Map, Compass and Land Navigation

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Land Navigation Skills Importance

- Many emergency situations will not become survival situations if you do not become lost.
- Many people carry compasses without knowing how to use them.
- The path of least resistance is usually best. A map and compass can help you travel this way.
- Land Navigation is one of the first skills taught by Estela Wilderness Education during courses. It is placed high on the hierarchy of skills.
- Without direction, do you know where you are going in the woods?
Comfort in Location

- Human beings feel comfort in knowing their place with respect to time and space. Ex. “Honey, I’m only 10 minutes from home.”
- What happens to a person when they become lost? When they don’t know how long it will be until they’re home? How far they are from safety?
- Short term: Fear, anxiety, rushing, mistakes, etc.
- Long term: injury or death
Navigation Myths

• Moss only grows on one side of a tree.
• My compass will work all the time, my GPS won’t.
• I won’t get lost! I’m an outdoorsman.

Navigation Reality

• Moss grows on all sides of trees.
• You can break your compass or lose it.
• Even seasoned outdoorsmen get lost, injured and die.
Why People Get Lost

- Shame (Everyone is going to laugh at you “Woodsman.”)
- Fear (I have to get off this mountain NOW!)
- Change of Plans (Last minute tip on where the fish are biting.)
- Peak baggin’ or Summit Fever (the final destination is home, not the top.)
- Ego (I’m not lost, I know where I am.)
- Many other factors not listed here.
Map Alone (Part I)

- A map is a representation of part of the earth (sometimes entire.)
- Most common used by outdoorsmen is the Topographic Map or Topo Map.
- Topo maps feature imaginary lines called Contour Lines that connect areas of equal elevation.
- Contour Intervals, or the elevation change between contour lines, can be low if the area is relatively flat (10 ft. per interval) or high if the area’s elevation varies greatly.
- The Topo Map also shows roads, buildings, vegetation, water and many more details.
Map Alone (Part II)

- With only a map, a person can perform “map recon” of the actual area without leaving the comfort of home. It allows a view of the area without actually being there.
- Able to determine: nearest road, stream, place of refuge, etc.
- With a map you can answer: What is the gradient like? What direction do you go towards safety? Towards danger?
- A person can get an approximation of orientation (more to come on this) from looking around and laying the map as the land actually sits.
- A map provides info in unfamiliar lands.
Map Distortion/Inaccuracy

• The earth is round, a map is flat. There is no way to make a round object out of something flat or vice versa (think orange peel.)

• It may be years before a map is updated. Make sure to use the most recent version. There may be new developments or changes in topography not noted in older versions.
North? Norths?

- **Magnetic North**
  This is the North you will use for the majority of your navigation.

- **True North**
  This is the direction of North along the Earth’s surface towards the North Pole. Direction towards the North Star.

- **Grid North**
  Direction towards north pole along grid lines on a map projection. Rarely used in field orienteering and navigation for the outdoorsman.
What is Latitude? Longitude?

• The earth is divided into 360 degrees of longitude (imaginary lines running North and South.) These are divided into 180 degrees East of the Prime Meridian and 180 degrees West of the Prime Meridian. These lines are widest at the center of the earth and most narrow at the two poles.

• There are 180 degrees of latitude with 90 north of the equator and 90 south of the equator. These lines run parallel.
What is Latitude? Longitude?

- To make location more accurate, each degree of latitude and longitude is broken down into further degrees called minutes (shown with a ‘) and seconds (shown with a “.”)
- A minute of latitude is approximately 1.15 miles. A second is about .02 or about 100 feet.
- Therefore, a 7.5 minute map series covers approximately an area of approximately 8.625 miles by 8.625 miles. This is a total area of almost 75 square miles (74.39 to be exact.)
- Your navigation skills better be accurate!
Common Map Colors and Symbols (part I)

- Blue = Water \((Water\ is\ usually\ named\ and\ is\ in\ italics)\)
- Black = cultural features (manmade)
- Brown = Earth (topographic contours)
- Green = Vegetation
- Purple = Revisions to Map (still present on many maps but not used anymore)
- Red = Land grids and important roads
Common Map Colors and Symbols (part II)

