Map and Compass Navigation

By C. Kohn

Agricultural Sciences

Waterford, WI

Intro to Navigation

- **Outdoor recreation is an excellent way to appreciate natural resources and the environment – the more that an individual can experience the outdoors, the more they will want to protect these resources.**
  - However, individuals who enjoy of the outdoors also have obligations associated with this recreation.
- **One of the main obligations associated with outdoor recreation is the concept of the Leave No Trace Ethic.**
  - This means that those who enjoy the outdoors have an obligation to respect the rights of other individuals.
  - This also means enjoying outdoor resources in a manner that ensures that they can be enjoyed for generations to come.

Source: http://images.campgroundsigns.com/img/lg/K/leave-no-trace-campground-sign-k-0520.png

Leave No Trace

- **The Leave No Trace Ethic has 7 principles:**
  1. Plan ahead and prepare. Do not put yourself or others at risk.
  2. Stay on durable surfaces as often as possible; do not leave trails or set up tents or light fires outside of established sites.
  3. Pack out whatever you pack in. Never litter or leave trash.
  4. Leave what you find. Only take photos.
  5. Minimize the impacts of fire, or avoid it altogether.
  6. Respect wildlife; do not disturb or feed them.
  7. Be considerate of other visitors. Leave the wilderness better than you found it.

Source: http://www.scouting.org/Home/OutdoorProgram/OutdoorEthics/LeaveNoTrace.aspx

Leave No Trace and Navigation

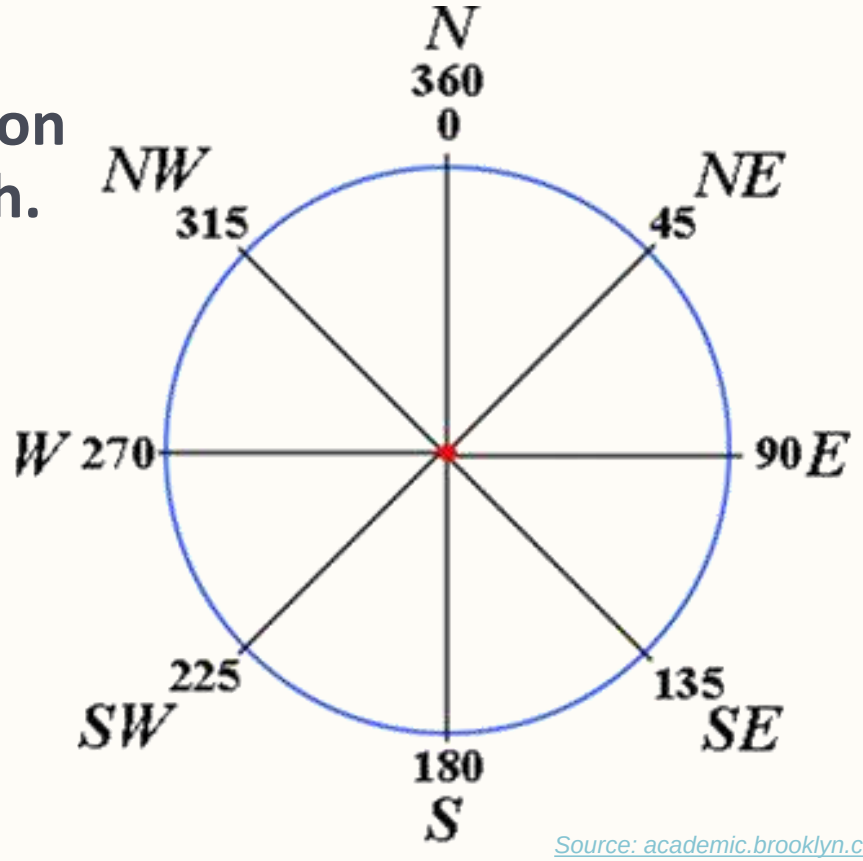
- **The first rule of Leave No Trace is to plan ahead and be prepared.**
  - A major component of this aspect is understanding and properly practicing navigation, especially in wilderness areas.
  - Use of effective navigation with a map and compass can help to ensure your own safety as well as the safety of those who use or oversee wilderness areas.
  - Use of effective navigation will also ensure that you stay only in appropriate areas of a wilderness, reducing your impact and increasing the sustainability of your use of that area.

Source: pack1863.com

Key Terms

Navigation consists of a few key terms:

- **Course: this is your planned route. A course can be a straight line or it might consist of multiple legs, or segments; each leg may travel in a slightly different angle from the rest of the legs.**
- **Bearing: this is the direction from your current location to another point on a map in degrees from true north. A compass is broken into 360 degrees.**
  - North is at 0°
  - East is at 90°
  - South is at 180°
  - West is at 270°



Source: academic.brooklyn.cuny.edu

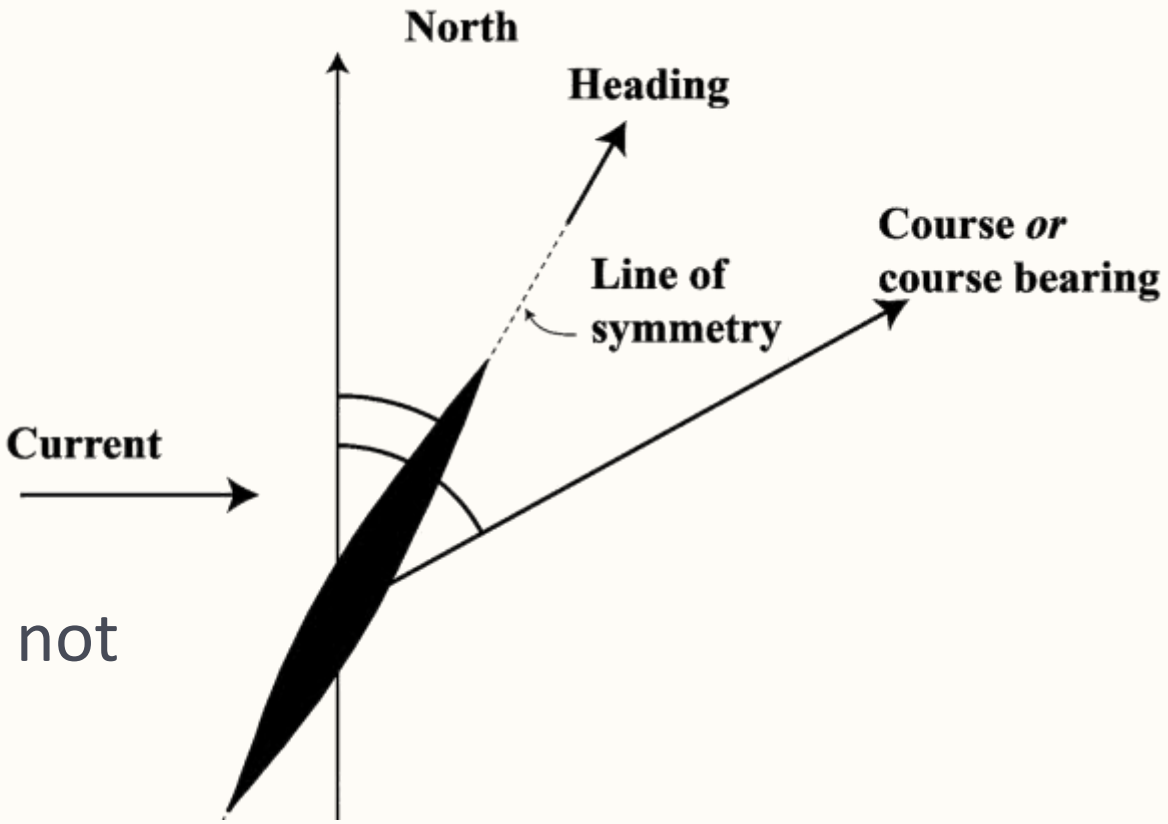
Key Terms

- **<u>Course Bearing</u>: this is the specific bearing that you would follow to stay on your course (or to stay on a specific leg of your course).**
  - For example, if you wanted to kayak to a lighthouse that was directly east of you, your course bearing would be 90°.
  - In the right image → the course bearing from B to C is 71°.

Source: www.paddlinglight.com

Key Terms

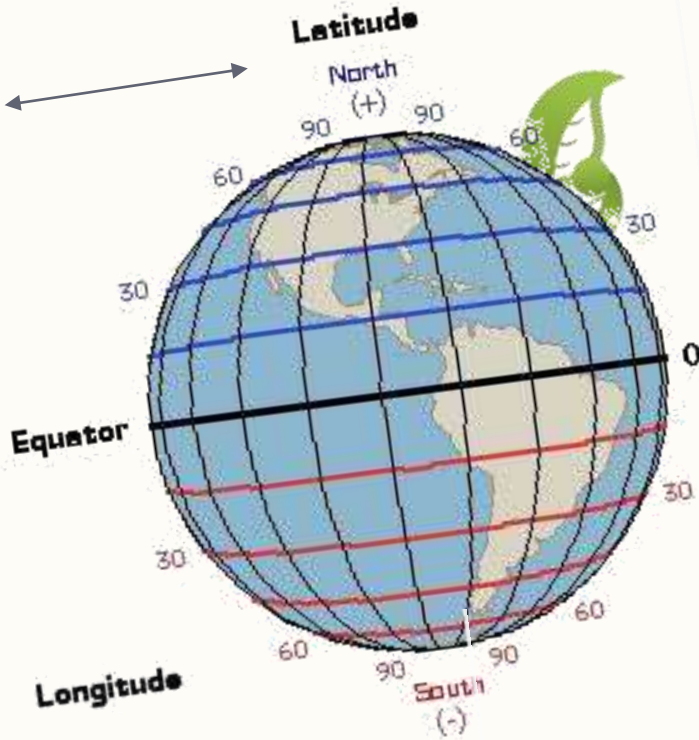
- **<u>Heading</u>: this is the direction that you are moving to get to a destination; usually your course bearing and your heading are the same thing.**
  - However, these can be different.
  - For example, if you were paddling a kayak in a strong wind or current, your kayak would be pointing in a different direction than your course bearing in order to make up for the changes caused by the wind.
  - In this example, your heading would not be the same as your course bearing.
    - Source: http://www.paddlinglight.com/

