171st Rivervalley Scout Group Navigation Training Manual

DRAFT 1

Version 1.0 – May 2009

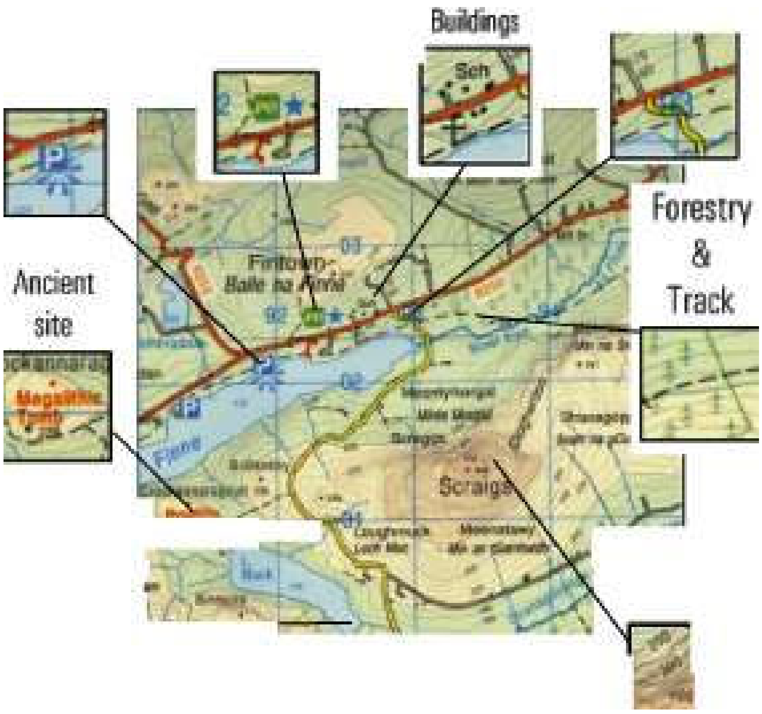
Introduction

The ability for a Scout to travel safely anywhere in the wilderness means determining where you want to go, and the route choice to get there. Maps and guidebooks are the fundamental tools both for trip planning and while you are out on the trail.

Reference to Sheet 56

Understanding Maps

The map is the main item needed for navigation. A map is a two-dimensional representation of the three-dimensional world you'll be hiking in. You'll end up using a variety of maps to plan and run your trips but perhaps the most useful map to use is an Ordinance Survey map. An Ordinance Survey map uses markings such as contour lines to simulate the three-dimensional topography of the land on a two-dimensional map. Other maps that you'll find helpful are local trail maps, which often have more accurate and up-to-date information on specific trails than O.S. Maps do. Here's a brief overview of the basic language of maps. Maps are available in laminated and non-laminated formats such as plain and waterproof paper. If you can afford to spend double the money on a laminated map it is well worth while, since they last a lot longer when used in poor weather (which is when they are most needed) and do not need a map case (which makes using the map more difficult).



Map Legend
The map legend contains a number of important details.

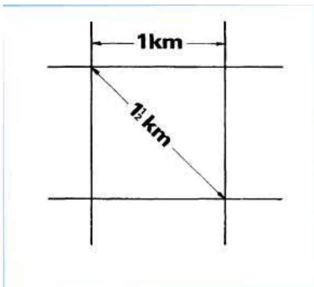
- Map Name
- Year of Production and Revision
- General Location & Adjacent Maps
- Map Scale
- Contour Interval
- Magnetic Variation
- National Grid System Co-ordinates & Latitude and Longitude
- Index of Features

Scale
All maps will list their scales in the margin or legend. A scale of 1:50,000 (be it inches, feet, or meters) mean that 1 unit on the map is the equivalent of 50,000 units in the real world. So 1 cm measured on the map would be the equivalent of 50,000 cm (0.5 Km) in the real world. Most Irish

hill-walking maps are 1:50,000 (also know as the Discovery Series), although there are a number of areas covered by 1:25,000. Standard Outdoor Ordinance Survey maps (1;50,000) are usually published in 2cm quadrangles. This represents 1 km on the ground..

Scale	Map to Landscape	Kilometre	
1:25,000	1 cm represents 0.25 of a kilometre	1 km = 4 cm	100m = 4 mm
1:50,000	1cm represents 0.5 of a kilometre	1 km = 2 cm	100m = 2 mm

When you know the scale of a map you can measure the length between two points in centimetres or millimetres and convert it into actual distance on the ground On the discovery series 1:50,000 maps grid lines2cm / 1km apart, which makes it possible to estimate distance quite quickly. Also the diagonal of a square is approximately 1.5 km



Map Coordinate Systems

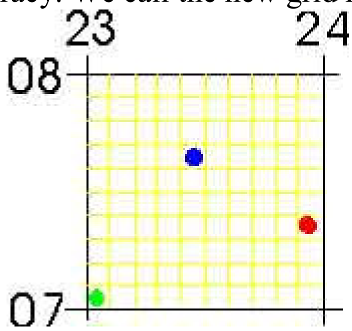
There are two general methods recording a point on a map in Ireland.

1. National Grid system

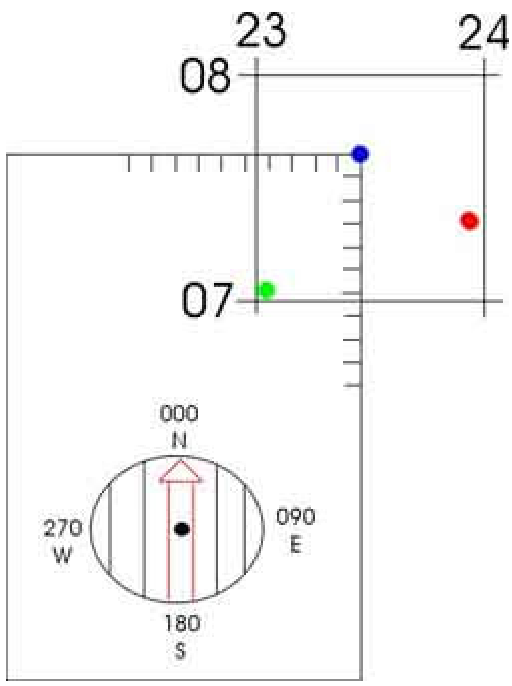
Irish National Grid Sub-zones

On the current Discovery Series Maps Ireland is covered by a grid system of five by five squares. These are labelled A-Z (except I). Each of these squares is 100 km by 100 km. Each of these grids is divided in to 10,000 sub-grids measuring 1km x 1km (1000 meters) The light blue grids printed on most Ordinance Survey maps represent this sub-grid system. Along the outside of the map on the top and bottom are a series of numbers called the Eastings. These numbers increases with each additional grid east. A Second set of numbers runs up either side of the map, these are called northings, which increase as you go north.

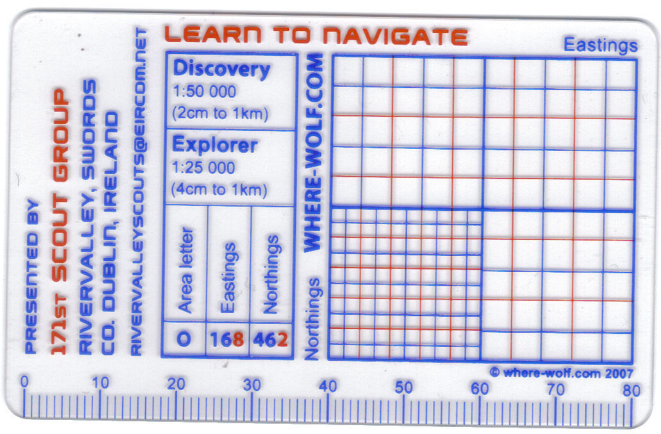
Whether you are using 1:50,000 or 1:25,000 a square on the grid will always represent 1 km. This means that a diagonal will represent approx 1.5 km. This allows easy estimation of distance on the ground. The map consists of a series of squares such as those shown below. The numbers are used to give a grid reference. We read along the bottom followed by the top, so that in this example 2307 would refer to this 1km square area. This is not really sufficiently accurate to pinpoint your position, so the square is divided into 100 smaller squares. Now each small square represents 100m square, and we have therefore got more accuracy. We call the new grid reference a 6-figure grid reference.



Examples:
The green circle is in 230 070
The red circle is in 239 073
The blue circle is in 234 076
On the map itself we do not have the yellow lines. Instead we must either estimate, or measure the tenths of the square. One way of doing this is to use a roamer scale on the compass. This is usually found on compasses at the more expensive end of the market. These compasses may will have a scale at the edge of the compass as in the diagram below but a good mountaineering compass such as a silva type 4 has a number of scales on it the outer one been 1:25,000 and the middle one been 1:50,000 an the inner one been 1:63,360 which is the imperial inch to a mile used on older maps. To use it take the corner of the compass where the scale starts and place it on the point which you need a grid reference for (we shall use the blue spot). Now the number of lines will give the grid reference as 234076, as before. Note you take the nearest line within the grid square. On the compass there may be several roamer scales for various scale maps. It is important to use the correct one.



G (Grid Square) 478 E 578 N Full descriptions
G 478 578 Grid Square, Easting first, Northing second -
The grid system is quick simple and very accurate.
The Rivervalley Roamer



The Rivervalley Roamer is clear and can be placed over the map. It has the lines drawn in to allow for accurate calculation of the grid reference. The full box is for a 1:25,000 scale and the lower left hand box is for the 1:50,000 scale. There is also a small ruler along the base to allow the measurement of distance.

At the time of writing this document there are proposals by the OSI Ireland to abolish this system and replace it with the new grid system used called IMT which they currently use on non outdoor maps such as town planning and on the GPS systems used for these maps. This will mean that the OSI will usea single standardised set of grid references for all and in doing so scrap the old system as we know it.

Using the geolives mapping software that the group is now using for hike planning you can have a look at the forest gate at the Ow river bridge in Aghavannagh. The discovery grid reference is T 055

(93) 861 (25) using what they call the 11 digit sub zone Irish grid - this is what we as scouts know as the national grid a-z and 3 digits for the easting and northings (although they use 5 for 1 metre accuracy – 3 digits gives 100m accuracy) and then they have an "Irish grid" (no prefix or suffix) for the same spot referenced 305593 186125 which puts the 3 on front of the easting and a 1 in front of the northing to replace the "T" reference The assumption is that the grid system itself remains intact but the prefixing of the grids changes from a single letter to a number in front of both easting and northing.

