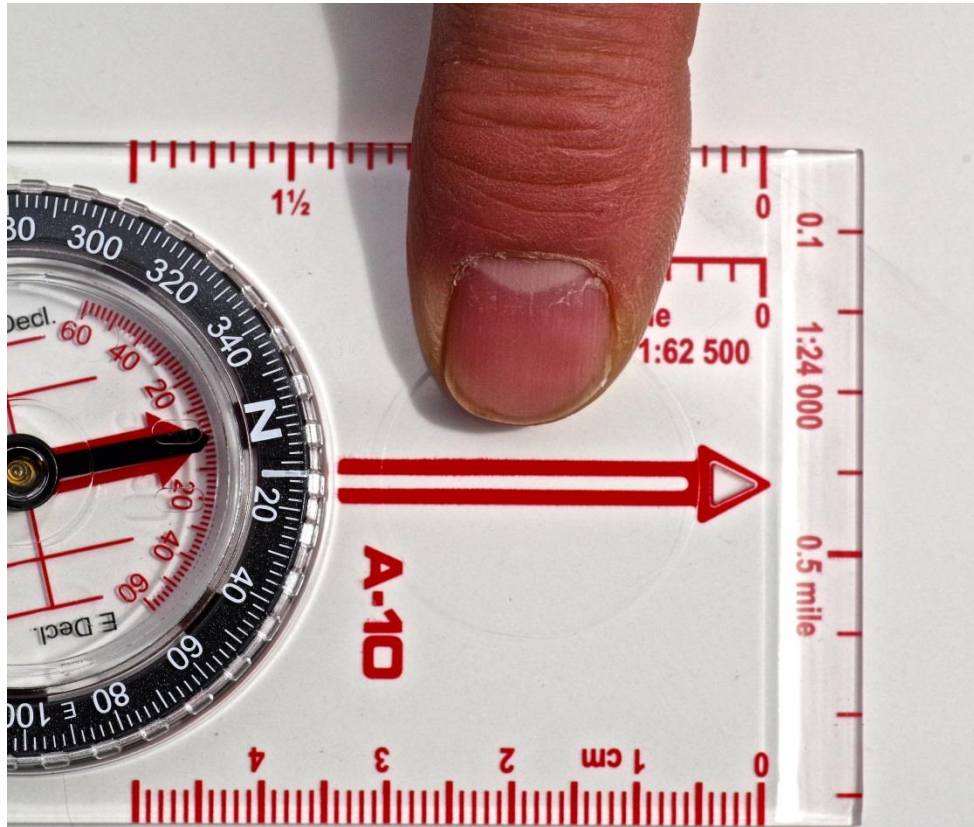




2. The Shed arrow is used to line up your Magnetic North needle with the bearing you dial in on the compass housing.



- The Direction of Travel arrow is inscribed on the flat exterior of the plate outside of the compass housing. This is used after you have lined up the two interior arrows. This arrow is used to point in the direction you will actually walk when following a precise bearing.



This static white line inside the compass housing is where you dial in your bearings.



## Steps in Dialing in and Following a Bearing

So far, I've just talked about the compass layout. Here's how you put it all together. First, stand up and "plug" the compass into your midsection. The bottom plate of the compass should rest squarely in your gut and will not be turned at any point. The compass dial, however, will be turned: you will dial in a bearing, let's say, of 84 degrees.



This is done by rotating the numeric dial until the number is lined up on the static white line on the housing. Next, turn your entire body (not the compass) until the red Magnetic North needle lines up directly over the red shed inside the housing. Once this is done, look at which way the direction of travel arrow on the outside is pointing. That is the way you walk to get to your destination, if you have pre-determined bearings.



If you want to practice this outside, then use the following three bearings on level ground. This will create a triangle pattern and have you arrive back at your starting point if you have performed all of the above steps correctly. This is based upon my pace count so you may be a few feet short or overstep your starting position but you should be in line with your point of origin (marked it with a water bottle). A pace is where you count every time your right foot touches the ground. Walk five paces for each bearing.