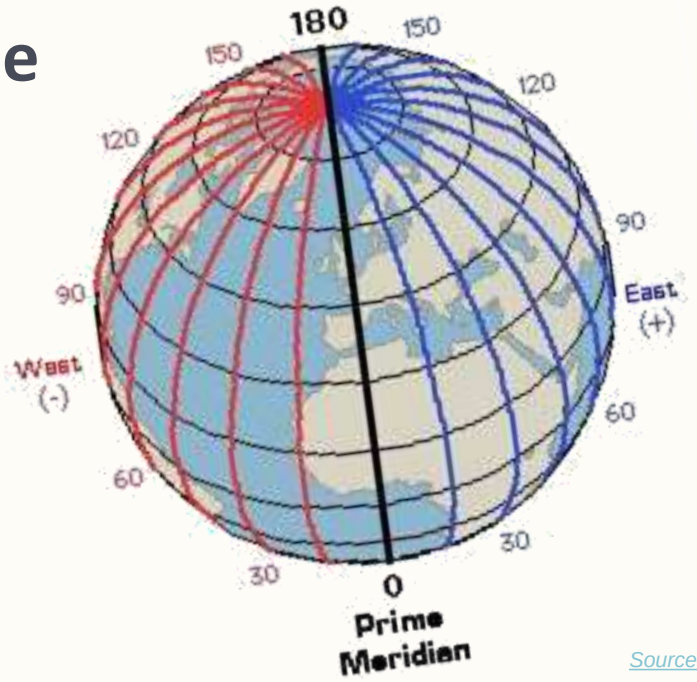


Source: artofwayfinding.blogspot.com

Reading a Map

- **A map has a few key aspects that help you to figure out where you are and where you need to go.**
  - First, look at the title of the map to get an idea of the geographical area covered by that map.
- **Next, pay careful attention to the latitude and longitude of the map. This is the grid system of the map that allows you to pinpoint your current and intended locations.**
  - Latitude are the lines that run from east to west.
  - Longitude are the lines that run from north to south.





Source: mrkash.com

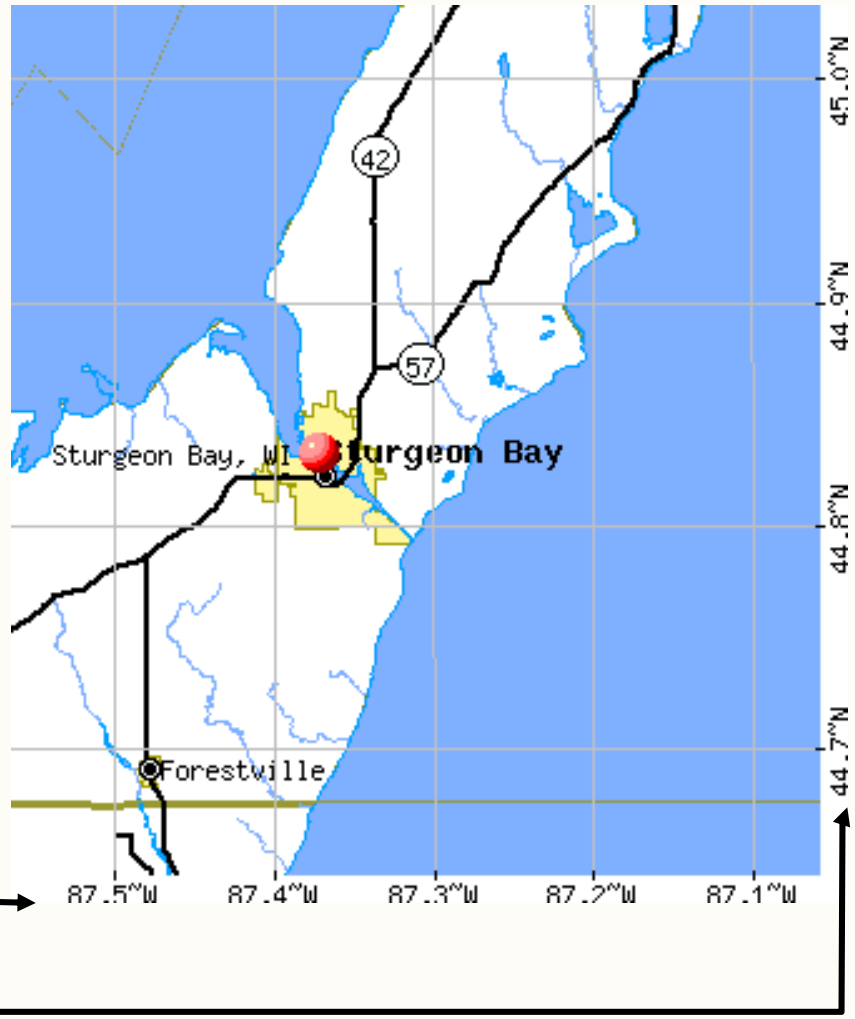
Latitude and Longitude

- **Latitude and longitude are measured in degrees.**
  - The equator is 0^{o} latitude; the degrees of latitude increase as you make your way away from the equator.
  - Longitude works the same way except that it is from east to west; the prime meridian is 0^{o} longitude (this runs north and south from London).
- **A location is then described in degrees north/south latitude and degrees east/west longitude.**
  - For example, Washington DC is at 38^{o} north latitude, 77^{o} west longitude.
  - Waterford WI is at 42^{o} north latitude, 88^{o} west longitude.
  - Because Waterford is further north and west than DC, it will have larger degrees for both latitude and longitude.

Degrees, Hours, Minutes

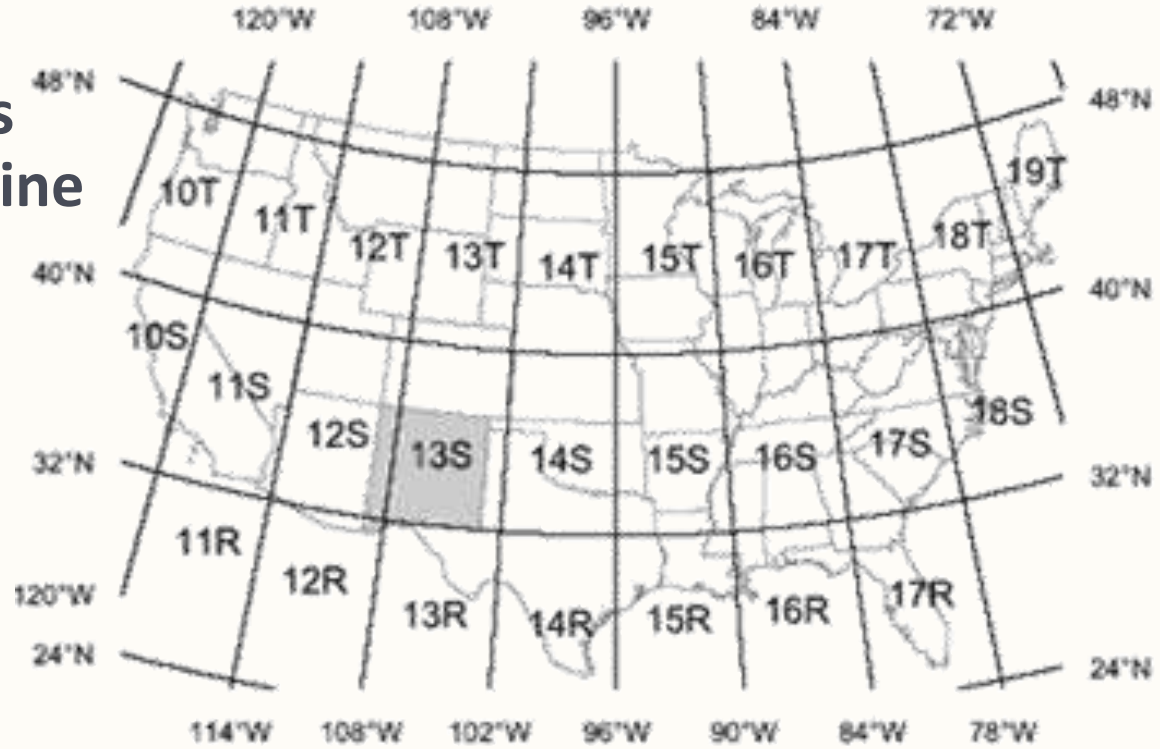
- **Typically latitude and longitude are more specifically expressed in degrees, minutes, and seconds to provide exact locations in a very precise manner.**
  - Specifically Washington DC is at 38°54'19" N, 77°02'14" W (38 degrees, 54 minutes, 19 seconds north, and 77 degrees 2 minutes, 14 seconds west).
  - Waterford, WI is at 42.47’58”° N, 88.14’8”° W (42 degrees, 47 minutes, 48 seconds north, and 88 degrees, 14 minutes, 8 seconds west).
- **To read latitude and longitude on a map, look at the sides of the map.**
  - The numbers on the top and bottom of the map are longitude.
  - The numbers on the left and right of the map are latitude.