2. Longitude and Latitude

This is the traditional system for global positioning. Maps are drawn based on latitude and longitude lines. Latitude lines run east and west and measure the distance in degrees north or south from the equator (0° latitude). Longitude lines run north and south intersecting at the geographic poles. Longitude lines measure the distance in degrees east and west from the prime meridian that runs through Greenwich, England. The grid created by latitude and longitude lines allows us to calculate an exact point using these lines as X axis and Y axis coordinates. There are 360 degrees of longitude. Latitude is a series of belts that circle the Earth. The equator is 0 degrees, and the North Pole is 90 degrees north latitude. The border between western Canada and the United States is exactly 49 degrees north latitude. For both latitude and longitude, every degree is broken down into 60 minutes. Each minute is further broken down into 60 seconds. Longitude and latitude measurements are located along side the grid measurements on discovery series maps , but are printed in black. Longitude is located at the top and bottom of the map. Latitude is determined with the scale on the side of the map. The N represents north, because the same reference is used in the southern hemisphere. The north south designation may be deleted from latitude if it is clearly understood that you are referring to the northern hemisphere. If there is any doubt add the N designation to prevent ending up somewhere in Chile. .

Both latitude and longitude are measured in degrees (°).
1° = 60 minutes
1 minute = 60 seconds

Therefore:
7 ½ minutes = $^1/_8$ of 60 minutes = $^1/_8$ of a degree
15 minutes = ¼ of 60 minutes = ¼ of a degree

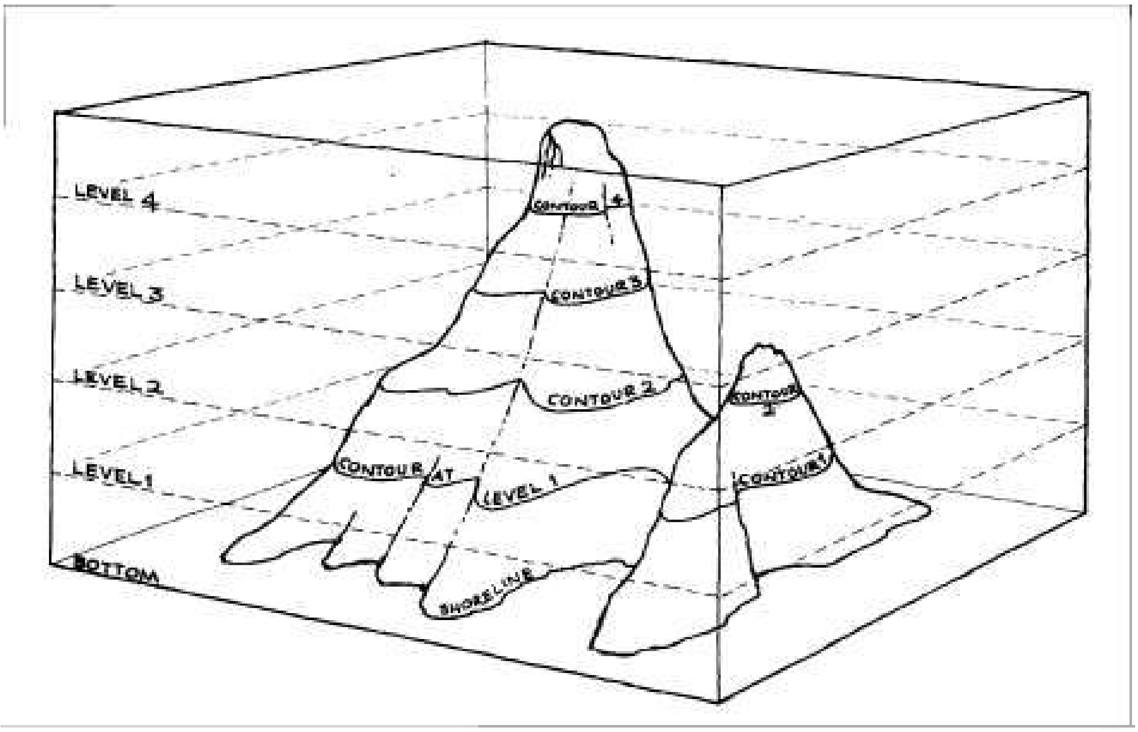
Which one to use

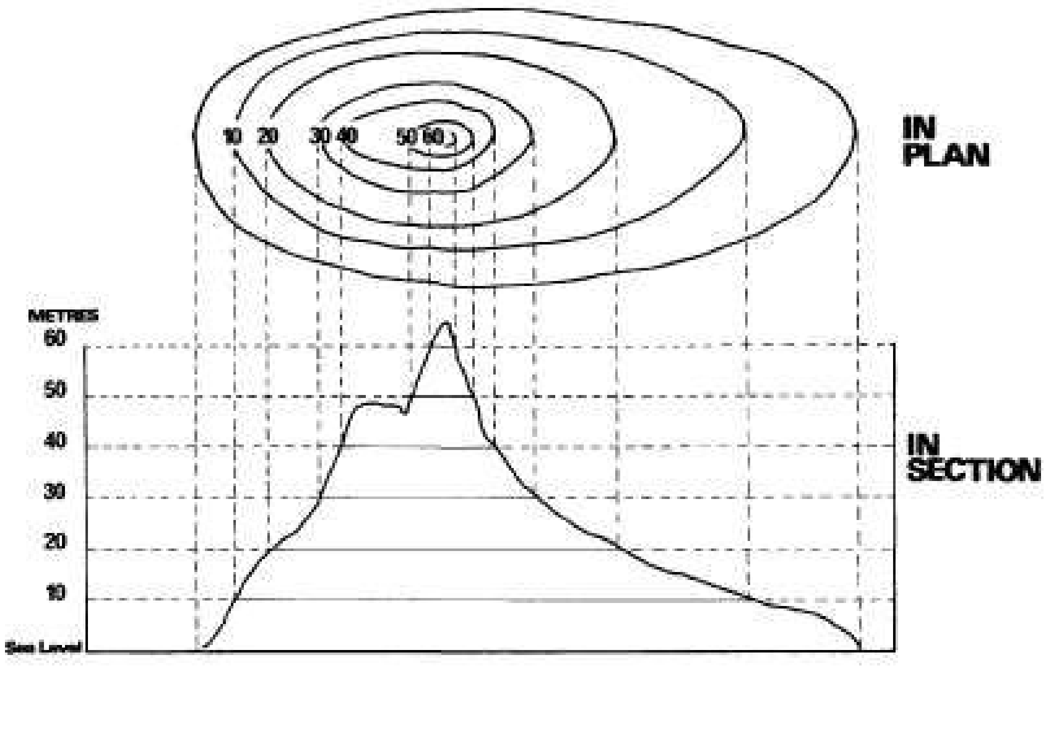
The grid system is generally much easier to use and is fairly standard for guidebooks and reference points used by guides, foresters, and land rescues. Most aircraft navigate with longitude and latitude and most GPS units give coordinates as longitude and latitude. This makes it important to know both systems. For general travel and route finding the grid is probably a better system. If sending word out for a rescue to park wardens, rangers, or guides the grid system is generally the preferred system. When communicating directly to an aircraft give longitude and latitude. If using a GPS be prepared to use both systems.

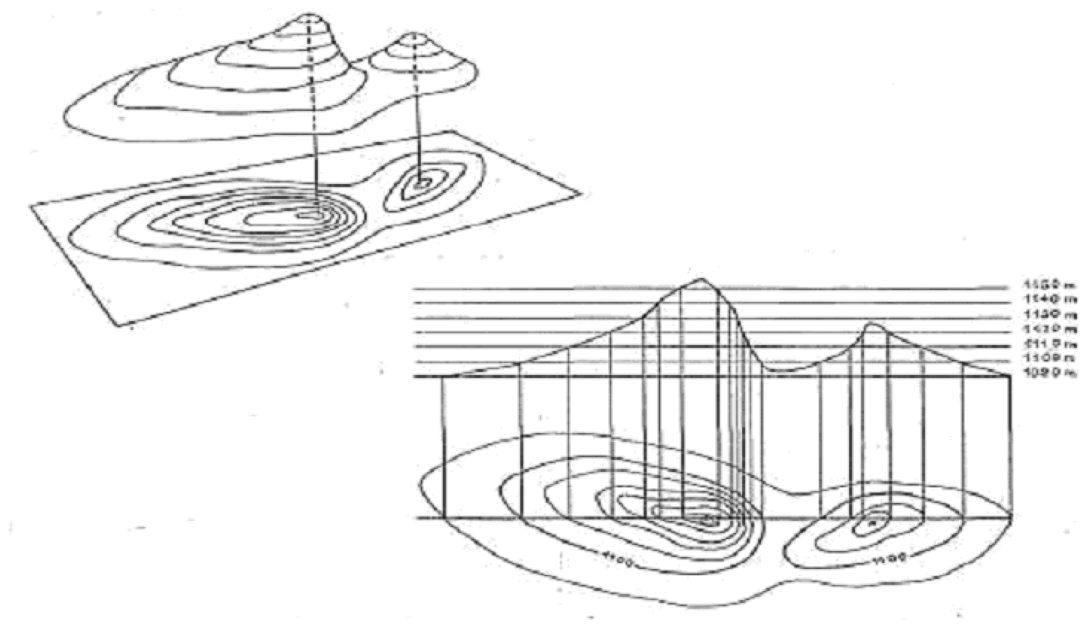
Contour Lines

A contour line is continuous line of the same elevation around the edge of a feature. Think of it as the edging trim along each layer of a wedding cake. Each line gives an outline of what a feature looks like at regular intervals of elevation. The closer together the lines are, the steeper the slope. The close gathering of contour lines represents a steep slope. The spread out contour lines indicate a gentler slope. The contour lines are at 10-metre intervals, which are each line; represent an outline of the mountain 10 meters higher than the line below it. Contour intervals will vary with maps, and it is important to check the interval to interpret the map.

On Discovery Series 1:50000 scale maps the contour interval is every 10m







To understand the shape of the mountain it is helpful to use the contour lines to build an image of the feature, either in your mind or to draft out a profile on paper and build up a 3 Dimensional picture in your mind of what the ground actually looks like. Because the contour lines are at 10-Meter intervals we can only estimate what the terrain between each contour looks like. An 8-Meter cliff could easily hide between contours and not be recorded on the map. With this in mind it is good to remember that while these maps are generally very good, there is still room for the odd surprise. One of the most difficult things to interpret on a contour map is a sense of elevation, ridges, and valleys. Here are a few tips.