Carriage Road...............................  
Hiking Trails................................  
Main Road (highway)......................  
Park Loop Road............................  
Park Boundary..............................  
Ranger Station............................  
Campground...............................  
Picnic Area.................................  
Handicap Access...........................  
Trailhead....................................  
Points of Interest........................  
Elevation (in feet)....................... 1226  
Hiking Trail Difficulty Rating......... M  
Carriage Road Bridges................... 6  
Carriage Road Signposts............... 19  
Scenic Turnout...........................  P  
Food Service..............................  ?  
Boat Ramp.................................  ?  
Parking Area..............................  P  
Rest Room.................................  ?
Contour Lines and Topography

- Contour lines represent elevation change. For example, the space between two lines may be 10 feet.
- The closer lines are, the steeper the terrain. The farther apart, the flatter.
Understanding Map Scale

• 1:24,000 means 1 of anything on a map (1” or 1’) translates to 24,000 of the same in “real life.” Therefore, 1” on a map is 24,000” in real life. 2.5” on a map is about a mile on a 1:24,000 map. 1:25,000 is available as well as additional scales.

• 7.5 minute series is based on hours, minutes and seconds in latitude and longitude. Essentially, it covers 7.5 minutes of latitude and 7.5 minutes of longitude.
Prepping the Map for Use

- Find the north arrows at the bottom of the map. Use magnetic north for your navigation.
- Use a straight edge and draw magnetic north lines across the map parallel to each other.
- Your magnetic north arrow may be folded out of view but your parallel lines will be visible.
- Coat with a map sealant or Thompson’s Water Seal.
- Fold carefully and place in a zip-lock bag for use.
Care For Your Map

• Always carry in a zip lock bag. Treat with water proofing agent if possible (Thompson’s Water Seal works great!)

• Fold it properly and avoid multiple creases if possible. Always fold it the same way.

• Carry on your person, not in your pack.

• Carry a spare map (they can blow away.)

• Have a smaller map of the specific area photocopied for easy of use.

Map stored in Zip-lock Bag
Pacing (Part I)

• A pace is not a single step. A true pace is a step with your right then left or left than right.

• Derives from Roman times. 1000 (milli) paces was a Roman mile. Average pace of a Roman legion = 5.28 feet or 1/1000th of a mile.

• Pacing cannot be determined accurately by laying down a tape measure and taking a single pace. It must be done over a distance and be averaged by this formula

Distance in Feet divided by Number of Paces. This determines your “Factor.”
Pacing (Part II)

• Head to your local school’s outdoor track and find out how far a single lap is in feet. Usually, one lap is a ¼ mile.
• Take a 50’ tape measure and mark off 100’ feet or more (528’ is nice if you can do it.)
• Take normal strides and see how it changes with different footwear, weather conditions, pack weight, etc.
• Learn your body and what you can do.
• Personally, my factor is 5.6. Therefore, every pace I take is approximately 5.5’ long, and 94 paces equals a 1/10th of a mile.
• Learn to count “and one, and two, and three” as it makes for easy remembering.
Pace Beads and Use

• 4 on top represent miles and 9 on the bottom represent 1/10\(^{th}\) of a mile each.

• For every 1/10\(^{th}\) of a mile, one bead is pulled down for the first 9/10\(^{th}\) of a mile. When a mile is completed, the 9 are returned to the top and a single mile bead from the top 4 is pulled down.

• Originated with the U.S. Army Rangers to determine kilometers traveled.