Source: www.city-data.com



UTM

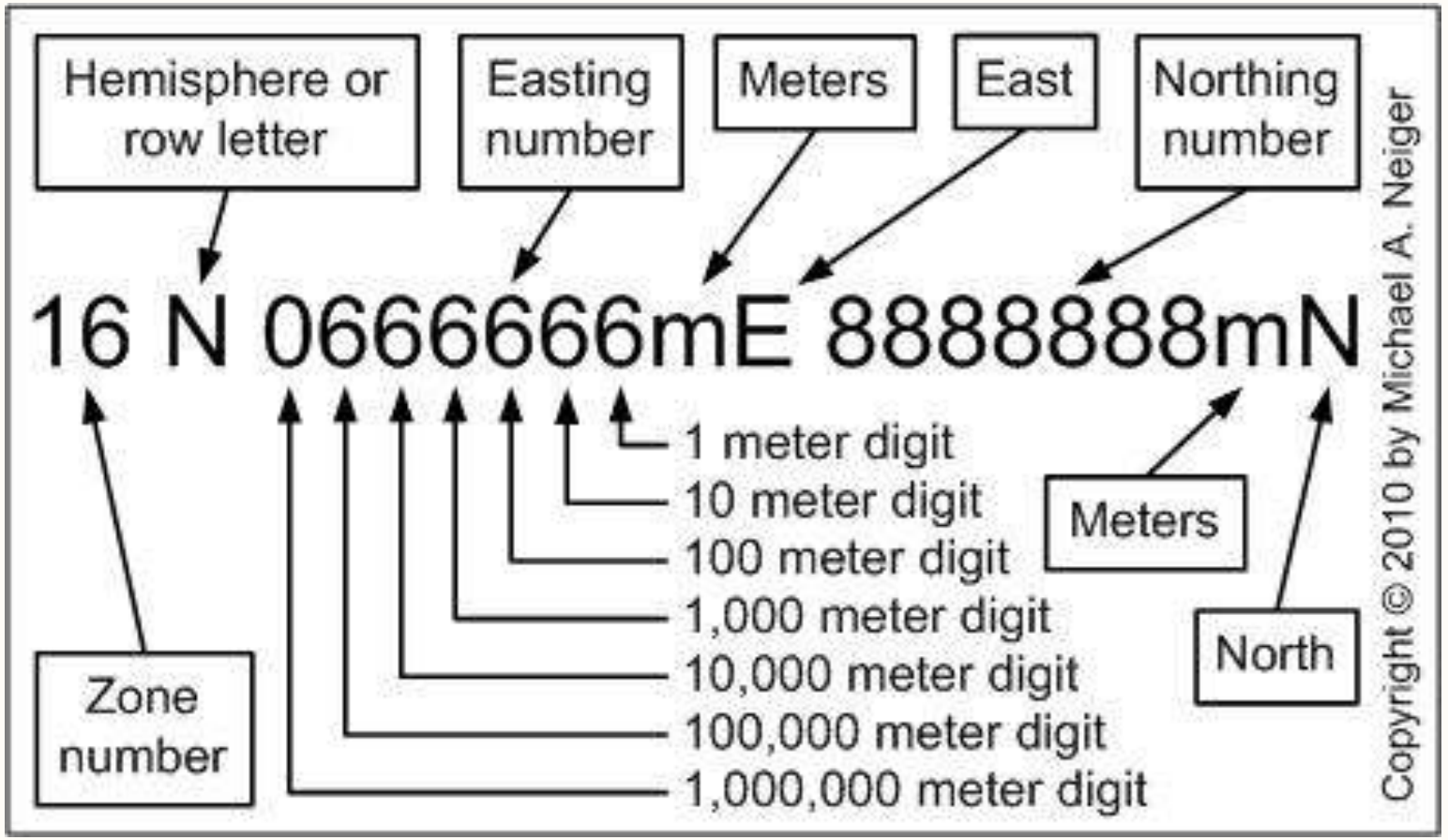
- **Locations can also be determined using UTM (Universal Transverse Mercator) Grid Coordinate System.**
  - This system divides the earth into a grid with equally-sized surface distances measured in meters (instead of into degrees with latitude and longitude).
  - UTM can actually be easier to read on a map because it divides the earth into 60 separate zones that are 6^{o} wide.
- **Each zone is determined by its *easting* and its *northing* numbers, which are used to determine where that zone is on an north-south and an east-west manner.**
  - Because UTM is so exact, it can be used to provide a very precise location (down to a single building).



Source: https://geoinfo.nmt.edu/publications/maps/gps/UTM_zones.gif

UTM ZEN

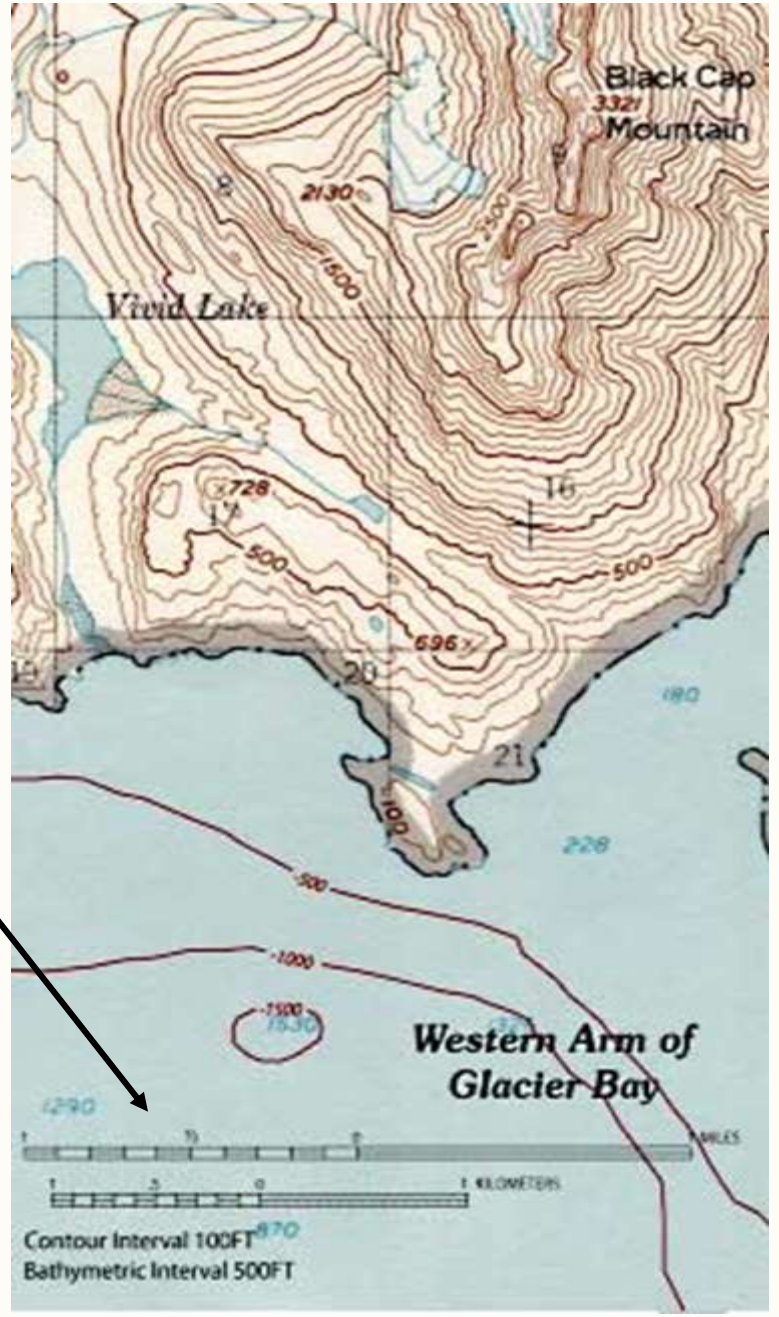
- **UTM locations on a map are always recorded using a <u>ZEN method</u>: Zone, Easting, Northing.**
  - Waterford Union High School is in Zone 16T, 400217 Easting, 473535 Northing



Source: therucksack.tripod.com

Measuring Map Distances

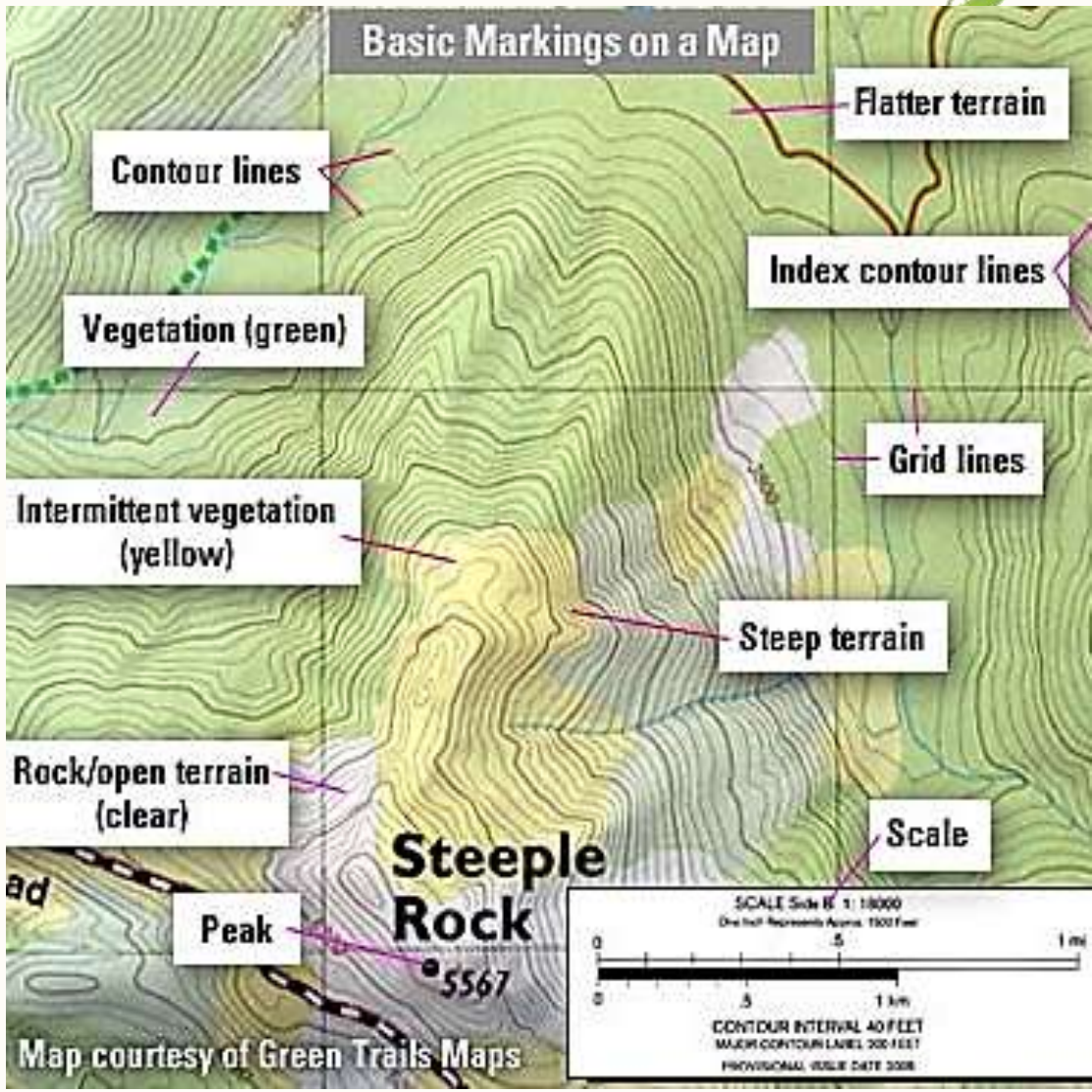
- **Typically a map will have a scale to help you measure the distance between objects.**
  - The scale is typically listed as a fraction, such as 1:24,000.
  - This would mean that one inch on the map equals 24,000 inches in real life, or one inch on the map is 2000 feet in that actual terrain.
- **In addition to the scale, a map should have a bar scale that shows distance in miles and/or kilometers.**
  - To use the bar scale, use a ruler or piece of paper to compare the distance between to objects to the size of a mile or a kilometer on the map as indicated by the bar scale.
  - You could also mark what a mile or kilometer is according to the bar scale on a piece of paper and measure the distance using that marked piece of paper.