- Water always flows down through valleys or gullies, never ridges.
- Creeks begin at higher elevations and flow down to lower elevations where they join to form larger but fewer rivers.
- When contours form a bulge that points from a lower elevation to a higher elevation, it is a gully, valley, or bowl.
- When contours form a bulge from higher elevations to lower elevations it is a ridge.
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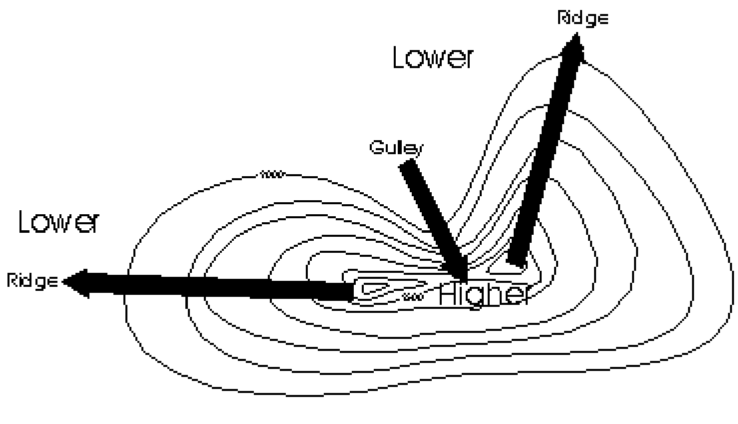
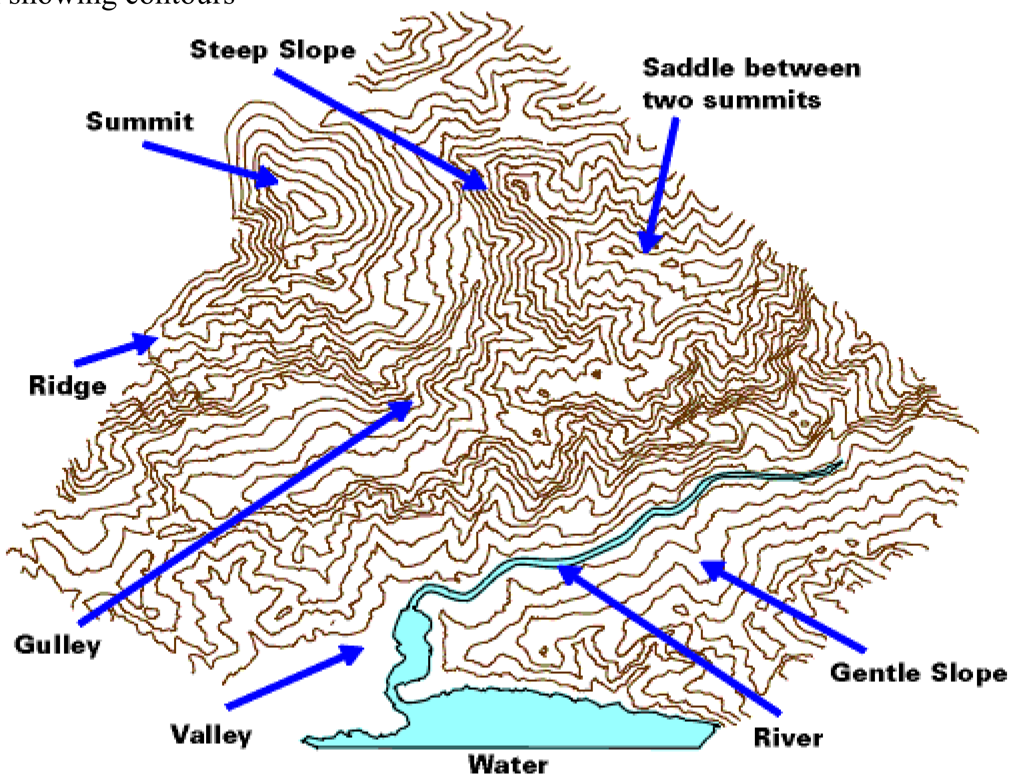


Contour lines are a method of depicting the 3-dimensional character of the terrain on a 2-dimensional map. Just like isobars in the atmosphere depict lines of equal atmospheric pressure, contour lines drawn on the map represent equal points of height above sea level.

Look at the three-dimensional drawing of the mountain below. Imagine that it is an island at low tide. Draw a line all around the island at the low tide level. Three hours later, as the tide has risen, draw another line at the water level and again three hours later. You will have created three contour lines each with a different height above sea level. As you see in Figure below, calculating lines of equal elevation all around the mountain, and then transferring these lines onto the map the three-dimensional shape of the mountain. On multi-coloured maps, contour lines are generally represented in brown. The map legend will indicate the contour interval—the distance in meters between each contour line. There will be heavier contour lines every 4th> or 5th contour line that are labelled with the height above sea level. Figure 6.5 illustrates how a variety of surface features can be identified from contour lines.

3D View of Mountain showing how contours relate to height

Top View of Mountain showing contours



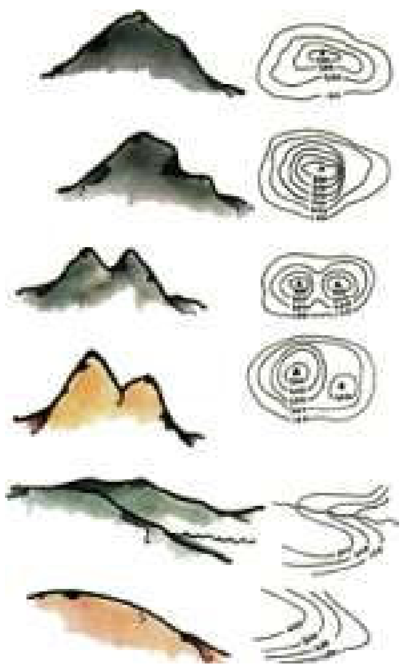
Interpreting Contour Lines

Steep slopes - contours are closely spaced
Gentle slopes - contours are less closely spaced
Valleys - contours form a V-shape pointing up the hill - these V's are always an indication of a drainage path which could also be a stream or river.
Ridges - contours form a V-shape pointing down the hill
Summits - contours forming circles
Depressions - are indicated by circular contour with lines radiating to the centre

We also use the map to allow us to interpret the aspect (slope) of the ground. The contour is used to help with this. A contour is a line connecting points of equal height. Usually the contours are at 10m intervals shown in brown, with a thicker line marking 50m. Also spot heights are used to give the height of a certain point. They are indicated by a Black dot. The height is marked somewhere along the contour. When you look at the height the right way up, you will be looking uphill. There are several contour features which you would expect to find in most mountainous regions. It is a good idea to be able to recognize these.

These are other features which you will come to recognize with time. With practice you will be able to relate the contours on the map to the ground and decide what is suitable for you to walk over. Care needs to be taken when switching between scales of map since the contours are closer together on the 1:50,000 because the square is smaller. The cartographer may sometimes miss out the minor (10m) contours if the ground is too steep, and you should watch out for this.

Imagining that each feature has four sides that go either up or down can help you identify the feature on the ground

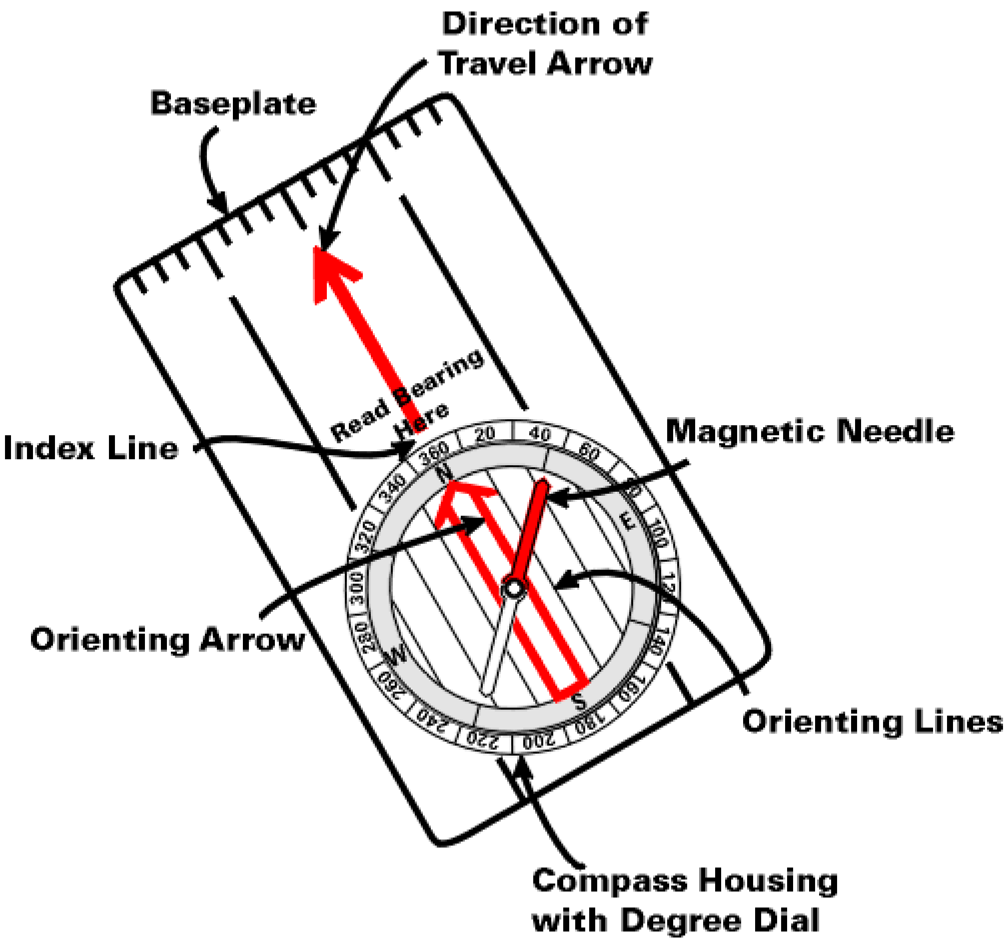


The Compass

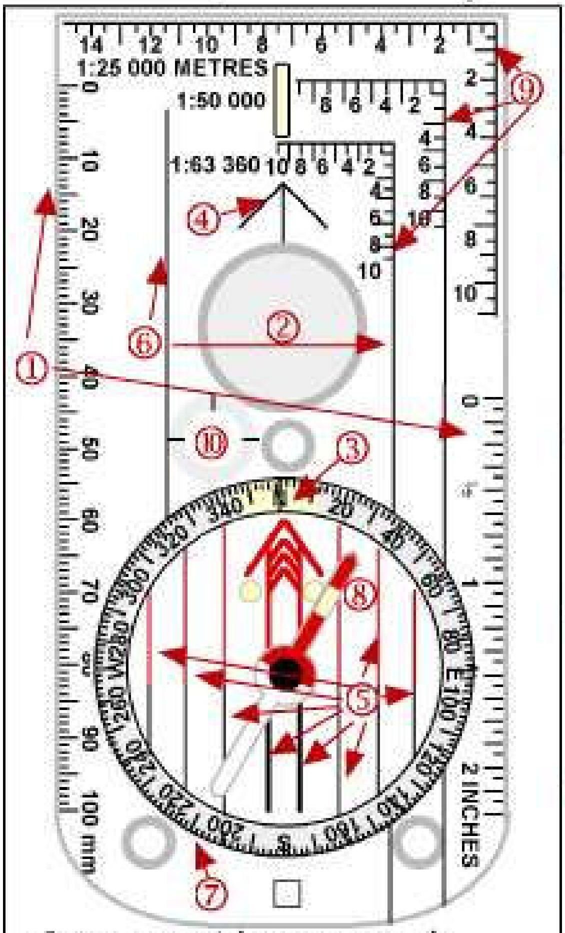
There are several types of compass available on the market. The price may vary from €10.00 for a basic model to €40.00 for a model with more scales. As a general rule the price will increase as more scales are added to the base. A typical compass is shown below. Note that there are likely to be more scales on a real compass.