53 degrees

171 degrees

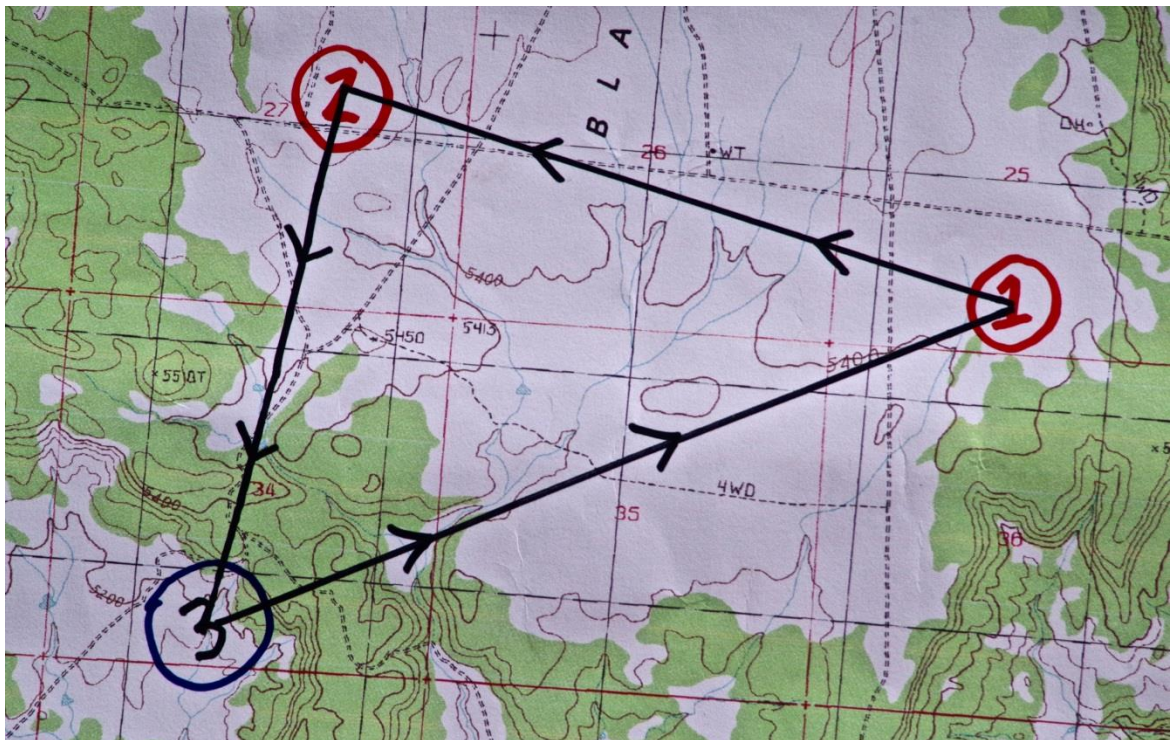
289 degrees

The above is simply an overview of how to use a compass and walk a bearing. You haven't adjusted for declination because there's no topo map involved, which is what we will look at next.

## Putting Map & Compass Together to Walk a Bearing



- 1) Lay out a topo map on a flat surface and mark off three arbitrary spots, spaced a few miles apart. Let's say that you are going on a three-day backpacking trip and each "X" will indicate a new campsite. Draw a line with a ruler or the edge of your compass, connecting all three spots.





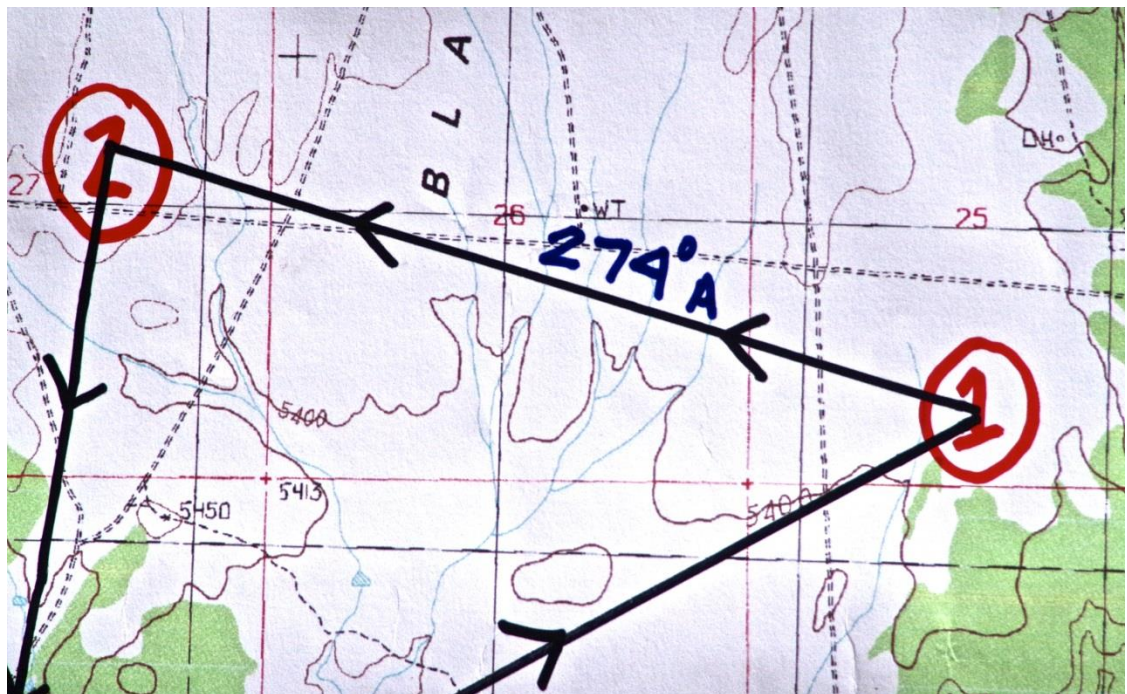
- 2) Here's how to determine the adjusted bearing from point 1 to point 2: place your compass edge on the line and dial the compass housing until the "N" is at the top and the red lines in the compass housing are parallel with the grid lines on your topo map.