Source: pubs.usgs.gov

Topographic Maps

- **A topographic map will show changes in elevation.**
  - A topographic map uses contour lines to show increases or decreases in elevation.
  - A contour line is a line on a map joining points of the map that are all at that same height above (or below) sea level.
  - For example, all of the points on a map that are 2000 feet above sea level would be shown by a continuous line labeled “2000”.
- **The contour lines are an excellent way to understand the kind of terrain shown in a map.**
  - Contour lines that are close together show steep terrain, while contour lines that are far apart show gradual slopes.
  - V-shaped lines show gullies, ravines, and valleys.



Source: www.patriotnetdaily.com

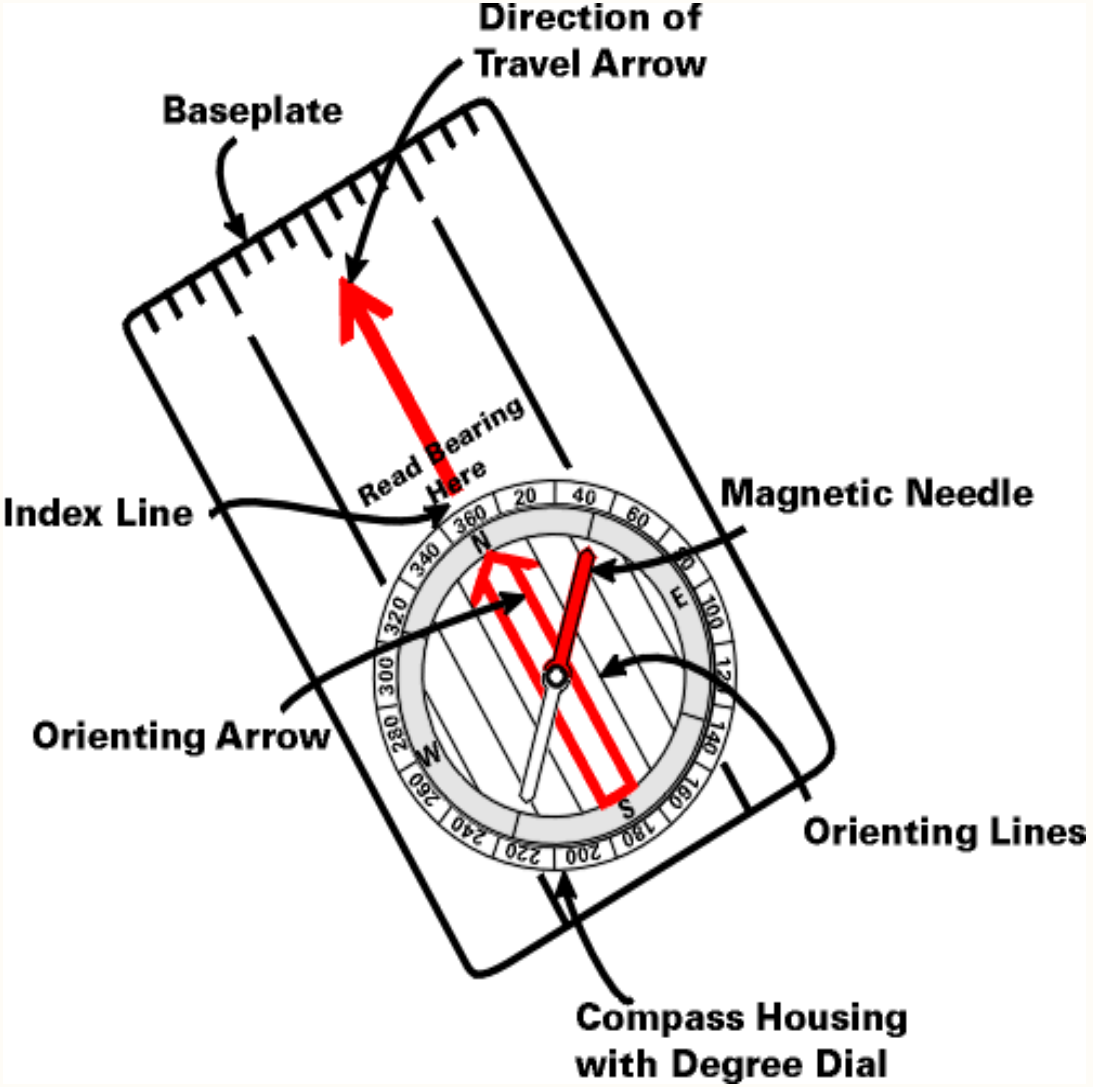
Parts of a Compass

- **Base Plate – A hard, flat surface located at bottom of compass. The dial is mounted on this. This is placed on palm of hand when holding a compass.**

- **Compass Dial – A ring with degrees 0 to 360 etched on the outer edges. This is also called the bezel or the azimuth ring.**

- **Direction of Travel Arrow – This arrow is located on front of base plate. It points to the way you will be traveling after a bearing is set.**

Text from maricopa.gov/parks/doc/arizonastandards



source: http://www.ussartf.org/images/compass.gif

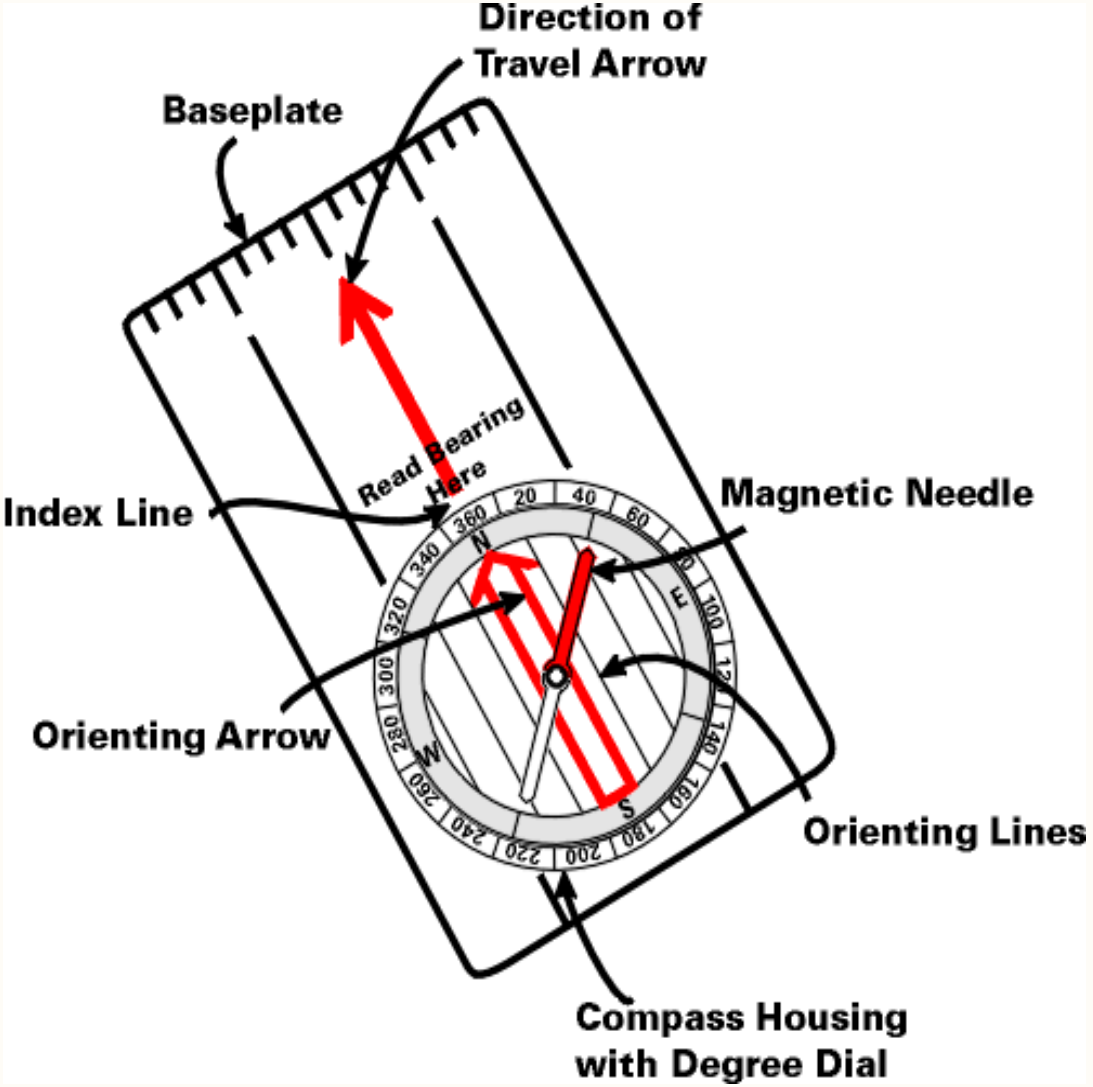
Parts of a Compass

- **Orienteering Arrow - This arrow is located on floor of compass dial beneath magnetic needle. It rotates as dial is turned. This arrow is used when aligning a compass to a map.**