The compass consists of a magnetized metal needle that floats on a pivot point. The needle orients to the magnetic field lines of the earth. The basic compass is composed of the following parts:

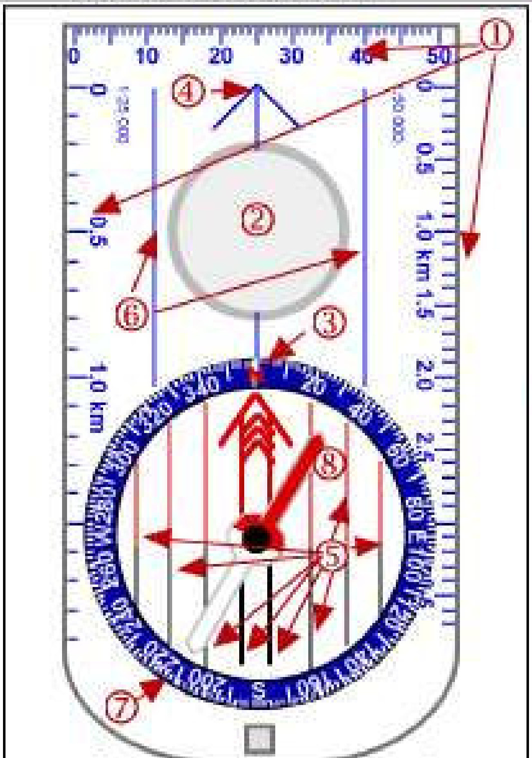
- Base plate
- Straight edge and ruler
- Direction of travel arrow
- Compass housing with 360 degree markings
- North label
- Index line
- Orienting arrow
- Magnetic needle (north end is red)



Know your compass



Compasses with a romer scale i.e. Silva Expedition 4



Compass without romer i.e. Silva Field 7 & Ranger 3

① **Scale Ruler** : Used to measure distances on the map

② **Magnifier** : For helping to read details or in cluttered areas

③ **Index Line** : This is the point where you read off the bearing. Some models this is luminous.

④ **Direction of Travel Arrow** : To point the compass in the direction that you are travelling.

⑤ **North/South Orienting Lines** : To help you taking bearings from a map.

⑥ **Parallel Lines** : These lines run parallel with the direction of arrow line. They can be used when taking map bearings.

⑦ **Compass Housing** : A rotating dial normally marked in degrees.

⑧ **Magnetic needle** : The red half points to magnetic north.

⑨ **Romer Scale** : To help take grid references. Be careful to use the correct scale.

⑩ **Stencil hole** : Used in marking exact positions on the map.

All these part are on the **Baseplate** which allows you to line up features on the map. The rounded corners allow it to be held comfortable in the hand. Some models have silicon feet to stop it moving on the map.

Using the Map and Compass together

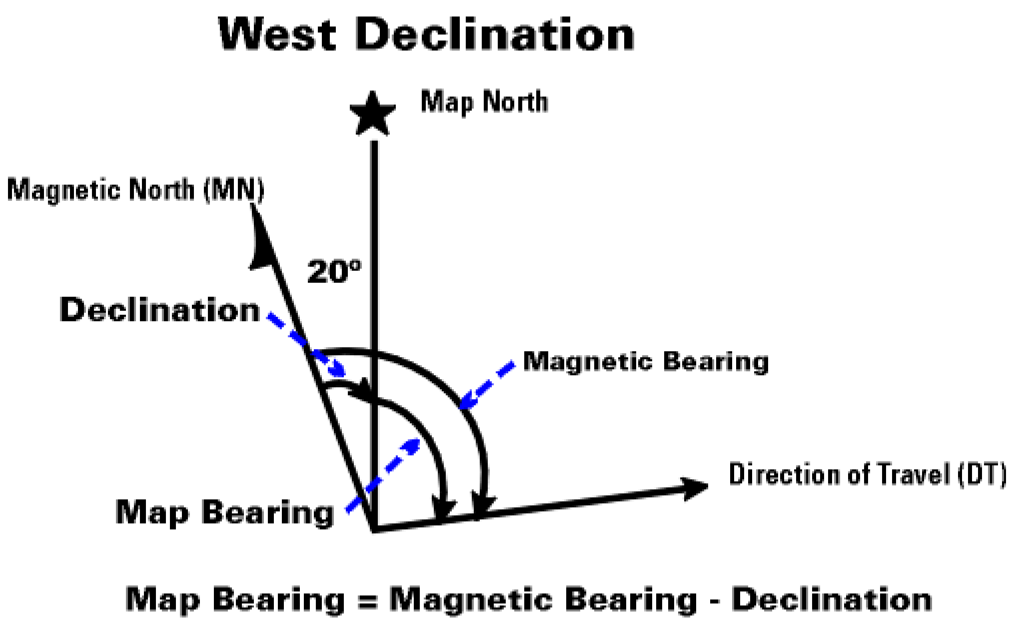
What is north?

No, this is not a silly question; there are three types of north.

- **True North:** (also known as Geographic North) the geographic North Pole where all longitude lines meet.
- **Grid North:** All maps are laid out with north at the top. Unfortunately due to the curvature of the earth, true north is not at the same as the north lines on the map.
- **Magnetic North:** Think of the earth as a giant magnet (it is actually). The shape of the earth's magnetic field is roughly the same shape as the field of a bar magnet. However, the earth's magnetic field is inclined at about 11° from the axis of rotation of the earth, so this means that the earth's magnetic pole doesn't correspond to the Geographic North Pole and because the earth's core is molten, the magnetic field is always shifting slightly. The red end of your compass needle is magnetized and wherever you are, the earth's magnetic field causes the needle to rotate until it lies in the same direction as the earth's magnetic field. This is magnetic north (marked as MN on an Ordinance Survey map). It currently lies in Northen Canada

Magnetic Variation (Declination)

You can see that location makes a great deal of difference in where the compass points. The angular difference between grid north and magnetic north is known as the Magnetic **Variation** or Declination and is marked in degrees on your map. Depending on where you are, the angle between true north and magnetic north is different. In Ireland, the angle of Variation varies from about 6 degrees. The magnetic field lines of the earth are constantly changing, moving slowly westward (1 degree every six years). This is why it is important to have a recent map. An old map will show a Variation that is no longer accurate, and all your calculations using that Variation angle will be incorrect. As you will see, understanding this distinction becomes important when navigating with a map and a compass. In Ireland we have a western declination as the magnetic north poles lies to the west of the Map North



Which North to Use

So we have three types of north to contend with. When you look at your map, it is drawn in relation to grid north; when you look at your compass, it points to magnetic north. To make the map and compass work together you must decide on one North as your point of reference and base all your calculations on that. As you can see the following chart, failure to take declination into account can put you way off target.

Declination or Degrees Off Course	Error Off Target after Walking 10 Miles (16km)
1°	**920 feet (280meters)**
5°	**4,600 feet (1,402 meters)**
10°	**9,170 feet (2,795 meters)**

Map Bearing + Magnetic Declination = Compass Bearing
Compass Bearing - Magnetic Declination = Map Bearing.

East Declination:

If your declination is east (USA) then magnetic north is greater than true north the map bearing is greater than the magnetic bearing. You need to make the two world's equivalent by adding or subtracting the declination.

- **Map Bearing to Magnetic Bearing: If you are taking a bearing from one point on your map to another point on the map with respect to true north, then you are working with the map bearing. Now you want to figure out where your position is in the magnetic bearing. In order to transfer this information back to your magnetic bearing you need to subtract the declination from your map bearing compass bearing to create the proper magnetic bearing. Map bearing - Declination = Magnetic Bearing.**
- **Magnetic Bearing to Map Bearing: If you use your compass to take a bearing from your current position to a point on the landscape, then you are working with the magnetic bearing. Now you want to figure out where your position is on the map. In order to transfer this information back to your map you need to add the declination from your magnetic bearing compass bearing to create the proper map bearing. Magnetic bearing + Declination = Map Bearing.**

Orientating the Map

The first use of the compass is to orientate the map. It is easiest to read a map if the map is oriented to the surrounding landscape. If you see a valley on your left, then the valley shows on the left on the map. You can do this by eye or with your compass. This means that either by sight or compass you line the map up in such a way that the features around you are in the correct place when you look at the map. It is not always necessary (and in fact it is better not to if possible) to use the compass for this. You could use known or recognizable features around you to perform this task. In good visibility you can rotate the map using visual references instead of the compass.

If you cannot do these using features then you should use the compass to line up North on the map with North on the ground. The map will then be pointing the same way as if you had orientated it using features on the ground. This is referred to as 'setting' or orientating the map

- Using Land Features: Lay the map on the ground or hold it horizontally. Rotate the map until recognized features on the ground roughly align with those on the map.
- Using the Compass:
    1. Identify your declination from your map. If your declination is west of true north, subtract the declination from 360 degrees (Ireland). S
    2. Set the compass at the correct declination bearing so that you compensate for declination.
    3. Place your compass on the map so that the edge of the baseplate lies is parallel to the east or west edge of the map with the direction of travel arrow toward the north edge of the map.
    4. Holding the compass on the map, rotate the map with the compass until the north end of the magnetic needle points to the N on the compass housing (i.e. the red north end of the magnetic needle and the orienting arrow align). This is often referred to as "boxing the needle" since the magnetic needle is inside the "box" formed by the orienting arrow. The map is now oriented with respect to magnetic north. This means that the compass needle direction north is the same as true north on the map

Bearings

The main use of the compass is for navigating in poor visibility. It should be used along with the techniques of timing and pacing. Here we will discuss how to take a bearing from the map and follow it. We will assume that we wish to go from the blue dot to the green dot.

- Put the compass on the map ensuring that the base is aligned with the points which you wish to move between. The direction of travel indicator should point the way you want to go.
- Rotate the compass housing so that the orienting lines are lined up so the red north arrow on the housing points to grid north. Note it does not matter which way the needle is pointing.
- Take the compass away from the map, and add magnetic deviation to the bearing. At the time of writing this was 4º. It varies depending on where in the world you are. It also reduces by approx ½º every 4 years.