• Civilians in the U.S. use mile measurements more frequently and this is why they have been adapted to miles instead of kilometers.
Pacing

- Full left stride then full right stride = One Pace
Compass Alone

- If left with only a compass, an outdoorsman can still navigate effectively and accurately over distance.
- It is possible to travel in one direction and backtrack with accuracy to the general starting point.
- A map can be drawn with scouting trips.
- Even a simple button compass can give an advantage over a person without navigation tools.
**Types of Compasses**

- **Button**: commonly carried in survival kits or on jacket lapels. Accuracy varies but can be generally good.
- **Lensatic**: popularized by military. Used for calling in artillery and general orienteering. Great for intended purpose. Inability to see through base is a hindrance.
- **Baseplate**: most common sold at most outdoor stores. Excellent for land navigation, orienteering, learning map and compass.
- **Electronic**: Wristwatch, car, etc. Batteries fail.
- **Improvised**: shadow sticks, magnetized needle, etc.
Anatomy of the Compass

- **Directional of Travel Arrow**
- **Inclinometer Needle**
- **Rotating Bezel or Dial**
- **Scales**
- **Pacing Beads**
- **Lanyard made from gutted 550 parachute cord**
- **Lid with Sighting Mirror**
- **Magnetic Needle (red points North)**
- **Ruler/Straight edge**
- **Small Magnifying Lens**

**The “Shed”**

**Small Magnifying Lens**
“Red In The Shed”

• This phrase is used to remember how to take a proper bearing.
• This picture shows the shed, a small outline within the bezel resembling a shed.
Personal Favorite Compass

- Suunto MC-2
- Lid acts as an extension of the baseplate for long line drawing. Also protects the compass.
- Luminous bezel (activate with light.)
- Small rubber knobs on base provide grip on map for neat line drawing.
- Easy to manipulate with winter gloves on.
- Lanyard replaced with “gutted” 550 paracord and pace beads attached.
- Worn inside the shirt when actively navigating. Won’t snag on branches there.
- Carried in leather case for added protection when stored in pack.
About Declination

- Is defined as: the angle between the geographic and the magnetic meridian at a given point, expressed in plus degrees east or minus degrees west of true north. (www.dictionary.com)
- Some compasses feature declination adjustments on the bezel. We don’t advocate changing it.
- What happens if you forget to change it back? Don’t get in the habit of changing it at all.
- Don’t throw out that little screwdriver in case it does shift on you in the field by accident.
- Use the map orientation method shown later to avoid using the declination feature on your compass.
Taking a Bearing (Azimuth) Without a Map

- Make sure your bezel is turned to 0 degrees north.
- Point your directional arrow on the compass towards your target destination.
- Notice where the magnetic north needle is pointed.
- Rotate your bezel until you place “Red in the Shed.”
- When the north needle is in the shed, read your bearing/azimuth at the directional arrow.

When walking this bearing, find a prominent feature along the route. Walk to it and shoot your next bearing from it.

If you did have a map, you should measure the distance from your starting point to your destination and convert it to paces to ensure you don’t end up short or long.
Taking Bearings

Standing

Kneeling (note elbow resting on knee for stability)
Bearing with a Sighting Mirror

- Hold the mirror at an angle to provide a view of the bezel.
- Line up the directional arrow with a prominent point.
- Make sure “red is in the shed” and read the bearing.

Note the magnetic needle in the shed
Taking a Back Bearing
(Reverse Azimuth)

- To determine a back bearing or reverse azimuth, you must either add or subtract 180 degrees. If your original bearing is…

**Over 180 degrees then Subtract 180 degrees.**

**Under 180 degrees then Add 180 degrees.**

- It is also possible to simply turn the compass around or put the opposite side of “red” in the shed. However, your bezel may rotate and you could be off. Record your bearing and do it the proper way.
Offset Shooting

1.) Bearing from car to campsite is originally 190 degrees Southwest

2.) Back bearing is deliberately offset fewer degrees. Vehicle will be west down the road.

Campsite

- Offset shooting allows a person to have an approximate idea where an object is. With a direct bearing in the situation above, a person may reach the road but not find his/her car. The curves in the road prevent a clear line of sight. With an offset, when he/she reaches the road, they will know whether to travel West or East and can avoid a long walk one way, then back the other.
Boxing an Obstacle

2.) Turn right, add 90 degrees and count paces until you pass the object. Now at 200 degrees bearing.

4.) Turn left again, subtract 90 degrees and walk same number of paces past object as in step 2. Now bearing 20 degrees.

3.) Turn left subtracting 90 degrees and walk past object. Back to 110 degree bearing.

1.) Original Bearing 110 degrees. Walk until you can’t pass the object.