- **Magnetic Needle – A magnetized piece of medal floating in compass dial. The red end of arrow always points north and the white end of arrow always points south.**

- **Orienteering Lines - A series of parallel lines located on floor of compass dial. These lines are used when aligning a compass to a map.**

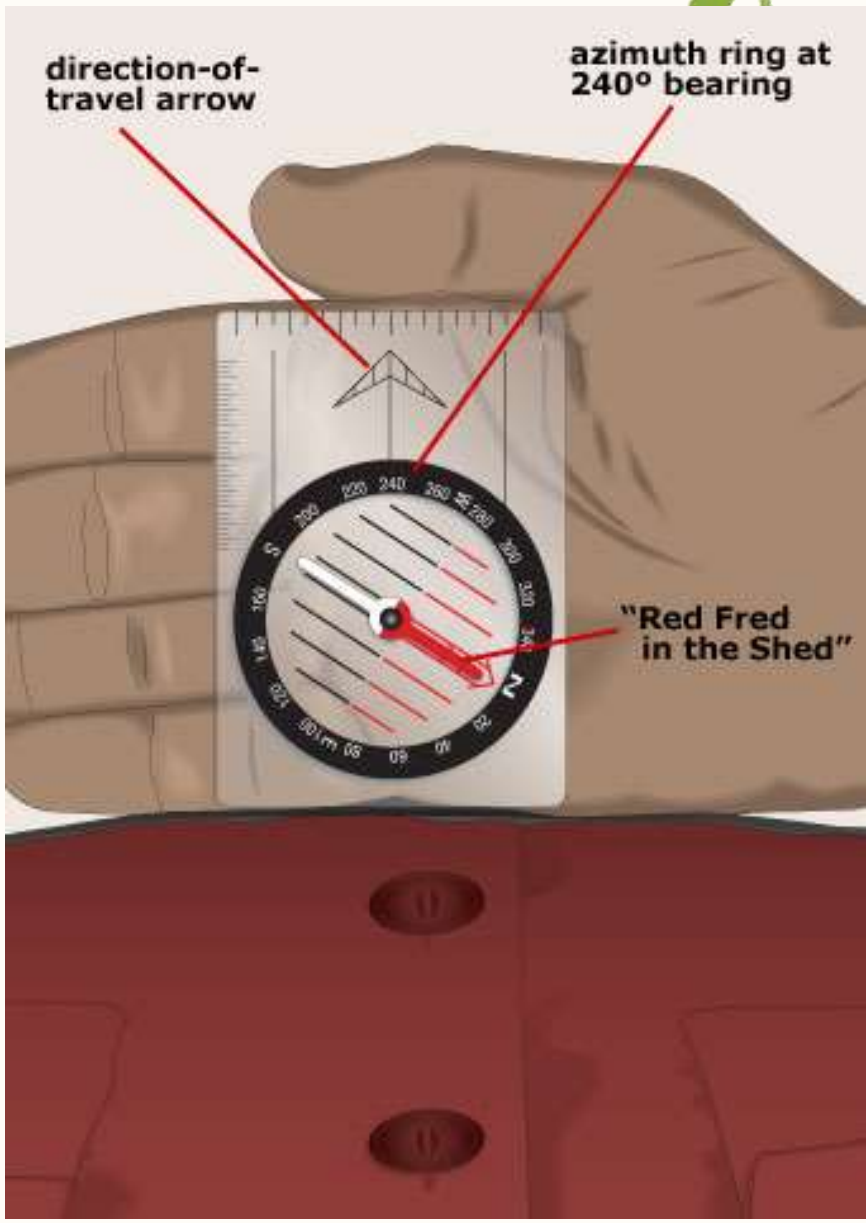
Text from maricopa.gov/parks/doc/arizonastandards



source: http://www.ussartf.org/images/compass.gif

Using a Compass

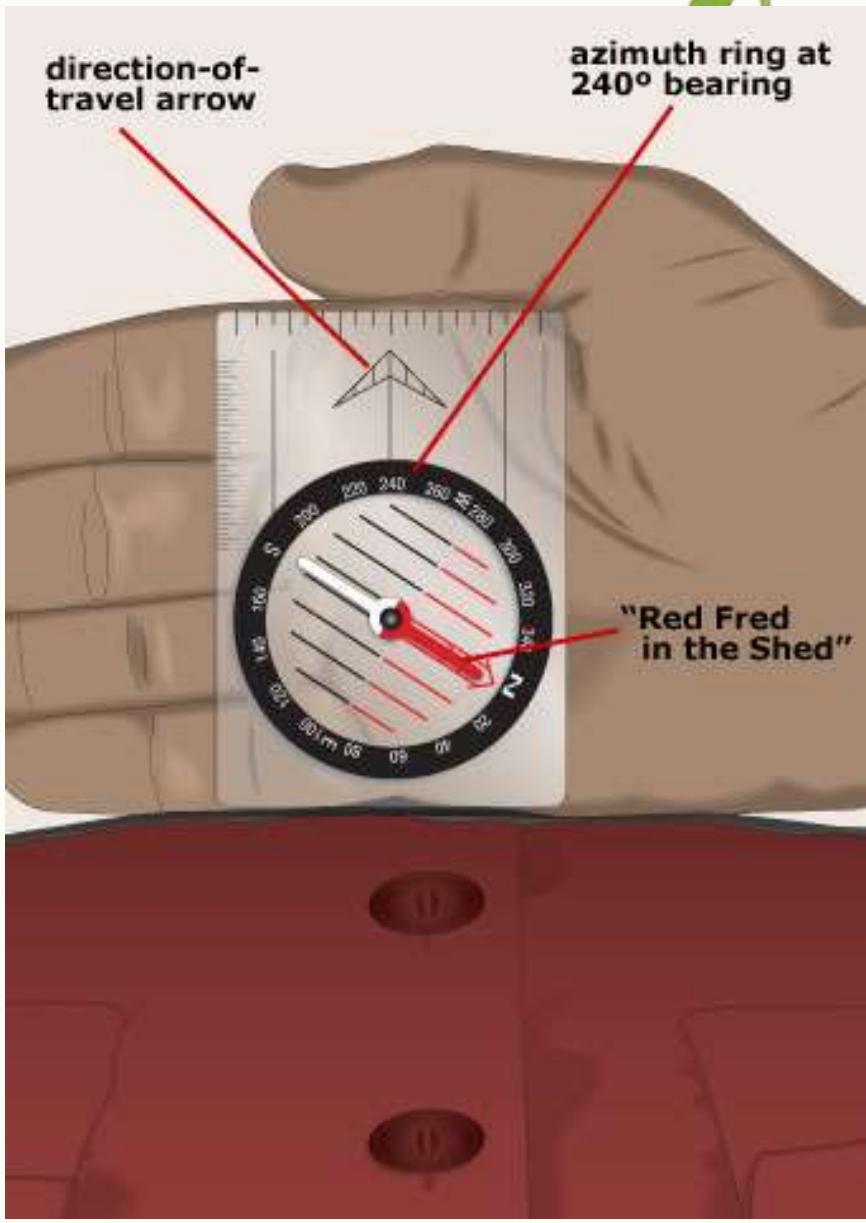
- **Using the compass to find your course bearing:**
  - Begin by holding the compass level to the ground away from all metal and electronic objects. (The compass is magnetic; metal/electronic objects will throw off your navigation).
  - The direction of travel arrow (on the edge of the compass) should always point away from your body towards your intended destination.
- **Imagine the magnetic needle (the one that always points north) is called "Red Fred". Imagine the red Orienteering Needle is called "The Shed".**
  - You always want Red Fred to be in the Shed.



Source: https://www.hunter-ed.com/images/drawings/compass_red_fred.jpg

Red Fred in the Shed

- **Once you are pointing your compass in the direction of your intended travel, you will always want to "Put Red Fred in the Shed".**
  - In other words, turn the dial of your compass until the orienteering needle ("The Shed") is over the top of the magnetic needle ("Red Fred").
- **Read the bearing (the degree as determined by where the direction of travel arrow and index line meet the compass dial).**
  - In the example to the right, the course bearing would be 240°.
- **Recheck your bearing regularly to make sure you reach your target.**
  - Pick multiple landmarks along your way and confirm you've stayed on your intended path after arriving at each one.



Source: https://www.hunter-ed.com/images/drawings/compass_red_fred.jpg

Course Bearings with a Map & Compass

- **To use a map and compass to determine your course bearing, place your compass so that the edge of your compass forms a line between your starting point (A) and your end point (B).**
  - It can help to physically turn your map and compass so that the top of your map is pointing due north.
- **Make sure that the direction of travel arrow is pointing in the direction you intend to move (and not vice versa).**