- Take the compass and whilst keeping it flat, rotate the whole compass so that the needle is in the centre of the red arrow on the housing.

- Looking down on the compass follow the direction arrow to a feature such as a large rock (but not a moving one such as a sheep). Now walk to this feature keeping track of the distance walked. Now find another feature in the same way, and continue till you reach your destination.

It is possible to reverse this procedure, and take a bearing from the ground and convert it to the map. This is usually done to check the bearing of a wall for example, or to pinpoint your location using features such as lakes and peaks. To do this
1. Point the direction arrow along the line of the wall or to the feature.
2. Rotate the housing so that the needle is within the red section of the housing.
3. Subtract magnetic deviation.
4. Place the compass on the map and line up the housing with the grid lines.
5. The direction arrow now points in the direction of the wall, or towards the feature from where you are.

By using this technique with two (or better still three) features you can locate your position on the map.

These are the main uses for the compass, and they should be practiced in good visibility so that they can be applied in poor weather when you will really need them. The most common mistake is to be 180º out because you have lined the housing up incorrectly, or pointed the compass in the wrong direction on the map. It is best to guess the bearing first and this mistake will then become obvious.

FINALLY, ALWAYS TRUST THE COMPASS

Using the Compass

When you point the compass at a target and align the needle with the orienting needle, you are taking a bearing.

The front or top bearing/sighting line will align with a number between 0 and 360. This is the angle of degrees the line you will be travelling is from magnetic north. If it doesn't make sense don't worry, it's not that important. What is important is if the guide book you have been following says to travel at a bearing of 291 degrees, you know to rotate the housing so that 291 lines up with the front or top sighting line, move the compass and yourself until the needle aligns with the orienting needle, and you follow the sighting lines

Using Map and Compass

Even after years of using a map and compass I could never remember how to correct for declination. Do I add declination or subtract it? What if I'm out west versus in the east? While navigating through dense fog on a sea kayaking trip, I finally came up with an easy way to remember. As long as you remember the basic principles, you

Bearings:

The compass is used primarily to take bearings. A bearing is a horizontal angle measured clockwise from north (either magnetic north or true north) to some point (either a point on a map or a point in the real world) (see Figure 6.8). Bearings are used to accurately travel to a destination or to locate your position. If you are working from your map, it is called a map bearing and the angle you are measuring is the angle measured clockwise from true north on your map to this other point on the map. If you are taking a bearing off a real point on the landscape with a compass, you are using your compass to measure the angle clockwise from magnetic north to this point on the landscape. This is called a magnetic bearing. Remember that the bearing is measured clockwise. If you think of true north as 12 o'clock then a bearing to the right of that (1 o'clock) is greater than true north and a bearing to the left of True north (11 o'clock) is less than true north.

Using Map & Compass Together

Adjusting Your Compass for the Local Declination:

Another way to deal with declination is to adjust your compass. Some compasses have an outer degree ring that can be unlocked either with a set screw or a latch. This allows you to reset the compass to account for declination. For example, if the declination were 14 degrees east, you could rotate the degree dial to the right so that the magnetic needle was pointing to 14 degrees instead of 360 degrees. Once you do this, you will no longer have to add or subtract for declination because your compass is aligned to true north. Now when the compass needle is inside the orienting needle, the compass bearing that you read off your compass will be in relation to true north instead of magnetic north. If you have a fixed-ring compass, you can mark the declination angle on the compass ring with a piece of tape.

Wilderness Navigation

Navigation in the wilderness means knowing your starting point, your destination, and your route to get there.

Check Your Position Regularly;

Make it a habit of keeping your map and compass handy and refer to them every hour or so to locate your position (more often in low visibility). Keep track of your starting time, rest breaks and lunch stops, and general hiking pace. This will also give you an idea of how far you have travelled and whether your Time Control Plan is accurate (see Planning Your Day, page 00).

Identify Terrain Features:

With the map oriented, look around for prominent features landscape features such as mountains, valleys, lakes, rivers, etc. Make a mental note of the geographical features you will be travelling along and seeing during the day. If you keep the terrain in your mind, you will usually have a general idea of where you are just by looking around.

Real Life Scenarios

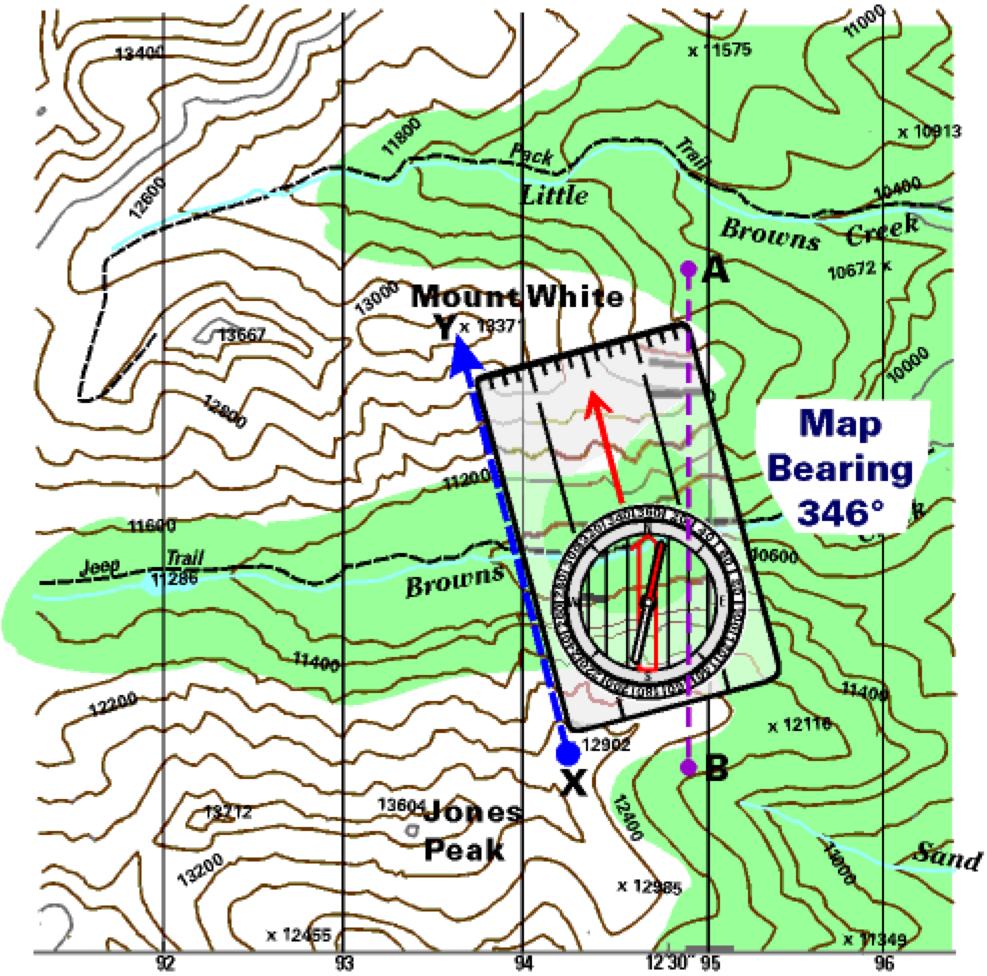
Let's look at some common backcountry scenarios and see how you can use your map and compass to navigate.

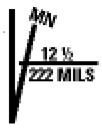
Scenario #1 - Lost in the Fog:

Okay, you hike in along the trail and then bushwhack off trail to a nearby alpine lake to camp. When you wake up the next morning, you are fogged in. You know where you are on the map, but you can't see to find your way out. What you need to do is take a bearing on your map from your known campsite back to a known point on the trail that you can identify on the map. Then follow your bearing through the fog (or you might decide to wait out the fog if there is difficult terrain to traverse - see Chapter 7: Safety and Emergency Procedures: Dynamics of Accidents page 00). Here's your procedure:

Taking a Bearing from the Map (Map Not Oriented):

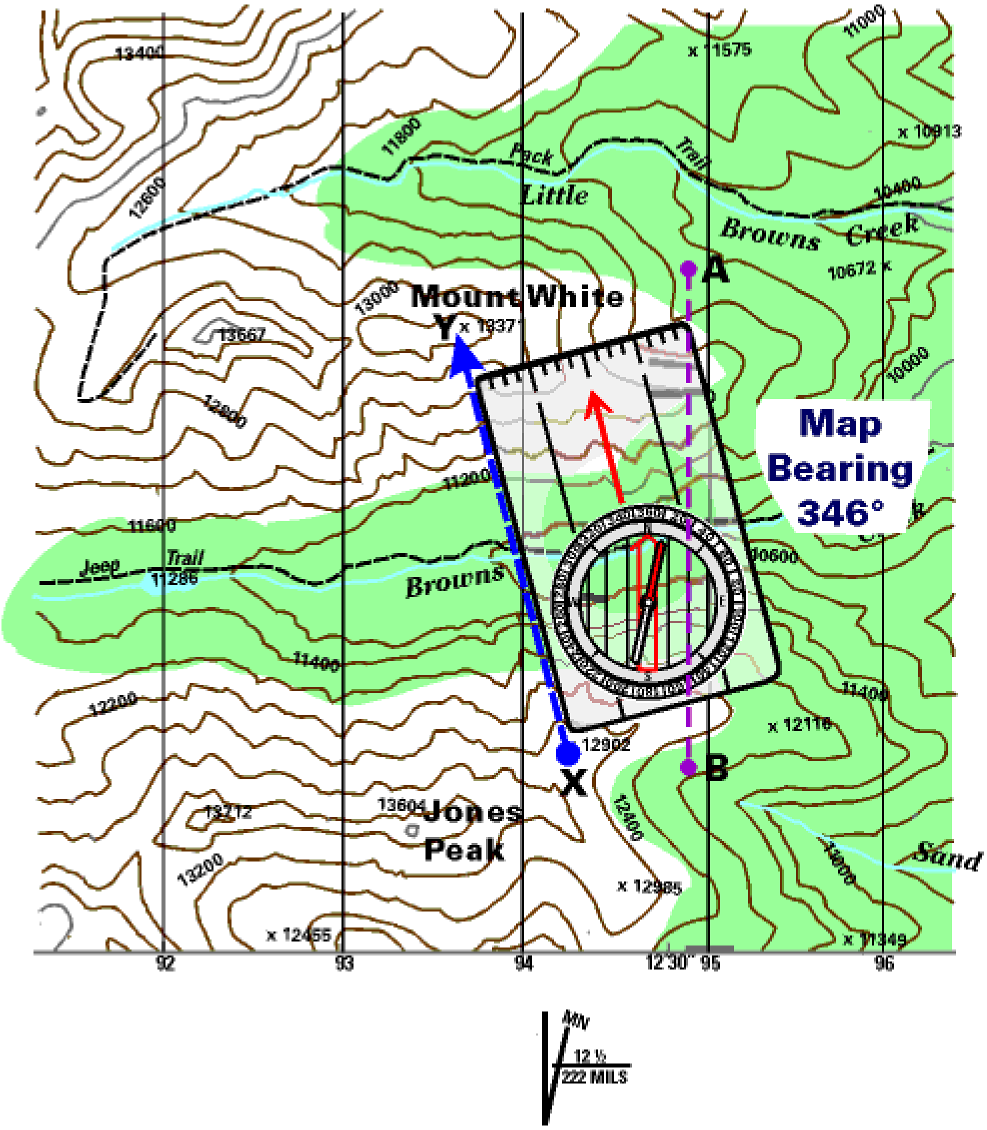
1. **Lay the long edge of the compass base plate on the map, making a line from the starting point to the destination (from point X to point Y). Since the base plate is parallel to the direction of travel arrow, the base plate can be used to set the direction to the destination.**
2. **Holding the base plate steady, rotate the compass housing until the compass orienting lines and orienting arrow are pointing to true north. Here you see the orienting lines and arrow are parallel to the line from A to B as well as to the map gridlines.**
3. **Read the bearing (in degrees) from the degree dial at the point on the compass base plate marked "Read bearing here." In this case the bearing is 346 degrees.**





