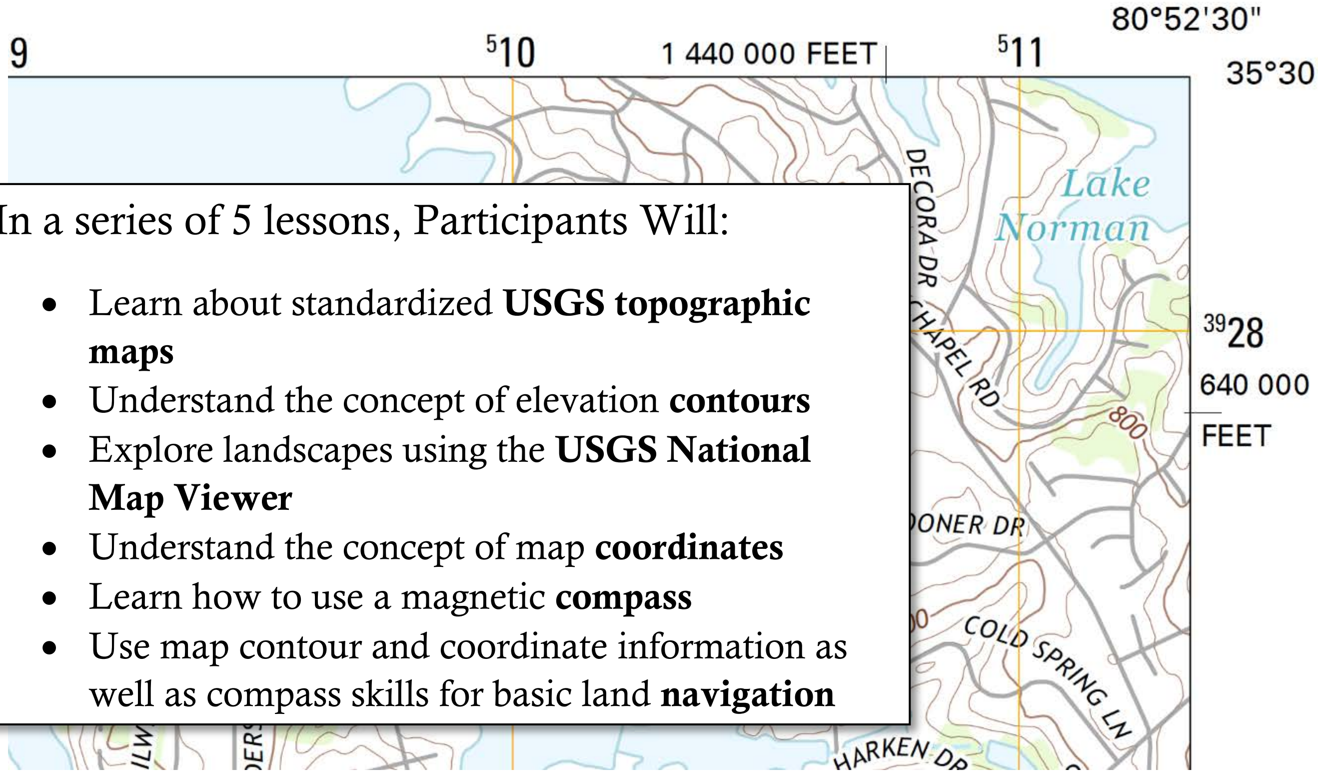
Teaching Topos

2021 Edition

Participant Handbook

Understanding Topographic Maps & Contours



In a series of 5 lessons, Participants Will:

- Learn about standardized **USGS topographic maps**
- Understand the concept of elevation **contours**
- Explore landscapes using the **USGS National Map Viewer**
- Understand the concept of map **coordinates**
- Learn how to use a magnetic **compass**
- Use map contour and coordinate information as well as compass skills for basic land **navigation**

NSF DUE-0903270; 1205110;

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TEACHING TOPOS

Participant Handbook

Lesson 1: Topographic maps

Key Concepts:

- What is a topographic map?
- Parts of a topographic map
- Standard topographic symbols and colors
- Where to find topographic maps – paper and digital

Activities:

- Activity 1: Exploring paper topographic maps
- Activity 2: Exploring the USGS National Map Viewer
- Activity 3: Mobile Connect - Exploring topographic maps on a mobile device

Introduction: What is a topographic map?