Source: en.wikipedia.org

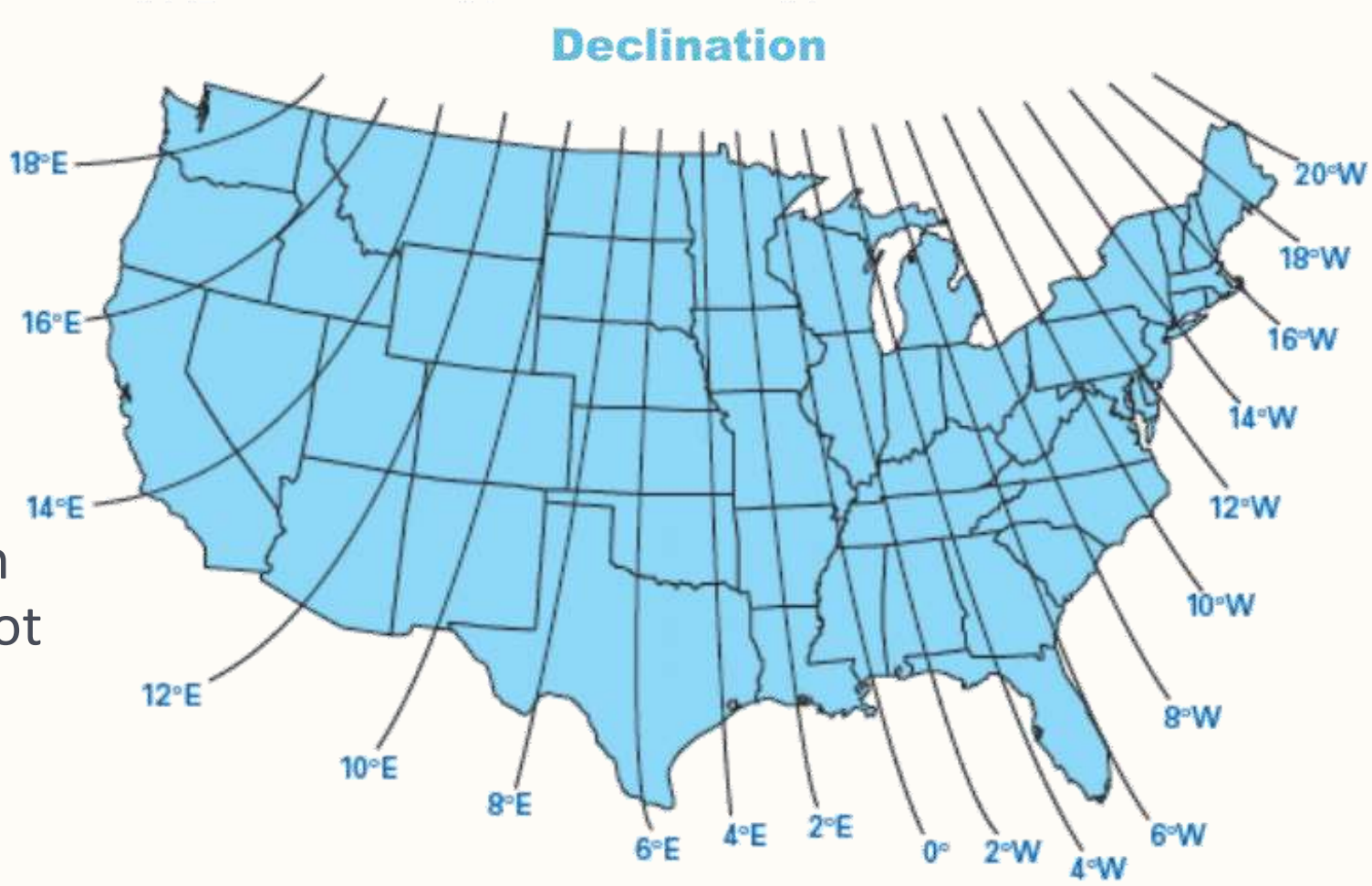
Course Bearings w/ a Map & Compass

- **Turn the bezel of the compass so that north on the dial is pointing to the top of the map.**
  - You may need to adjust this dial to adjust for declination (*more on this on later slides*).
- **Read the course bearing (in degrees) where the index line meets the dial.**
  - To reach your destination, keep the course bearing degree aligned with the direction of travel arrow.
  - As long as Red Fred stays in the Shed while you are walking, you should be heading in the right direction.

Source: en.wikipedia.org

Declination

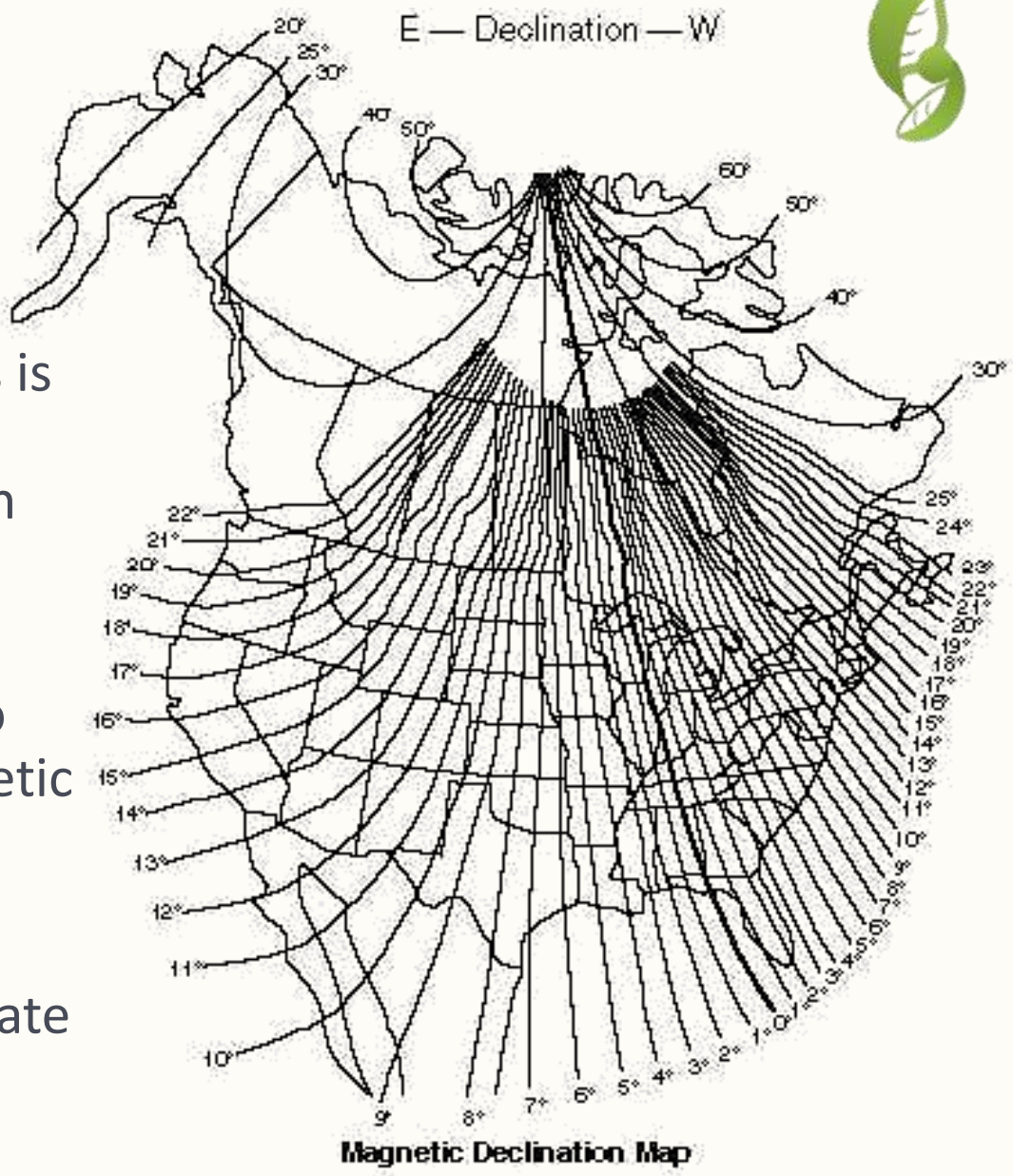
- **The red arrow of the compass always points to *magnetic* north, but not necessarily to the true geographical north.**
  - This is because the magnetic north pole is not in the same location as the geographical north pole.
  - The magnetic north pole is actually in northern Canada.
  - As a result of this, the direction that a compass points to will not always be the same as straight north.