Taking a Bearing from the Map (Map Oriented to Magnetic North):

1. **Orient the map with the compass (see page 00).**
2. **Lay the long edge of the compass base plate on the map, making a line from the starting point to the destination (from X to Y). Since the base plate is parallel to the direction of travel arrow, the base plate can be used to set the direction to the destination.**
3. **Holding the baseplate steady, rotate the compass housing until the orienting arrow coincides with the North end of the magnetic needle (known as "boxing the arrow").**
4. **Read the bearing (in degrees) from the degree dial at the point on the compass base plate marked "Read bearing here." In this case the bearing is 338 degrees.**



Scenario #2 - Heading to the Summit:

You have been hiking along the trail and found a good campsite that is marked on the map. You see a summit ridge above treeline that looks like a great place for photographs, but there's a valley thick with Douglas fir between you and the summit. What you need to do is take a bearing from your current position to the summit and use that to travel through the forest. Here's your procedure:

Taking a Bearing from the Land:

1. **Point the compass direction of travel arrow to the destination on the land.**
2. **Rotate the compass housing until the north orienting arrow of the compass housing lines up with the red magnetic needle. This is referred to as "boxing the needle," since you want the needle to be inside the box defined by the orienting arrow. The north orienting arrow must be pointing in the same direction as the red (north) magnetic needle. Your compass will look like the figure above with the needle boxed.**
3. **Read the bearing (in degrees) from the degree dial at the point on the compass base plate "Read bearing here."**

Walking a Bearing Taken from the Land:

1. **After taking the bearing, as described above, hold the compass level and in front of you, so that the direction of travel arrow points to the destination.**
2. **Rotate your whole body until the magnetic needle lies directly over the orienting arrow. Make sure the north end of the magnetic needle points to N on the compass housing. The direction of travel arrow points to the destination.**

3. Site a prominent feature to which your direction of travel arrow points. Walk to that feature. Continue to sight on other features along the bearing and walk to them, until you reach your destination.

Walking a Bearing Taken from the Map:

To walk a bearing taken from the map, you may need to correct for declination if you did not orient the map to magnetic north before you took your bearing. Once you have corrected for declination, follow the same procedure as indicated above for walking a bearing taken from the land.

Techniques for Walking a Bearing:

Sometimes the terrain isn't always so cooperative to let you just follow your bearing in a straight line so there are a number of techniques to use when travelling on a bearing.

- Line of Sight Walk to an obvious landmark—a tree or boulder that is directly on the bearing. Then take another bearing on the next obvious landmark and walk to that. Keep it up until you reach your destination. By going to intermediate landmarks, you minimize the chances of veering off your bearing.

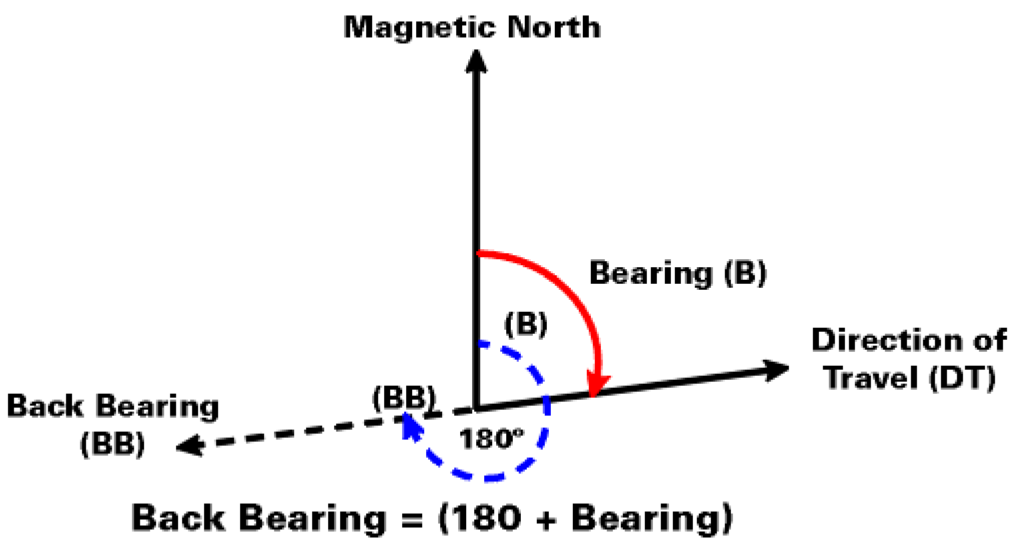
Scenario #3 - Retracing Your Steps to Camp:

You got to the summit and got some great photos, even one of a baby mountain goat. Now it's time to get back to your campsite. You could just follow your back bearing (see below) back to your location, but there is bound to be some error, when you hit the trail where will you be in relation to your campsite? The best bet is to intentionally aim off. Here's your procedure:

- Back Bearings to check your position while walking a bearing, you can take a back bearing. Before you start to walk on your bearing, turn around take a bearing 180 degrees off of the bearing you are going to walk. For example, if you are going to walk a bearing of 45 degrees, shoot a bearing directly opposite your course of 225 degrees. Locate some landmark along this bearing. Once you have moved a short distance along your bearing, turn around and shoot a bearing back to that landmark. If you are on course, that bearing will still read 180 degrees off your bearing of travel (in this case 225 degrees). If it doesn't, it means that you are off course. Sailors and sea kayakers use back bearings all the time to check for lateral drift from wind or currents. Back bearings are also useful if you are heading out to someplace and then returning along the same line of travel (see Figure 6.14). There are two basic formulas for calculating a back bearing.

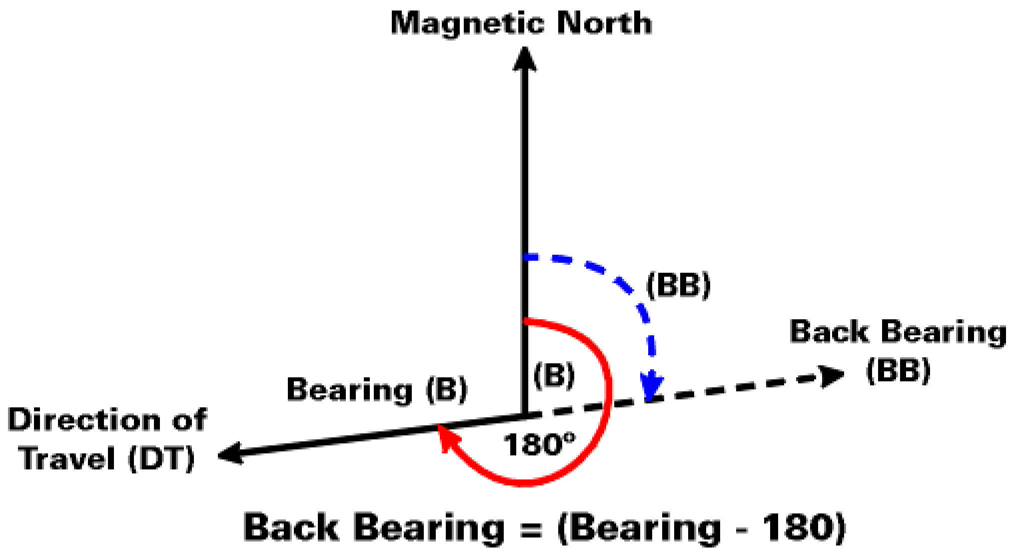
When the Direction of Travel Bearing is Less than 180° (see Figure 6.14):

- Back Bearing = (180° + Direction of Travel Bearing)
- BB = 180° + B
- 225° = 180° + 45°

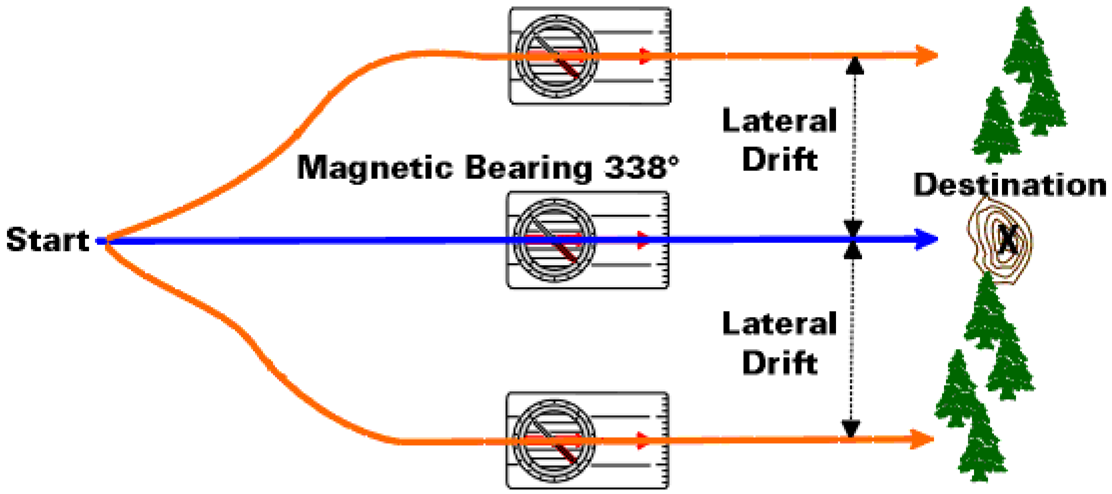


When the Direction of Travel Bearing is Greater than 180 degrees (see Figure 6.14):