***This is important:*** the N must always be on top so it corresponds with Grid North which at the top of the topographic map.



Notice how the red lines inside the compass housing are parallel to the black grid lines on the topo map. The bearing in the compass housing is 285 degrees but I haven't adjusted for declination yet.

- 3) Record the bearing on your compass dial and then adjust for magnetic declination. Where I live in Arizona, I have to subtract 11 degrees to get my adjusted bearing (though this could change by one degree next year). If you are back in the eastern U.S. you may have to add, based upon the information obtained from the USGS site for your region. Write the final number down on the line on your map so you have this adjusted bearing visible for when you arrive at the field and plan on walking your proposed route.





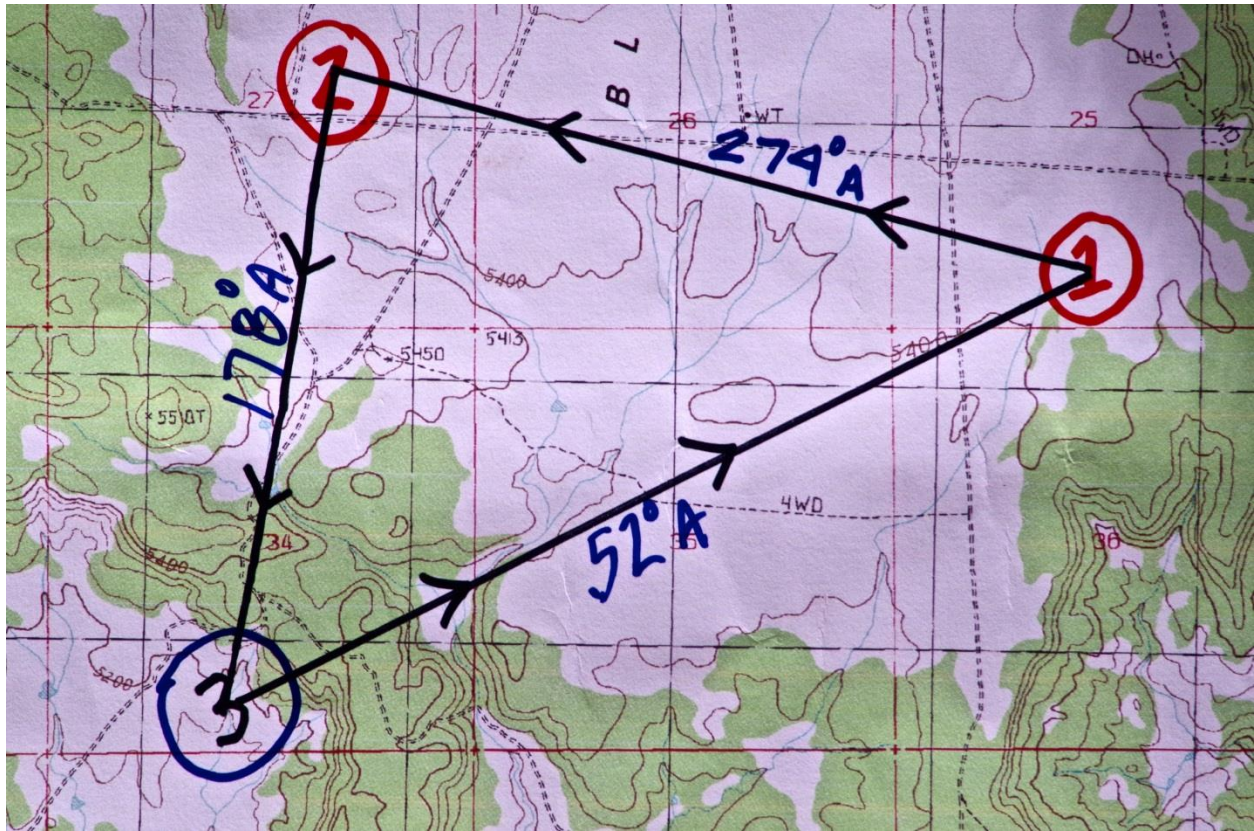
Perform this exercise for the two remaining marks on your map and you will have obtained the adjusted bearings for each route.