5.) Continue on original bearing of 110 degrees towards destination.

General Tip:
If you turn LEFT, LOWER (the bearing.)

If you turn RIGHT, RAISE (the bearing.)

<table>
<thead>
<tr>
<th>Boxing Left</th>
<th>Boxing Right</th>
</tr>
</thead>
<tbody>
<tr>
<td>Subtract 90</td>
<td>Add 90</td>
</tr>
<tr>
<td>Add 90</td>
<td>Subtract 90</td>
</tr>
<tr>
<td>Add 90</td>
<td>Subtract 90</td>
</tr>
<tr>
<td>Subtract 90</td>
<td>Add 90</td>
</tr>
</tbody>
</table>
# Importance of Accuracy

<table>
<thead>
<tr>
<th>Declination or Degrees Off Course</th>
<th>Error Off Target After Walking 10 Miles</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 degree</td>
<td>920 Feet (280 meters)</td>
</tr>
<tr>
<td>5 degrees</td>
<td>4,600 Feet (1,402 meters)</td>
</tr>
<tr>
<td>10 degrees</td>
<td>9,170 Feet (2,795 meters)</td>
</tr>
</tbody>
</table>
Step 1.) Place a stick in the ground about 3’ high. It does not have to be a perfectly straight stick.

Step 2.) The first shadow cast is always the Westward shadow. Mark the tip of the shadow with a twig or small stone.

Step 3.) Mark the tip of the shadow as it creates an arc with the movement of the sun. Multiple markings are best. Noon will have the shortest shadow.

Step 4.) Mark the tip of last shadow of the day. The longer you wait, the more accurate the shadow stick method is.

Step 5.) Draw an imaginary line between the tips of the shadows. This is your East/West line. Directly 90 degrees in between is North/South. Stand on the line with your back to the stick and you are facing North.

This system will give a relatively accurate indication of direction. It will remain accurate for approximately 2 weeks.
Improvised Compass

• A sewing needle or straightened fish hook can be used as an improvised compass needle.
• It is magnetized by rubbing it against a magnet in a single direction from the halfway point of the needle to the tip. Stroke 25 to 30 times.
• If you don’t have a magnet, look for a creek. The black specks in the silt are usually magnetic. Gather it (time consuming) and use this with your needle.
• The needle is floated on water and it will align North and South.
• Use the Sun to help determine which end is North and South.
Improvised Compass

- Take an analog watch and line up the shadow from a stick with the hour hand. Halfway between the minute hand and the shadow is North.
- For a digital watch. Take a piece of paper and draw an analog watch’s face. Follow same steps.

U.S. Army Survival Manual Fig. 18-2
Compass Trouble Shooting (Part I)

• Buy the best you can afford. You don’t want to “pay for it” after you buy it. Understand?
• Hold your compass flat, level and away from metal or magnetic objects when reading it.
• Protect your compass from damage by carrying it in a case or around your neck.
• Take two compass readings with different compasses or two people with one to ensure accuracy.
• Trust your instruments.
• DO NOT CHANGE DECLINATION ON COMPASS BEZEL (more about this later)
• Note the 5 degree plus change in bearing due to the metal in the watch. If you wear eyeglasses, is the frame made of metal? Believe it or not, they have thrown off bearings during our courses.
Map and Compass

• Provides the best combination for land navigation.

• Allows a person to properly:
  Orient a map
  Plot a course
  Find location
  Much, much more!

• Pair with a GPS for better accuracy. Remember, batteries fail so don’t rely on that electronic crutch.
Map with Compass (Part 1)

Orienting a Map

- Orienting a map means placing it on a surface and lining up magnetic north on the map with magnetic north on the compass.

- To orient a map
  1. Have map and compass ready. Make sure compass bezel is turned to 0 degrees north.
  2. Place edge of compass on the magnetic north needle of the compass rose or one of the parallel lines you drew in preparing your map.
  3. Without picking up the compass, turn the entire map with the compass on top of it until you put “Red In The Shed.”
  4. Your map is now oriented to the land.
Orienting a Map Reference Picture

• Compass Lined up with Magnetic North Needle.