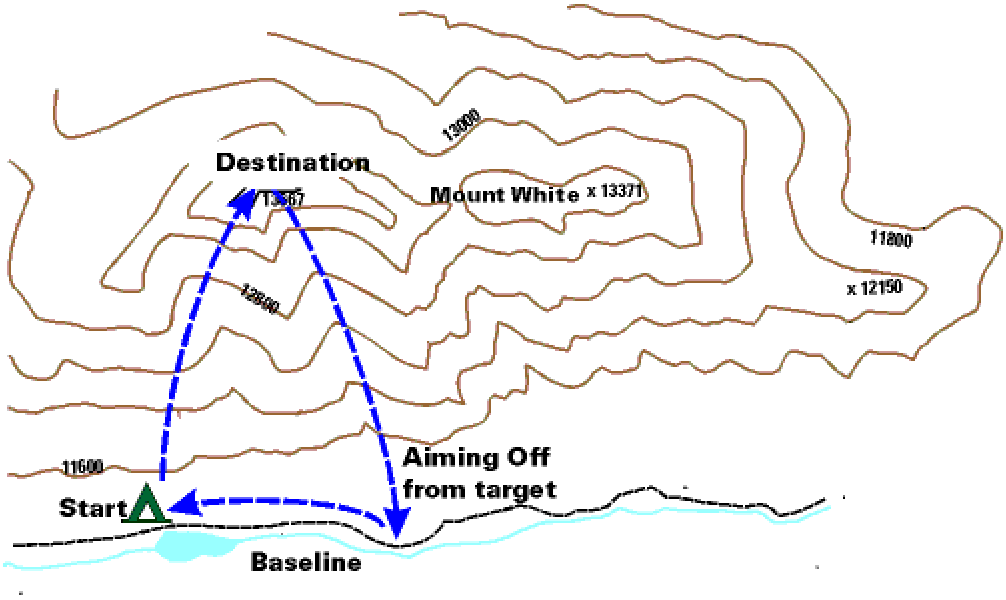
- If the Direction of Travel Bearing is more than 180 degrees you use a different formula (otherwise you will have a back Bearing greater than 360 degrees). If we reverse our example from above, let's say your Bearing is 225 degrees (which is greater than 180 degrees) then you're back bearing works out to 45 degrees.
- Back Bearing = (Direction of Travel Bearing - 180°)
- BB = B - 180°
- 45° = 225° - 180°



- Aiming Off: It is almost impossible to walk a perfect bearing. In most cases your error can be anywhere from 3-5°. This is known as lateral drift (see Figure 6.12) being off just a few degrees can make a major difference after several miles (see Table 6.1). Therefore, rather than head straight for your target, it is best to deliberately aim to one side of your target (left or right). Then you will know whether to turn right or left and walk to the target.



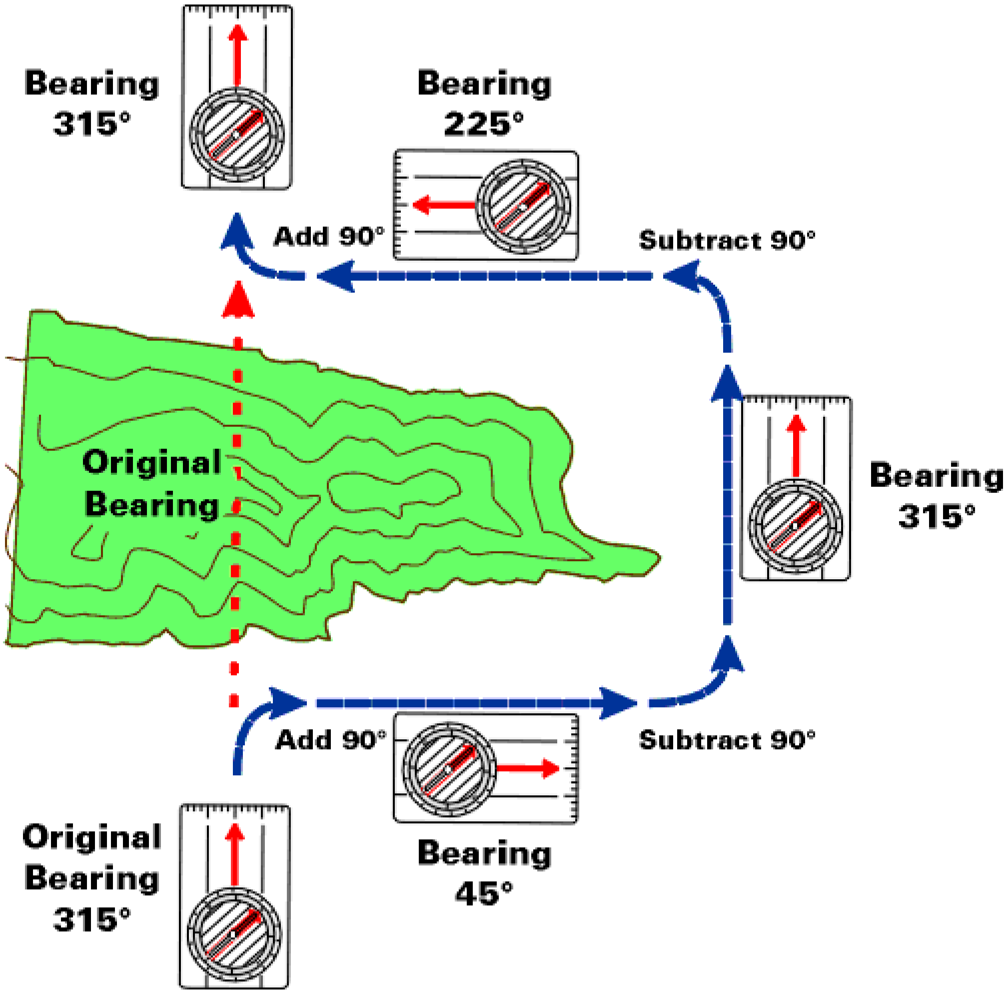
- Baselines: Baselines are helpful because they provide a large target to aim for. A baseline is a reference line that lies across your course. It can be a trail, cliff face, road, stream, or other feature. You can combine a baseline with aiming off to help navigate (in Scenario #3 the trail served as a baseline). Find a baseline near your destination, and then aim off of it. When you hit the baseline, you now know which direction to turn to walk along the baseline to reach your destination (see Figure 6.13).



Scenario #4 - There's Something in Your Way:

You're doing this incredible bushwhack and you've been diligently following a compass course, sighting from tree to tree. Up ahead there is a clearing, when you enter it you discover a bog. There's no way you can go straight through on your compass course. Now what? Here's your procedure:

- **Walking around Obstacles - When you reach an obstacle, the best method for maintaining your course is to hike a rectangle around the object (see Figure 6.14).**
    - **Set a new bearing 90 degrees from your original heading and walk that until you have cleared the obstacle along that axis. For example, if you original bearing was 30 degrees, hike a new bearing of 120 degrees. While walking, maintain a count of paces or otherwise track the distance travelled.**
    - **Go back onto your original bearing, parallel to you original course until you clear the obstacle along that axis.**
    - **Set a bearing 90 degrees back to your original bearing (in this case 300 degrees) and walk the same number of paces.**
    - **Now turn back to your original bearing. You will be along your original line of travel.**



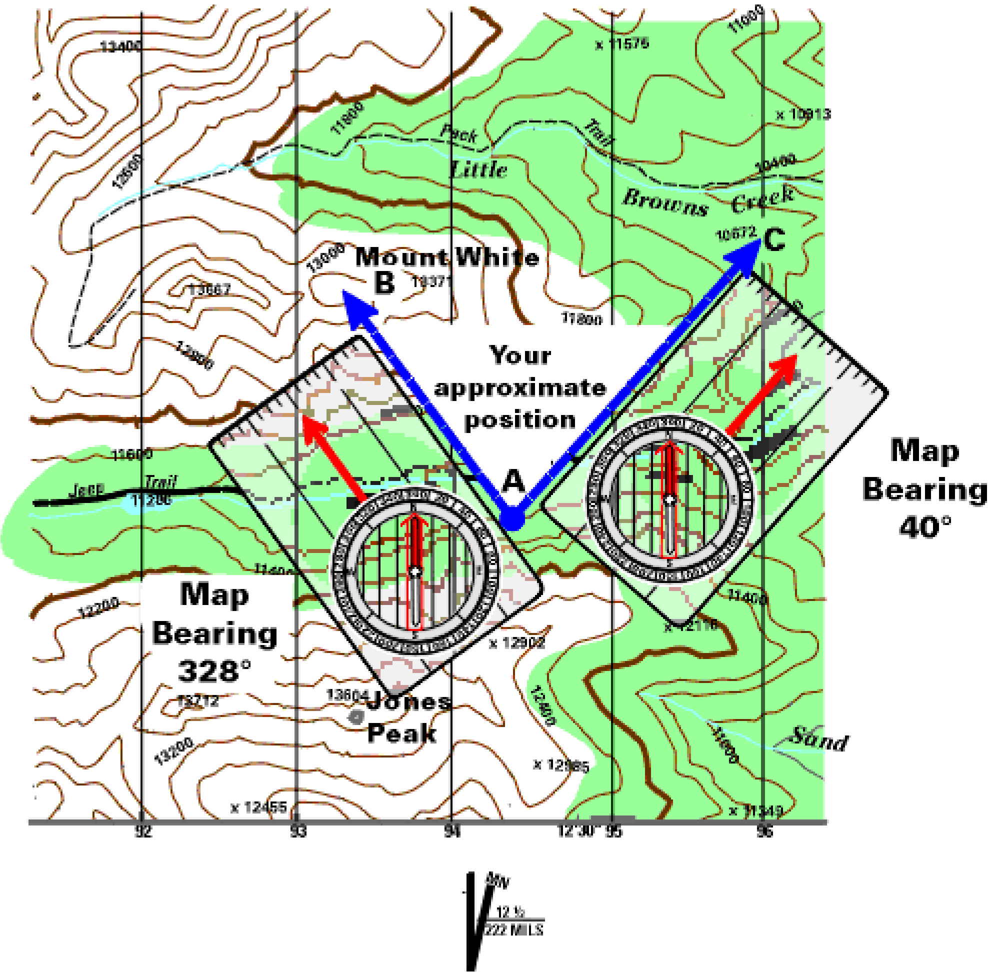
Scenario #5 - Now Your are really Lost:

You're hiking off trail through the broad alpine valleys and you're having this deep philosophical conversation about the connection of man with nature, so deep that you have lost some of your connection with nature. You look around and you don't know where you are. One alpine valley looks a lot like the last one you came through. Okay, so you're lost. Now what? Here's your procedure:

Triangulation

Triangulation is used to locate your position when two or more prominent landmarks are visible. Even if you are not sure where you are, you can find your approximate position as long as you can identify at least 2 prominent landmarks (mountain, end of a lake, bridge, etc.) both on the land and on your map. (See Figure 6.15).