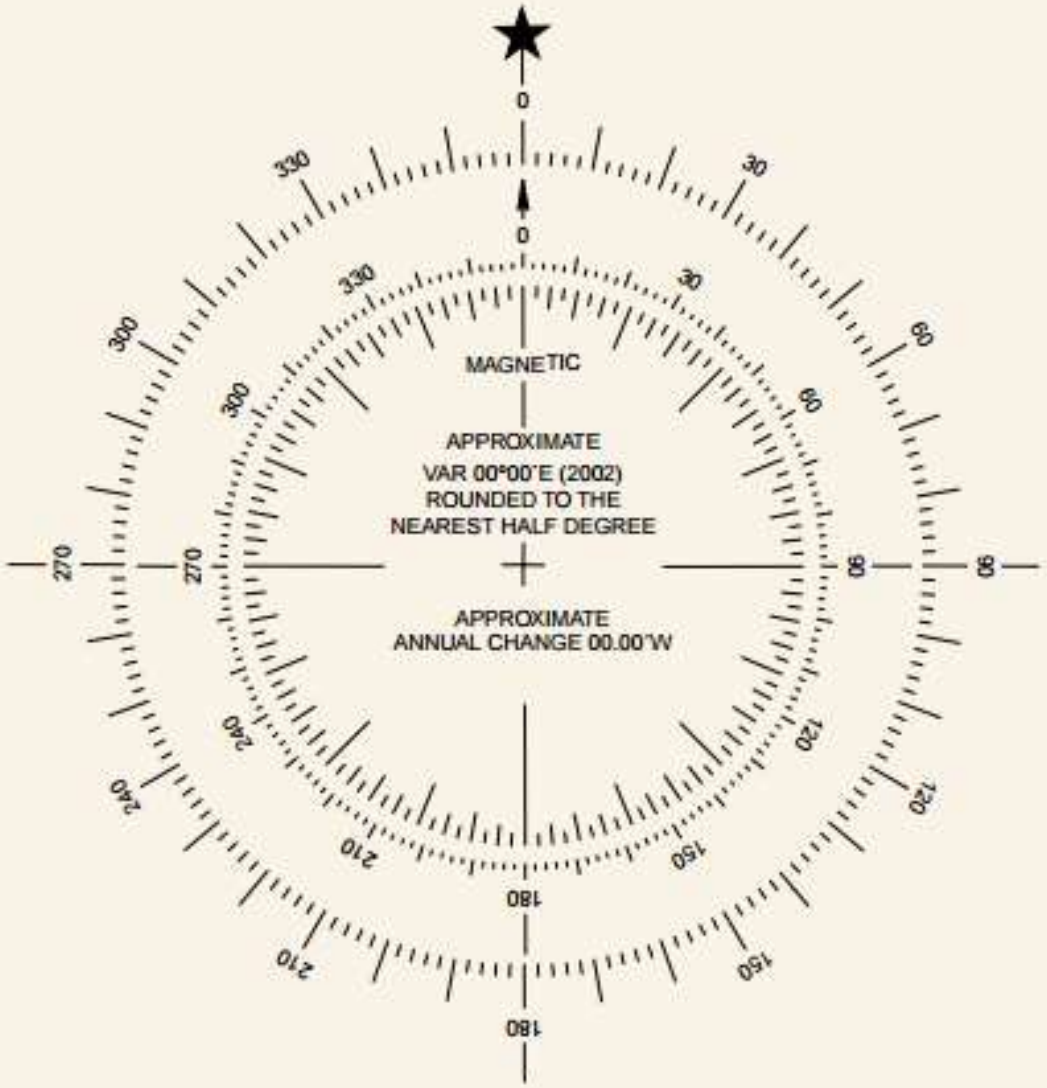
Source: canebrake13.com

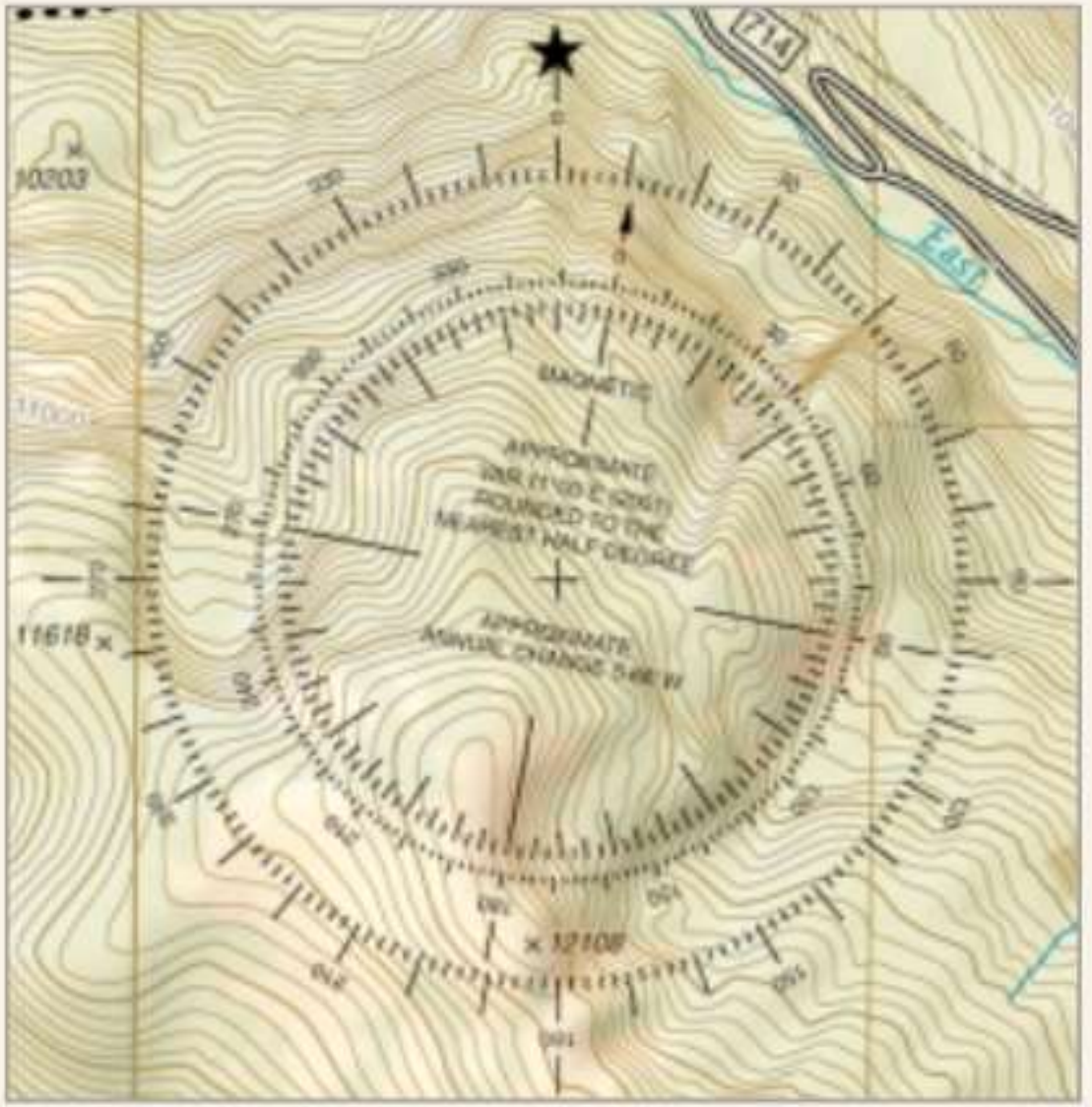
Declination

- **The difference between true north and the direction the compass points is known as declination.**
  - For example, Wisconsin has a 0-4^{o} declination. This is mostly because Wisconsin is directly south of the magnetic north pole and so the difference between the magnetic north pole and the true north pole is very minimal.
  - However, California has a 13-18^{o} declination due to the fact that it is both south and west of the magnetic north pole.
- **Declination changes gradually each year.**
  - For this reason, it is very important to have up to date maps that accurately indicate the degree of declination for a given area.



Source: homepage.smc.edu





Source: http://maps.nationalgeographic.com/downloads/Map_Skills_Booklet.pdf

Compass Rose with no declination deviation and one with an 11° East declination on a map. True north in both instances is at the top of the page.

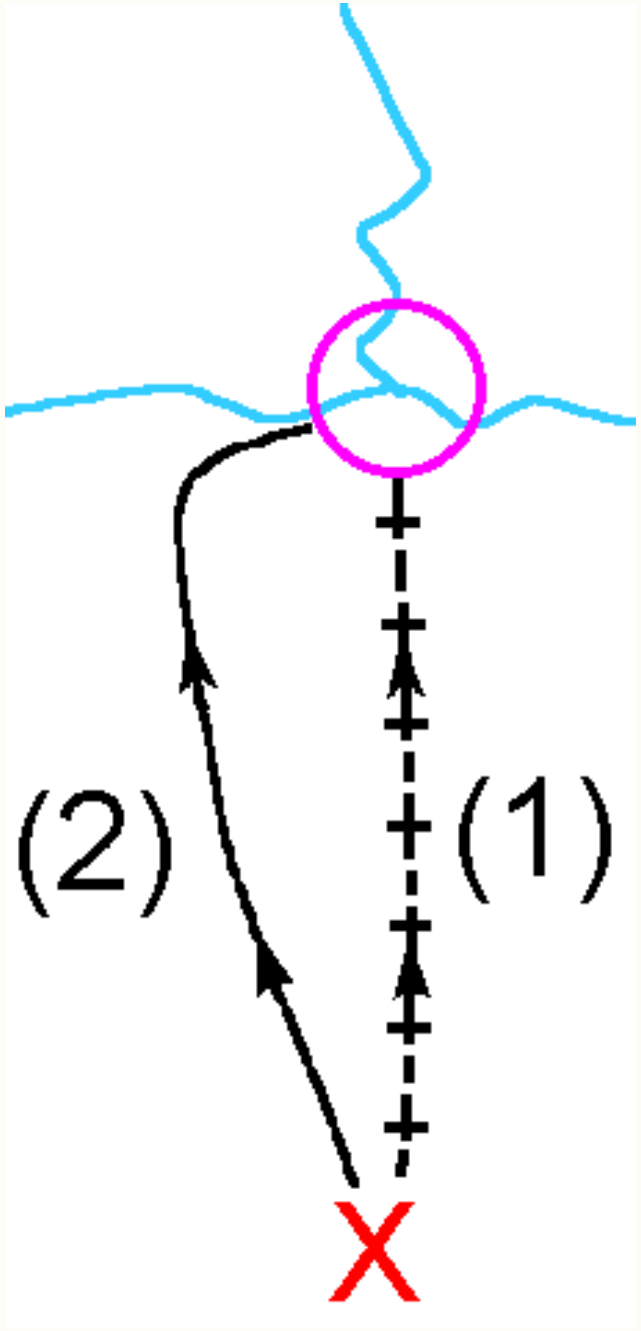
Declination & Course Bearing

- **When determining your course bearing, the amount of declination determines the actual direction that you are traveling.**
  - For example, if you are in the Grand Canyon National Park, you would have to change your direction of travel by adding 12 degrees once you have adjusted the dial to put Fred in the Shed.
    - *If your compass said that you were moving straight west, your course bearing would actually need to be 282^{o} (not 270^{o}) to go due west because of declination.*
- **The map you are using for navigation will specifically list what the degree of declination is for determining your degree of direction.**
  - On the right, declination is shown on a Grand Canyon map. Notice that the scale is adjusted clockwise by 12^{o}.

Aiming Off

- **<u>Aiming off</u> is a technique in which you deliberately follow a course bearing that is to one side of your intended destination.**
  - This tactic is helpful when your intended destination is not clear or if conditions prevent you from adequately seeing your destination (such as in foggy conditions or in a dense forest).
  - In right image, (1) is the intended path; (2) is the aiming off path.