The baseplate is aligned but the compass dial has not been adjusted yet to align N with the top of the map.



Once again, align the red lines inside the compass housing so they run parallel to the black Grid North lines on the map. Then read your bearing on the compass dial and adjust for declination. It's not until I get to the field where I'll be hiking, that I line up the Magnetic needle over the red shed.

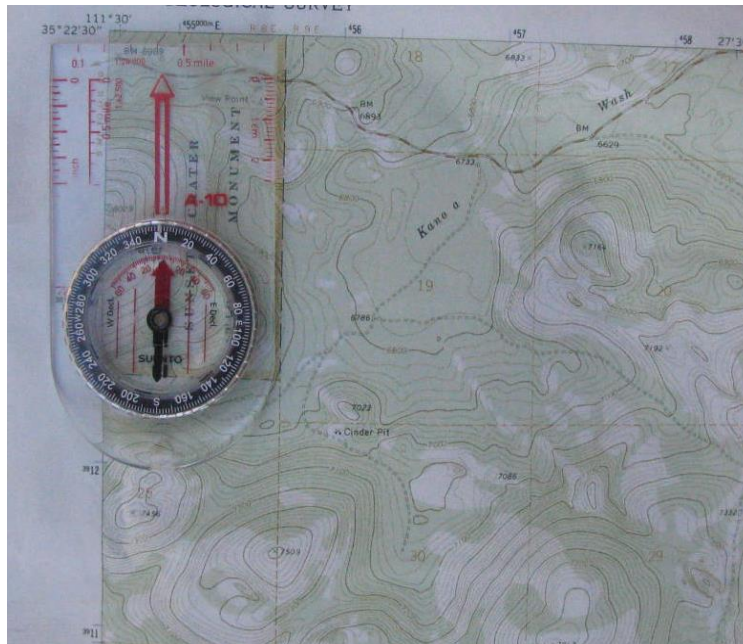


The completed bearings. To remind me that these have been adjusted for magnetic declination, I write in an “A” beside the bearing. Note the contour lines—this will be an easy hike along level terrain with a few small ridges to traverse near point 3. As to whether the roads will be there—who knows? This map was made in the 1970s. A visit to the local outdoor store or visitor center, prior to my trip, to talk to the locals will be the best bet.



## How to Orient Your Map Using a Compass

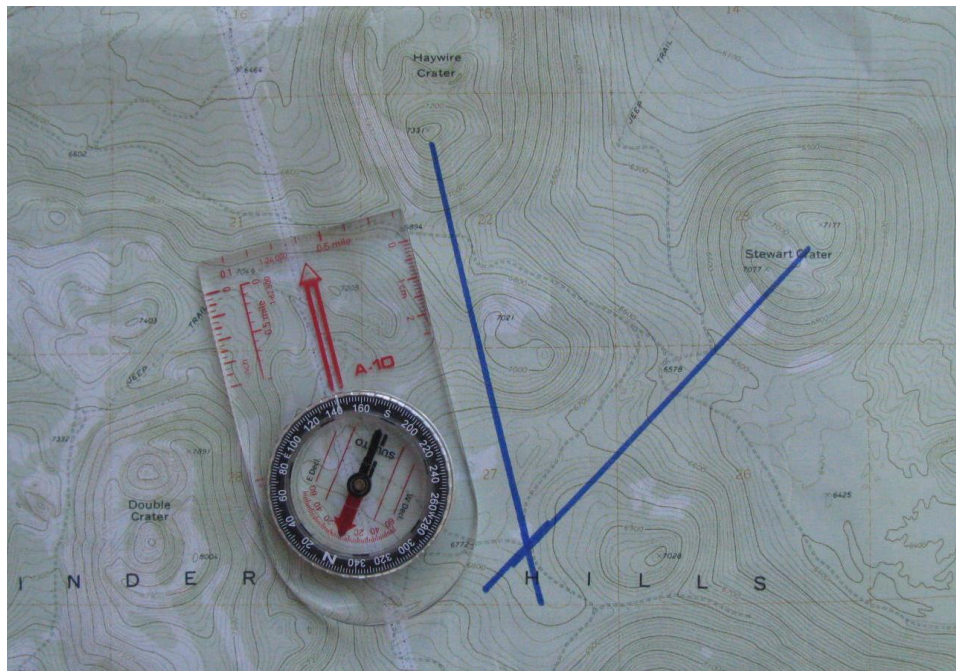
Correctly aligning my map to the surroundings is the first thing I generally do after getting out of my truck and preparing to hike. I unfold my map, lay it flat, and then place my compass along the top edge which is North. Then I adjust the compass dial until the “N” is at the top, which corresponds to North on my topo map. Next, I turn my entire body, with map and compass in hand, until the Magnetic needle is boxed in the red shed. My map is now properly aligned to my actual surroundings.