1. Orient the map.
2. Look around and locate prominent landmarks.
3. Find the landmarks on the map (preferably at least 90 degrees apart).
4. Determine the bearing of one of the landmarks (see Bearings page 00).
5. Place the compass on the map so that one side of the base plate points toward the landmark.
6. Keeping the edge of the base plate on the symbol, turn the entire compass on the map until the orienting arrow and the compass needle point to north on the map.
7. Draw a line on the map along the edge of the base plate, intersecting the prominent landmark symbol. Your position is somewhere along this line.
8. Repeat this procedure for the other prominent landmark. The second landmark should be as close to 90 degrees from the first as possible. Your approximate position is where the two lines intersect.
9. You can repeat this process a third time to show an area bounded by three lines. You are located within this triangle.
10. If you are located on a prominent feature marked on the map such as a ridge, stream, or road, only one calculation from a prominent landmark should be necessary. Your position will be approximately where the drawn line intersects this linear feature.



Other Tools

Altimeters

An altimeter can also be a useful navigation tool. An altimeter measures the local atmospheric pressure of the air just like a barometer. This is usually expressed in inches or millibars of Mercury. The altimeter displays the current altitude on a dial with a needle or with a digital display. Since atmospheric pressure is constantly changing due to weather (see Chapter 7 - Natural History: Weather page 00), you must calibrate the altimeter by first setting it when you are at a known elevation. Say you arrive at the trail head parking lot which the map indicates is at 2,400 feet (730 meters). Set your altimeter for 2,400 feet (730 meters). As you hike the altimeter shows the current altitude as your elevation increase or decreases. In order to maintain accurate readings you should recalibrate your altimeter several times each day. One good trick is to recalibrate or at least look at your altimeter reading before you go to bed. If the altimeter reads higher the next day, then the atmospheric pressure has gone up during the night (typically indicating stable or improving weather). If the altimeter reads lower, then the atmospheric pressure is falling (indicating potential stormy weather).

You can use your altimeter in navigation as another information source to help locate your position. If the altimeter is properly calibrated, you know that you are at a specific altitude. Think of this altitude as corresponding to a particular contour line on your map. This may be enough to give you a very accurate fix on your location. If you are hiking up a trail and it crosses a particular altitude (contour line) at only one point, then you know exactly where you are. In other situations, you know that you are somewhere along a contour line that lies at that altitude (elevation). Other clues may help pin down exactly where along that contour line you are.

Inexpensive altimeters are available for under $50 and are also prone to inaccuracies due to temperature. To minimize temperature problems it is best to let your altimeter adjust to the ambient air temperature before taking a reading. More expensive altimeters that automatically correct for temperature changes can run over $200. A digital watch with an altimeter/barometer is an item that combines two useful tools.

Watches

Wearing a watch in the backcountry is a point of personal wilderness ethics. Many people like to let nature set the pace of the day rather than a watch. I may not wear my watch, but I always bring one along. There are too many times when I have needed a watch. For example, to get an accurate check on how fast I am hiking to see if my Time Control Plan is correct (see Chapter 1 - trip Planning: Planning Your Day page 00), and especially in first aid and emergency situations where timing vital signs and knowing the exact time that things are occurring may be essential in proper diagnosis and treatment (see Chapter 9 - First Aid & Emergency Care: Patient Assessment page 00). Watches can also be used to determine basic direction (see page 00).

Global Positioning Systems (GPS)

The Global Positioning System is a network of satellites in orbit above the earth. A GPS unit is basically a radio receiver. The satellites transmit to the GPS unit which interpolates the signals into latitude and longitude which are displayed on the unit. Typically signals from three satellites are needed to identify a specific position and a fourth to interpolate altitude. GPS units are accurate to within a few hundred feet of your actual location. Although they can be used to very accurately determine your location and establish compass courses, don't rely on a GPS unit in place of solid knowledge of map and compass. Battery failure, damage to the GPS unit, or even leaving it behind at a rest stop could leave you lost if you don't have good map and compass skills. GPS units are particularly useful in locations where there a few landmarks to identify your location (for example long canoeing trips in northern Canada). GPS units are available as hand held units easily transportable in the backcountry.

Measuring Distance on the Ground

There are techniques we can use while navigating that will help us to determine how far we have walked, thereby

allowing us to calculate how much further we have to go and how long that will take us.

There are two methods to help us do this
* Over short distances - up to 500m - we usually use PACING
* Over longer distances - Over 1km - we usually use TIMING

Between 500m and 1 km we use both
With both methods the first thing to do is measure the distance on the map
2mm = 100m on a 1:50000 map

Pacing

You need to work out how many paces it takes you to do a measured 100m (An average person is about 50 - 70)
To keep numbers small, we only count one foot
(only count when your left foot hits the ground).
This is called double pacing
This is your pacing for 100m on flat ground
This will change for going uphill, going downhill and with different terrain
Don't convert your total distance to total paces.
For a 400m distance that would give you 4 x 60 = 240 paces - you will likely lose count.
Instead count 100m blocks - Count up to 60 four times

Timing

Naismiths Formula
Timing
The average walking speed is 5km
per hour
Plus an extra 30 minutes for every 300m climbed

Horizontal speed

Distance	Time
5km	**1 hr**
1 km	**12** min
100m	**1.2** min

Vertical Speed

Height	Time
300m	**30** min
100m	**10** min
10m	**1** min
1 contour	**1** min

If we had to walk 750m and climb 200m, how long should this take? Distance -1.2 min per 100m 7.5 x 1.2 = 9min Height -1 min per 10m 20 x 1 = 20min
Total time - 9 + 20 = 29 min

We don't always walk at 5km/hr We can work out different times for different speeds

	3km/hr	**4km/hr**	**5km/hr**	**6km/hr**
100m	2min	1.5min	1.2min	1min
200m	4min	3min	2.4min	2min
300m	6min	4.5min	3.6min	3min
400m	8min	6min	4.8min	4min
500m	10min	7.5min	6min	5min
1km	20min	15min	12min	10min

It is important for us to know how far we have walked in poor visibility, and also to know how long a walk should take us. For these reasons it is important for us to be able to look at the map and have some idea of how long a certain leg of a walk will take. It will also allow us to vary the route if we are going slower than expected. The speed of walking will vary with conditions both above and under foot, and this needs to be allowed for.eeds to be allowed for.

When calculating timings it is usual to use Naismiths Rule. This allows 5 km per hour with 10 min for every 100 m climbed. This applies to a fit adult. When walking with a mixed group it is usual to allow 4 km per hour. If going down hill, you should add an extra 10 min for 100 m descent if the ground is very steep. If it is a gentle slope you may subtract 10 min for 100 m descended. Generally I do not subtract time for down hill and find it works out reasonably well (but I do add times for steep sections).

Calculating from the above we are allowing 12 min to walk 1 km and 1 min added for every 10 m climbed. This is a good estimate, and can be used along with the map to plan a route. Rest is usually added at 10 min rest for every hour of walking. This does not generally allow for prolonged photo stops or lunch.

You should now be able to measure a distance on the map, calculate the height gain, and work out how long the section of walk should take. This will, as with everything else, improve in accuracy with practice. In poor weather the timing can be used to calculate how far you have walked. Using this in conjunction with the compass will allow accurate navigation.

To be even more accurate over short distances pacing can be used. You need to know how many double paces (one double pace occurs each time the same foot touches the ground) you take for 100m. I am fairly tall and usually take approx 65 on flat ground. Pacing should be tested on several types of ground, such as rough ground and going up hill so that you are aware of the differences from walking on flat ground.

Knowing that one grid square (40 mm on the 1:25,000) is 1 km we can state that 4 mm is equivalent to 100 m (65 double paces) and therefore 1 mm is equivalent to 25 m (16 double paces). This can now be used to measure distances on the map and accurately convert them to distances walked on the ground. It may be useful to keep beads on the compass string, to mark off the number of 100m walked, since it is all to easy to forget when pacing for real

Route Planning

There are two main purposes for the route card. The first is to leave with a responsible person so in the event of your being overdue they can alert the rescue services. If you are back always make sure they are aware, similarly if you have changed your plans and will be late back, since this avoids un-necessary call-outs. The second is to give you an idea of how long sections will take, and allow you to adjust your route depending on time and conditions.g on time and conditions.

The description below is the type of route card I use in Snowdonia. Additions for walking with groups in other areas may include the noting of escape routes. The link is to a Microsoft Word document with an embedded Excel worksheet used to calculate the route. This next section should be read in conjunction with it.

The route card

The first line is the date for the walk followed by the start time and the party. These are self explanatory.

To open the route double click on it. The speed should be entered in kph and this is used for the rest of the plan.
There is space for 15 points, and for each the following can be entered:
1. A description of the location
2. The 6 figure grid reference for the point
3. The bearing to the next point
4. The distance to the next point
5. The height of the current point
6. The height gain to the next point
7. The time is calculated using the speed, and 10 min for every 100 m climbed
8. Extra time can be used to add time for descent or rest
9. The expected time is calculated based on the above given the starting time.

The total distance, height gain and time are given at the bottom of the route
The weather report for the day should be entered
Finally the latest time of arrival can be entered.

The links below is a route planning application I wrote three years ago. It enables you to
1. Set up parameters such as speed and map scale.
2. Apply rules such as Tranters rule
3. Enter a route
4. Edit a route
5. Print a route
6. Work out gradients, times, energy usage.
7. Print an accident report form.

There is no manual, however the software should be fairly self explanatory. Note that windows 95 is needed for the installation wizard version, although the program will run under DOS or Windows 3.1. For this reason a plain zip file has been included as well. This will run on any system with DOS or Windows (it was written on a 386 with 8MB of RAM!!). If using this please read the readme file. If you have any suggestions for improvements please e-mail me and I will do my best to accommodate your suggestions. If some of the program seems a little "over the top", I wrote it shortly after ML training, and was trying to help re-enforce some of the concepts from the course.
Note: Fitness is the time it takes you to climb 300m in 800m. It is used when applying Tranters correction to Naismiths rule. This correction allows for your fitness when calculating the total time for a route.

Route Card

Makes you plan your walk before you go, is it feasible?
All your calculations are done before you leave in less stressful conditions than you may encounter on the hills. You can also take your time to ensure they are correct.
To let other people know of your plans.
Leave a copy with someone you trust, and someone who knows what to do if you don’t return e.g. Family, Hotel, Guesthouse, Gardai.
Do not leave this information on your car window.
Make sure that you inform them that you are down safely, even if you go to the pub to celebrate the days achievements - phone them!!
Too many people have heard on the radio about a rescue taking place in the area that they were walking in, only to realise that they forgot to inform someone that they were down safely, and everyone was out looking for them!!