• Rotate Map and Compass without picking up compass and put “red in the shed.”
Taking a Bearing with Map and Compass

1. Orient Map

2. Draw a line from start to finish

3. Lay compass edge along drawn line.

4. Hold compass baseplate and turn bezel until north needle is pointing parallel to MN parallel lines. Read azimuth over the travel arrow.
Resection

• First, orient the map to magnetic north.
• Second, find two known points/features in the distance and find them on your map.
• Third, take a bearing/azimuth to each of the locations and write it down.
• Fourth, find the back bearing/azimuth for each and draw them on your map.
• Finally, where the lines intersect is your approximate location.
Resection (Visual)

1.) From your location, it is a bearing/azimuth of 25 degrees to the Fire Lookout Tower. Back bearing/azimuth equals 205 degrees.

2.) From your location, it is a bearing/azimuth of 55 degrees to the Water Tower. Back bearing/azimuth equals 235 degrees.

3.) Where the lines intersect here (when drawn on your map) is your location.

Note: Actual degrees shown between lines not drawn for accuracy.
Triangulation (Part I)

- Works on the same concept as Resection only 3 (Tri) or more bearings/azimuths are used.
- The example to the right shows how to find location of self on a map.
Triangulation (Part II)

• The example to the right shows how to find location of an object from three known places.
• This is useful if communication between the known places is available.
• Ex. fire crews could pinpoint where a fire is on a map. They could then determine known water sources, sources of fuel, homes in danger, etc.
Celestial Navigation

- Find the big dipper. The North Star is almost directly in line with the bottom of the “lip” about 5 times the distance away of the space between the bottom two stars.
- The North Star is the last star in the handle of the little dipper. The little dipper always pours into the big dipper. It is also not always visible because it is dimmer.

U.S. Army Survival Manual Figure 18-3
1.) Create a “rifle sight” out of a straight immovable object with two sighting points in a line. You can also use two sticks (6’ and 3’ tall)
2.) Line up the sight with a star in the distance (except the North Star).
3.) Wait and record noticeable movement.
4.) Follow LURD and determine which direction you are facing.

<table>
<thead>
<tr>
<th>MOVEMENT</th>
<th>DIRECTION FACING</th>
</tr>
</thead>
<tbody>
<tr>
<td>LEFT</td>
<td>NORTH</td>
</tr>
<tr>
<td>UP</td>
<td>EAST</td>
</tr>
<tr>
<td>RIGHT</td>
<td>SOUTH</td>
</tr>
<tr>
<td>DOWN</td>
<td>WEST</td>
</tr>
<tr>
<td>LEFT/UP</td>
<td>NORTHEAST</td>
</tr>
<tr>
<td>RIGHT/UP</td>
<td>SOUTHEAST</td>
</tr>
<tr>
<td>RIGHT/DOWN</td>
<td>SOUTHWEST</td>
</tr>
<tr>
<td>LEFT/DOWN</td>
<td>NORTHWEST</td>
</tr>
</tbody>
</table>
Inclinometer

- Some compasses are equipped with an inclinometer inside the bezel to determine angles.
- This can be used to determine latitude and much more.
- Turn to 90 degrees and use the straight edge on the angle you are reading.
- If placed on a dash board, the inclinometer can be used to determine a vehicles traversing angle.
- If carried in avalanche terrain, it can be used to aide in avalanche avoidance. (slope 35 to 45 degrees are known to be high risk)
Determining Latitude with a Compass  
(advanced skill)

• Latitude is based on this simple formula, \((\text{latitude of any place in the northern hemisphere}) = (\text{latitude of the North Star at same place.})\)

• Using the inclinometer, point the top edge of your compass at the North Star.

• Read the angle with relation to the horizon and convert it to your approximate latitude.

• If two people are present, one can sight, the other can read.

• If one is present, the sighting mirror can be angled back to read the inclinometer without adjusting the compass.