## Triangulation or How to Locate Your Position on a Map

So, you're on a backpack trip or long dayhike and want to locate your position on the map using the terrain features around you. This is where triangulation comes into play. You will need to layout your map, grab your compass, and then look for 2-3 separate prominent landmarks such as a hill, mountain, or mesa.

- 1) Take a bearing from the first landmark and then record this on your map.
- 2) Take a bearing from the second landmark and do the same.
- 3) Extend the lines you've drawn until they intersect and this will indicate your location.

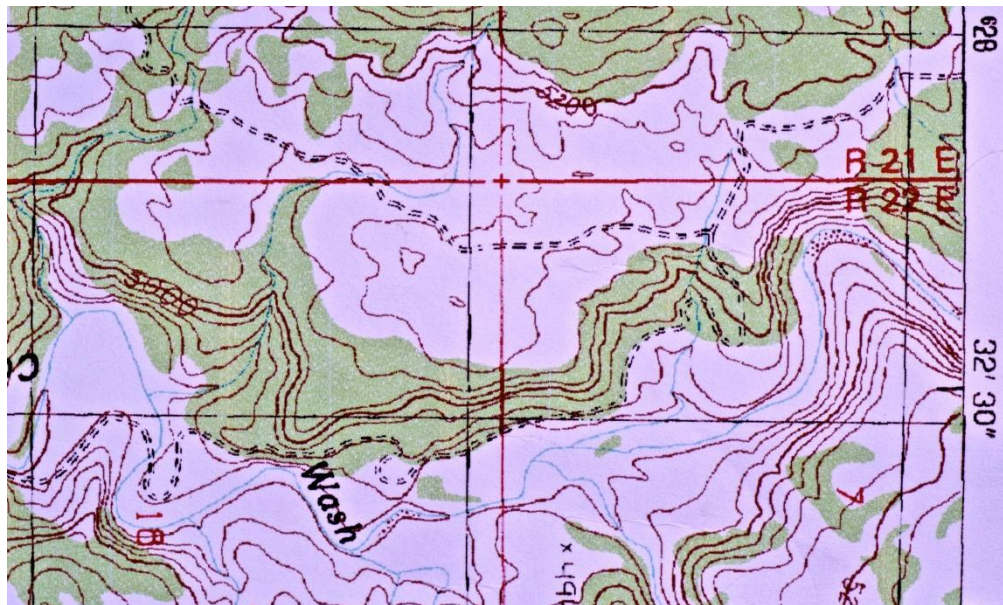


## Additional Tips for Staying on Your Route

A few other methods to employ for staying on track are the concepts of using handrails, backstops, chunking, and pace count. You already use some of these unconsciously on a daily basis so overlaying them onto a wilderness setting won't be much of a stretch. For instance, we all rely on handrails to move around the inside of our house in the dark or when driving to and from our house to the grocery store. We use pre-determined permanent objects/structures along the route that we have filed away as reliable indicators to help us to arrive at our destination.

When setting out on a hike in the backcountry using map and compass, you want to determine what permanent physical handrails will be present to your right and left along the way. For example, if I'm starting from the north and doing a hike to the "Wash" on the map below, I'll study the handrails beforehand. I don't just want to end up in the wash somewhere—I want to find the exact bend in the arroyo where the letter "W" in "Wash" is found.

In this case, I have a ridgeline that measures 5200 feet (top of map) that I will have to descend followed by a dirt road (dashed lines). For much of this section, the terrain will be flat as indicated by the considerable distance between contour lines. I will then come to another ridgeline (the 5000 foot mark), below which is another dirt road and the "Wash" (and hopefully a small stream). The cliffs to the south, just beyond the streambed will be my backstop. I know that once I hit the wash below and see the cliffs to the south that I will have gone far enough and will only have to walk a short distance to the east or west to find that exact spot where the "Wash" is at. During my hike, I will also have a finger-formation of rock jutting out to the east (just below the "R 22 E" on the map). This will serve as another handrail along the way. Keep in mind, that the roads may not be there depending on the age of the topo map but the ridgelines, hills, canyons, and other geologic features will be present. Power lines, railroad tracks, and blacktop roads should also be reliable but talk to the locals in the area first to see if your topo map features match up with current conditions, especially the water sources in the region.