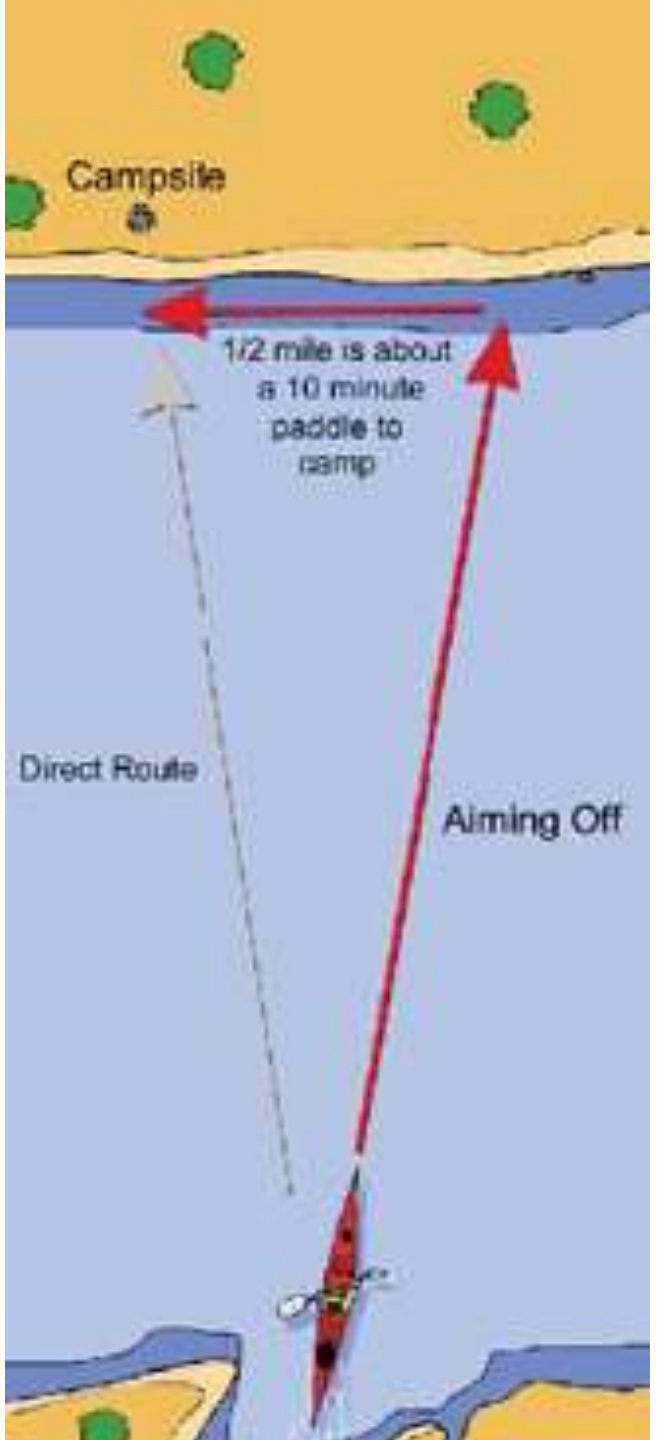
- **This tactic can also be helpful if you know that conditions might prevent you from possibly reaching your intended destination.**
  - For example, if you were paddling in windy conditions, it might be a good idea to aim off as your kayak or canoe might change directions repeatedly due to the wind.
  - If you don't aim off, you may miss your target and not know which way to turn to reach it as you get closer.



Source: www.waoc.org.uk

Aiming Off

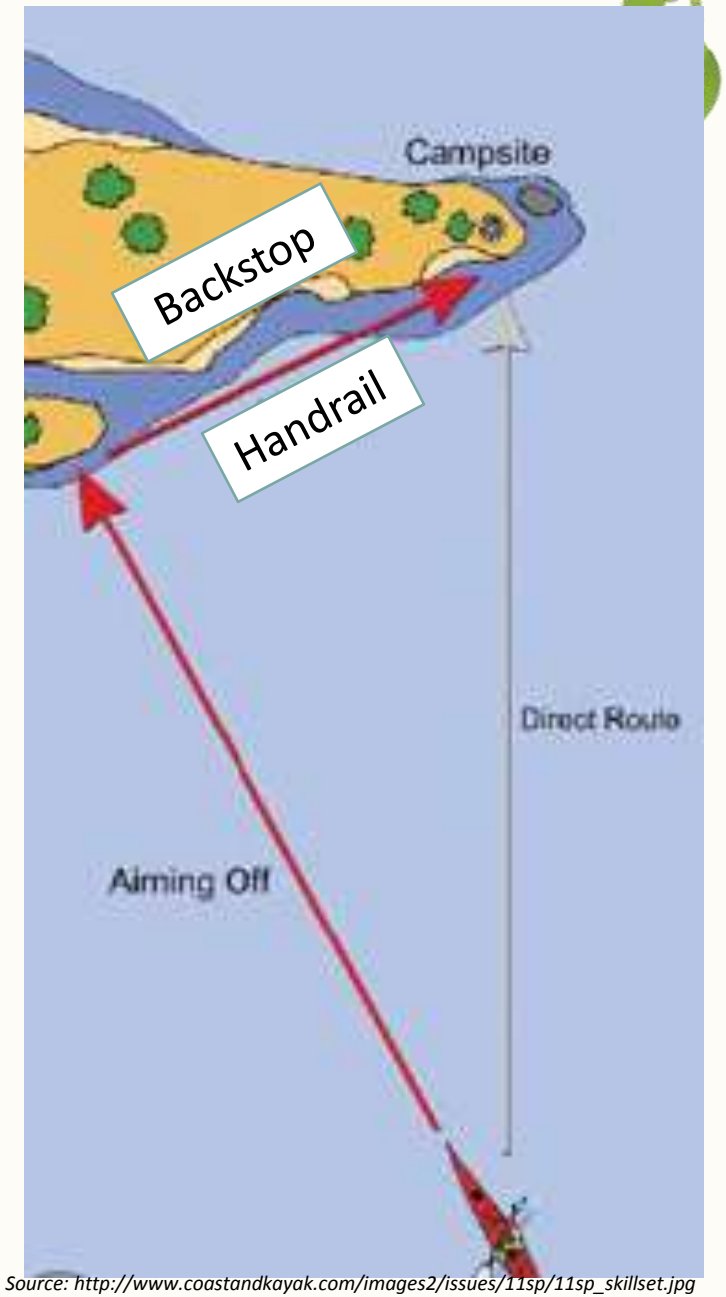
- **To aim off, you must first determine your course bearing.**
  - Once your course bearing is known, adjust your heading by a few degrees depending on the circumstances.
    - *For example, if you are paddling and your course bearing is a far-away campsite on a shore that is 90^{o} (due east) from your current location, but there is a brisk southerly wind, you would adjust your course bearing to perhaps 105^{o} and then turn north once you are in sight of the shore.*
- **In these cases, if you don't aim off, you wouldn't know which direction to travel (left or right) if you miss your destination.**
  - By intentionally going to the left or right of your intended destination, you know which direction to travel once you travel a set distance or landmark.
  - There is no specific change in path that works for aiming off; it all depends on the conditions of each situation.
  - Repeated practice is necessary to develop this skill.



Source: http://www.coastandkayak.com/images2/issues/11sp/11sp_skillset.jpg

Handrails and Backstops

- **Two other techniques to reduce your likelihood of getting lost include:**
  - Handrails: this is a technique in which you follow a prominent landscape feature to a destination (such as a shoreline, river, road, or cliff).
  - Backstops: this is a technique in which you keep a prominent landscape feature in sight to avoid going past an intended destination. This is basically the point that you should not go beyond and is always visible behind your intended destination.



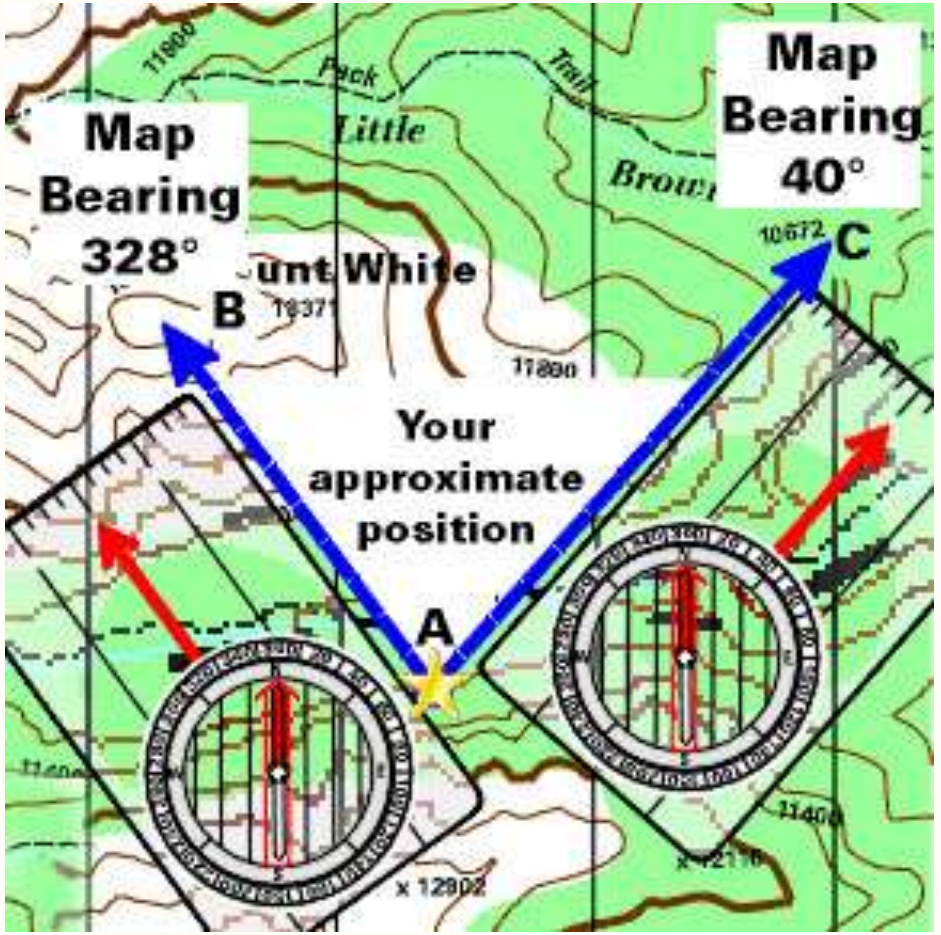
Source: http://www.coastandkayak.com/images2/issues/11sp/11sp_skillset.jpg

Triangulation

- **Despite your best efforts, sometimes you can still get lost in a wilderness.**
  - The first step in this case is to stay calm and avoid panicking. Take a breath, assess your situation, and keep your focus.
- **If you have a compass and a map, you can determine your location using triangulation.**
  - Triangulation is the method in which you determine your course bearing to two different visible landmarks in order to find your position on a map.

Triangulation

- **For example, if you know the summit of a mountain (B) is 328º from you and another visible landmark (C) is 40º from you, you can draw straight lines on a map from these points.**
  - Where these lines intersect is your current position on that map.
  - To make sure your estimation is correct, you can draw a line from a third landmark and make sure that it intersects at that same point.



Source: www.summitpost.org