How we can take something that exists in 3 dimensions (like the earth we see in front of us) and draw it on a sheet of flat paper in a way that makes sense? **Topographic maps** communicate information about elevation (height) and relief (landform, or shape) of the land, as well as distance and features. You probably have seen topographic maps before – all those wavy, thin lines in the background of what otherwise looks like any other map. Topographic maps use **contours** (those wavy lines) and a set of standard map **symbols**. They have been made and used by people for a long time – both on paper, and now in digital form as well.

Topographic maps: "Maps depicting the elevation and relief of the land surface or depth of a water body (bathymetry) in an area, usually shown using contour lines. Typically these maps include manmade features and administrative boundaries as well as vegetation and hydrographic features." - USGS.gov

What does that mean? It means these standard, easily accessible maps contain information about how steep the land is and what it looks like; where water flows and sometimes how deep it is; where forests, grasslands, and wetlands occur; and the location of buildings, roads, boundaries, and other human-created development.

Topographic maps have been produced for the entire United States. The government agency responsible for the production of these maps is the **United States Geological Survey** (**USGS**). USGS topographic maps share a common set of map **symbols** (see Appendix A) and are produced at the same map **scale** (1:24,000; or 7.5 minutes of latitude and longitude for the lower 48 states). The individual maps are called **quadrangles**. With the introduction of the digital "US Topo" mapping program, some standardized map features will be symbolized slightly differently, or represented by aerial photography, on updated maps (Figure 1). However, the principles for using and reading these maps remains the same.

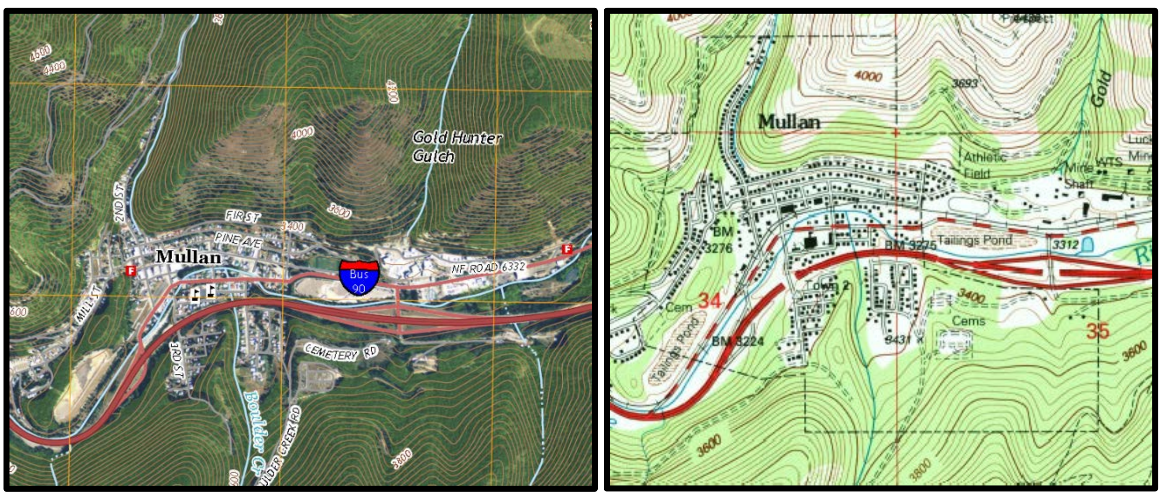

Figure 1: Side-by-side comparison of a 2013 US Topo map and a 1995 standard USGS contour topographic map of the same area (Mullan, Idaho).

Activity 1: Exploring Topographic maps

1. Let's get familiar with those maps! Identify the following key features on a USGS topographic map, searching the map margins and using the Glossary in this guide for more information if you aren't sure what you're looking for or looking at.
    a. Agency or author of map
    b. Map title (quadrangle name)

c. Road classification
d. Revision date
e. Quadrangle location
f. Quadrangle legend
g. Map scale: fractional and bar/graphic scale
h. Contour interval
i. North arrow
j. Declination
k. Map production information
l. Datum and UTM zone
m. Latitude and Longitude (map edges)
n. UTM coordinates
o. Section, Township, and Range (not present on all maps)