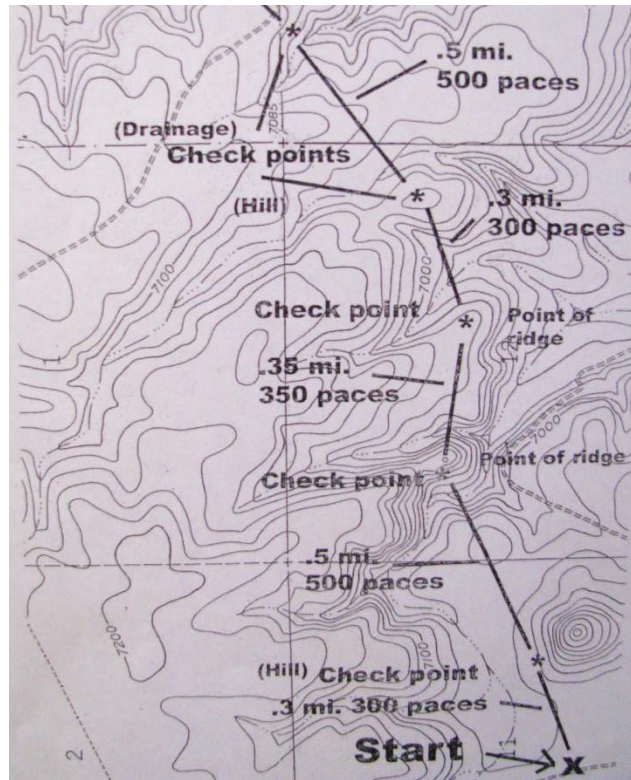


## **“Chunking” & Incorporating Pace Count**

The concept of “chunking” comes into play during a hike because I don’t just want to plot my bearing and then walk a few miles to the end without any reference points. This will result in me arcing to the right and getting off course as my right side is the predominant side in my walking stride. We see this all the time in our land navigation courses when we provide a bearing to the students and then tell them to meet us there in an hour. Those students, who work together in groups of two or three, leapfrogging as they go, stay on a straight line using nearby landmarks and arrive at the precise location. Those who hike solo, only glancing down at their bearing occasionally, end up arcing to the right (85% of humans are right-handed) and have to make up the distance. With chunking, I want to break up my hike into small segments which will help me stay on the bearing I need to follow. This technique is especially critical the further the mileage you have to cover.

Once you plot your bearing and identify your handrails and backstop, you will want to line up your compass’ direction of travel arrow with a prominent natural feature such as a stump, dead tree, boulder, etc... and then walk to that object following your bearing. This prominent feature should be 50-200 yards away depending on the terrain. In the desert, with such wide-open vistas, I’ll often key in on a distant tree or jutting boulder a few hundred yards away and then walk to that. Conversely in the forest or jungle, I may only walk fifty yards. Once I arrive, I search ahead for another distant feature that is in line with my direction of travel arrow. I keep doing this to ensure I’m staying on a precise bearing.

Again, working with 2-3 people and “chunking up” the route will really keep you headed in the right direction. If you’re alone, then you have more work to do. Depending on the distance, I like to stop every half mile or mile and do a quick check of my map, the handrails, and the distance we’ve covered to confirm we are on track. These checkpoints are usually tied in with shade or hydration breaks.