• Take multiple readings and average the results.
Recommended Gear

- Always carry an emergency kit in case your compass skills fail. (include provisions for fire, shelter, signaling and water collection at a minimum)
- Backup compass
- Fresnel lens
- Waterproof pad and pencil
- Small flashlight
Self Assessment

• Can you identify parts of a compass?
• How do you use a map alone for general way finding?
• Can you take a compass bearing? Back bearing?
• What is your pace? How do you use paces to determine distance traveled.
• What can throw off a compass’s accuracy?
• How do you box an obstacle?
• What is one way to improvise a compass?
• Can you orient a map?
• Can you find your location using prominent features, a map and a compass.
• How do you find your way at night?

IF YOU CAN’T ANSWER THESE QUESTIONS, YOU NEED TO REREAD THIS AND PRACTICE MORE!
Additional Resources

- Estela Wilderness Education (www.kevinestela.com)
- United States Geological Survey (www.usgs.gov)
- Suunto compasses (source of Suunto MC-2 Compass)
- Brunton compasses
- Maptools.com (excellent map reading tools in convenient sizes)
- U.S. Army Survival Guide FM 21-76
- www.nationalatlas.gov
- www.mapquest.com (get a map of a particular lat and long!)
- www.magnetic-declination.com (find out latitude and longitude of any city plus magnetic declination)
Misc. Notes
About the Author

Kevin Estela first fell in love with the outdoors as a child. Entertained by the WWII survival stories his father endured in the jungles of the Philippines, Kevin wanted to learn more. Kevin grew up hiking, woods bumming, fishing and hunting in New England and spent his free time outside or reading about survival and wilderness skills. Over the years, his childhood interests became stronger and developed into his lifelong passion. Kevin’s passion now includes sharing what he knows with his students, family and friends.

Kevin is the Owner and Head Instructor of Estela Wilderness Education. He brings extensive educational experience to the courses and material he offers. Kevin is a regular contributing author for various websites and magazines. He is a guest speaker at various sportsmen’s shows, speaking engagements and webinars. He is a product tester for Bark River Knife and Tool and a Mountain Khakis Professional Ambassador. Kevin has taught on both the East and West coast and has traveled around the country and even to the United Kingdom to teach bushcraft and survival skills. He has been featured on the History Channel as an on-air subject matter expert for Expedition Africa: Survival Tips and was the technical advisor for these promotional videos.

Complementing Kevin’s background in survival and wilderness skills is his martial arts training. Kevin is trained in Sayoc Kali and is an Instructor in the Filipino martial arts system. He is also a Black Belt in the Applied Self-Defense program at RISu Martial Arts and a Blue Belt in Brazilian Jiu Jitsu under Sifu Chris Smith. Kevin has also received extensive firearms training and has trained under the best instructors around.

Prior to starting EWE in April 2011, Kevin was the Lead Instructor of the Wilderness Learning Center and one of the only survival instructors “Certified” by survival authority Marty Simon. Marty helped hone many of Kevin’s skills and taught him many more based on his years as a military and civilian survival instructor. Kevin and Marty continue to have an ongoing friendship today and Kevin considers Marty a great mentor.

At the WLC, Kevin taught numerous classes and conducted seminars from 2007 to 2012. Kevin taught all aspects of survival psychology, firecraft, water collection, shelter making, signaling, food procurement, cordage, and other elements of the Basic, Advanced and Winter Courses. Kevin spent many years learning about outdoor recreational products while employed at a busy retail sporting goods store during high school and college. While at this store, he received training in rock and ice climbing as well as mountaineering in the White Mountains. He spent summers canoeing and kayaking on the Farmington River in New Hartford, CT and was employed by Mainstream Canoe and Kayak Corporation as a Guide and Instructor. While at Mainstream, Kevin was responsible for trip planning, children’s group outings, developing programs and running operations.

In addition to outdoors education, Kevin has been a Full-time High School History Teacher since 2006. Kevin is also a track and field coach to a championship high school team. Kevin received his B.A. in American Studies from Fairfield University in 2002, his M.A. in American Studies from Trinity College in 2004 and his C.A.S. in Secondary Education from the University of Bridgeport in 2007.

Kevin’s unique blend of survival skills and educational experience make him an instructor with much to offer his students.