## Incorporating Pace Count

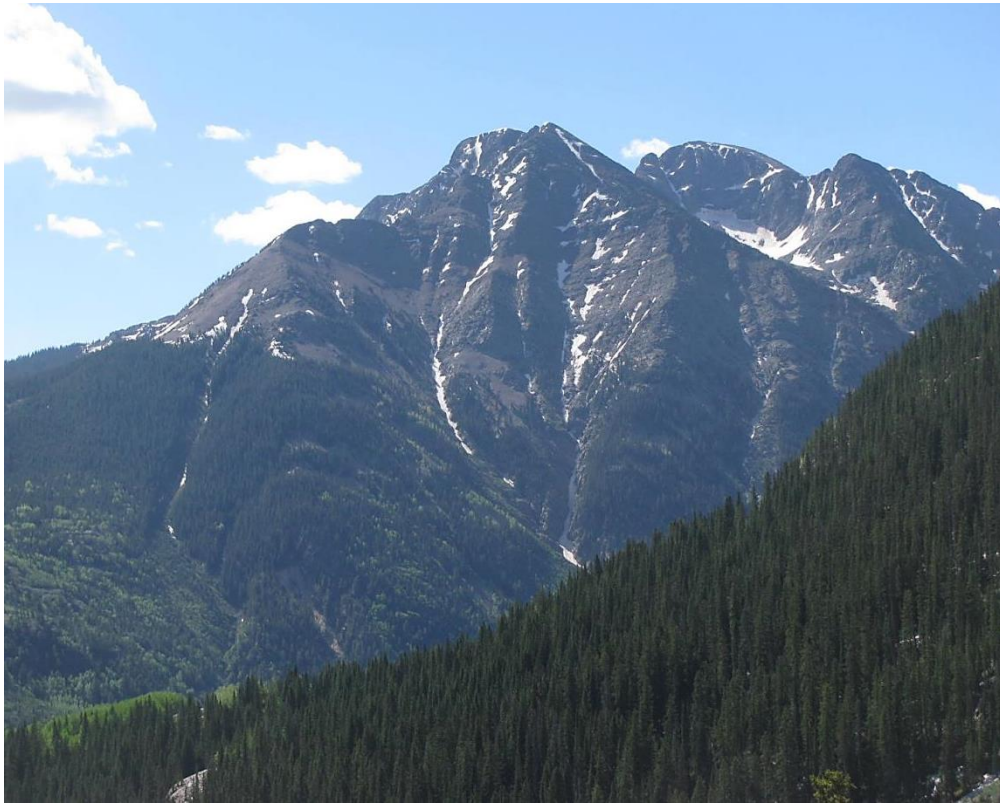
Pace count can also be helpful with the chunking method. Pace counting involves mentally recording every time your right foot (or left but stick with one side) touches the ground. While there are going to be variations between individuals, the average adult walks 250 paces in a quarter mile distance, 500 paces in a half-mile, 750 in three quarters of a mile, and roughly 1000 paces in one mile. In this example, the pace count corresponds to the decimal equivalent of each  $\frac{1}{4}$  mile increment. So, if I'm going on a trek that's 2.5 miles that will average out to 2500 paces. I will still use visual landmarks along the way to chunk the distance but I will also record every time I reach 100 paces. I can do this by writing it on my map, cutting a notch in a stick, placing a pebble in your pocket or tying a knot in a piece of rope (similar to the military approach of using "Ranger Beads").

Bear in mind, that all of the above is for a typical pace count. If I'm carrying a heavy pack, walking in sand, over hills, or at night, then I may have to add 10-15 in paces for every mile. I have to be honest, I don't use pace counting much in the desert where I can key in on distant landmarks. However, if I'm in a thick forest or jungle then it is extremely helpful.

To summarize, use handrails, backstops, chunking, and pace count as tools to help you stay on an accurate bearing. Keep in mind that for every degree you are off in your route-finding, you will end up a thousand feet off per mile from your desired location. Imagine what this will amount to on a ten-mile trek!

## How Much Mileage Will I Cover In An Hour?

This depends on the terrain, weather conditions, visibility, your pack weight, etc... The average mileage for a healthy adult on foot on flat terrain is two miles per hour. Extremely fit hikers can average three miles per hour. However, if you are trekking in the mountains, over sand dunes, a dense forest, or through canyon country, then you will have to factor in more time. Add in a cumbersome pack and dwindling energy levels at the end of the day, then your mileage will decrease accordingly. Start with the assumption that, given ideal conditions, you will make around two miles an hour and then adjust for the above factors as your hike unfolds. There are no shortcuts in the wilderness and often the longest route around a canyon or swamp is going to be *quicker* than trying to bushwhack across challenging terrain to maintain a linear path.



Thus far, this has been an academic approach to learning how to use a map and compass. You will have to put all this together on field-exercises and refine your navigation skills. Do this with a friend and over a short distance of  $\frac{1}{4}$  mile. This will enable you to safely build up your ability to walk a bearing and overlay what you are seeing on your topo map with the actual landscape.

## Suggestions for Purchasing and Programming a GPS

While I carry a GPS unit, it is no substitute for being able to use a map and compass. Learn the latter approach and you will always be able to find your way around the backcountry. Like all wilderness skills, land navigation is a perishable ability so practice several times a season or consider participating in an orienteering competition to keep you on track in the wilds.

A GPS can be a great tool to augment your map & compass skills. Purchase one of the higher-end models by Garmin that allows you to upload topo map software. Then you need to log some time at home figuring out the specific functions of your GPS model as each one is different. Never rely solely on a GPS as they can unexpectedly lose their data, are prone to damage if you drop it, and will sometimes lose the connection with the satellites.

If you are new to using a GPS, you will want to program the **Map Datum** to match up with the topo map you are carrying. This information can be found in the bottom left corner of your map or online as “Horizontal Datum.” In my case, I use *NAD 27 CONUS*. The **Position Format** will also need to be calibrated for your region. For my location, I use *UTM/UPS*.

PRODUCED BY THE UNITED STATES GEOLOGICAL SURVEY  
CONTROL BY ..... USGS, NOS/NOAA  
COMPILED FROM AERIAL PHOTOGRAPHS TAKEN ..... 1959  
FIELD CHECKED ..... 1962  
LIMITED REVISION FROM AERIAL PHOTOGRAPHS TAKEN ..... 1984 AND 1985  
FIELD CHECKED ..... 1986      MAP EDITED ..... 1989  
PROJECTION. .... LAMBERT CONFORMAL CONIC  
GRID: 1000-METER UNIVERSAL TRANSVERSE MERCATOR ..... ZONE 12  
10,000-FOOT STATE GRID TICKS ..... UTAH, SOUTH ZONE  
UTM GRID DECLINATION ..... 0°52' EAST  
1989 MAGNETIC NORTH DECLINATION ..... 12°30' EAST  
VERTICAL DATUM ..... NATIONAL GEODETIC VERTICAL DATUM OF 1929  
HORIZONTAL DATUM ..... 1927 NORTH AMERICAN DATUM  
To place on the predicted North American Datum of 1983,  
move the projection lines as shown by dashed corner ticks  
(3 meters north and 60 meters east)  
There may be private inholdings within the boundaries of any  
Federal and State Reservations shown on this map  
No distinction made between houses, barns, and other buildings  
Public Land Survey System is shown as published in 1962 and  
verified or supplemented in 1986

If I travel out-of-state, then I will have to adjust both of these for the new location or risk getting off course. Both features can be found by going to *Setup* then clicking on the *Units* section of your GPS. The proper adjustment of these key areas is crucial for using your device accurately. Most REI gear stores have 2-hour evening sessions that cover all of these nuts-and-bolts. Otherwise, pick up a copy of *The Basic Essentials of GPS*.

For additional reading on orienteering, check out the classic manual by Bjorn Kjellstrom, *Be Expert with Map and Compass*.



## A Few Tips for When You Are Afield

- 1) When you are in a group, don't play follow the leader and rely on just one person's route-finding ability. I see this happen a lot, where the group defers to the person who is the most experienced outdoorsman/woman and lets them lead the way, even though everyone has their own map and compass. If you have five people in a hiking group, then all five people should be double-checking bearings, handrails, paces, and identifying terrain features to stay on track.
- 2) Always get in the habit of looking over your shoulder as you hike as you may be going that same direction on the return trip. I do this just when I'm out on a short walk and not even doing land navigation. In particular look for prominent features such as boulders, fallen trees, or large stumps. This 360 degree approach to paying attention will help you become more attuned to the landmarks around you.
- 3) Get in the habit of using terrain association whenever you are in the outdoors and not just during land navigation exercises. Study the hills, canyons, mountains, lakes and other natural features around you and then pinpoint your location on a topo map. This is a tremendous awareness tool that will build confidence in your lostproofing skills.
- 4) Remember there are no shortcuts in the wilderness. Going around a canyon or swamp may involve more mileage but it is far better than burning up the day (and precious calories) scrambling through treacherous terrain.
- 5) Move smart not fast. Frequently identify and confirm landmarks, reference your map, compare your bearing and route with fellow participants, and don't be afraid to return to your last landmark or checkpoint if you've gotten off track.



Thank you for your interest in my books. If you have any questions, please feel free to email me at [anester@apathways.com](mailto:anester@apathways.com) or visit our website at <http://www.apathways.com> for a look at our other survival books, DVDs, and gear.

Enjoy the Wilds!

Tony Nester

Ancient Pathways Survival School, LLC

***About the Author:*** Tony Nester is the author of numerous books and DVDs on survival. His school *Ancient Pathways* is the primary provider of survival training for the Military Special Operations community and he has served as a consultant for the NTSB, FAA, Travel Channel, NY Times, Outside Magazine, and the film *Into the Wild*. When not trying to stay upright on a paddle board, he lives in a strawbale house in the mountains of Flagstaff, Arizona.