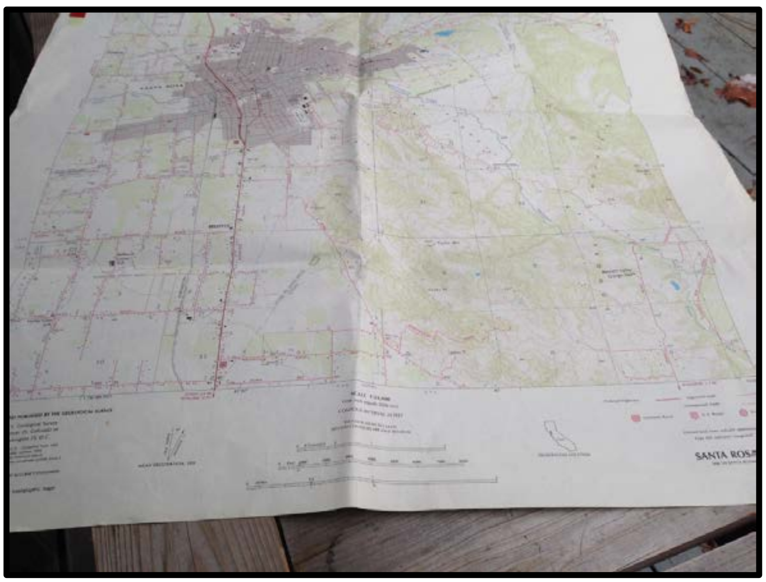

Figure 2: Search the map margins (edges) for the key features and labels on a standard USGS topographic map.

View the USGS topographic symbols found on The Topographic Map Symbols Guide provided by your leader to become familiar with the standard USGS symbols.

2. Compare two topographic maps of different terrain types side-by-side (for example, one map from a flat, coastal area with one map from a hilly, mountainous region).
   a. What are the quadrangle names of your two maps?

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   b. How would you describe the terrain of each area, given your current map knowledge? (Hint: What do the contours look like, in general?)

c. Are the contour intervals used on each map the same? If they are different, why might this be?

d. How are the symbols used on each map the same? How are they different?

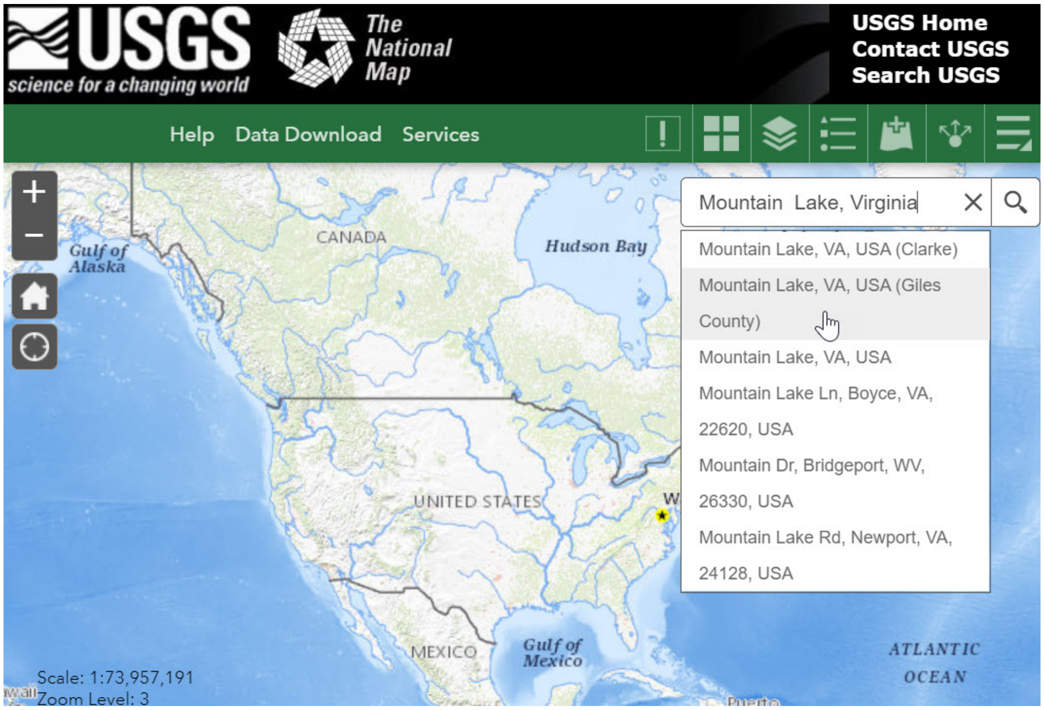
Activity 2: Exploring topo maps using the USGS National Map

Image licensed through Shutterstock

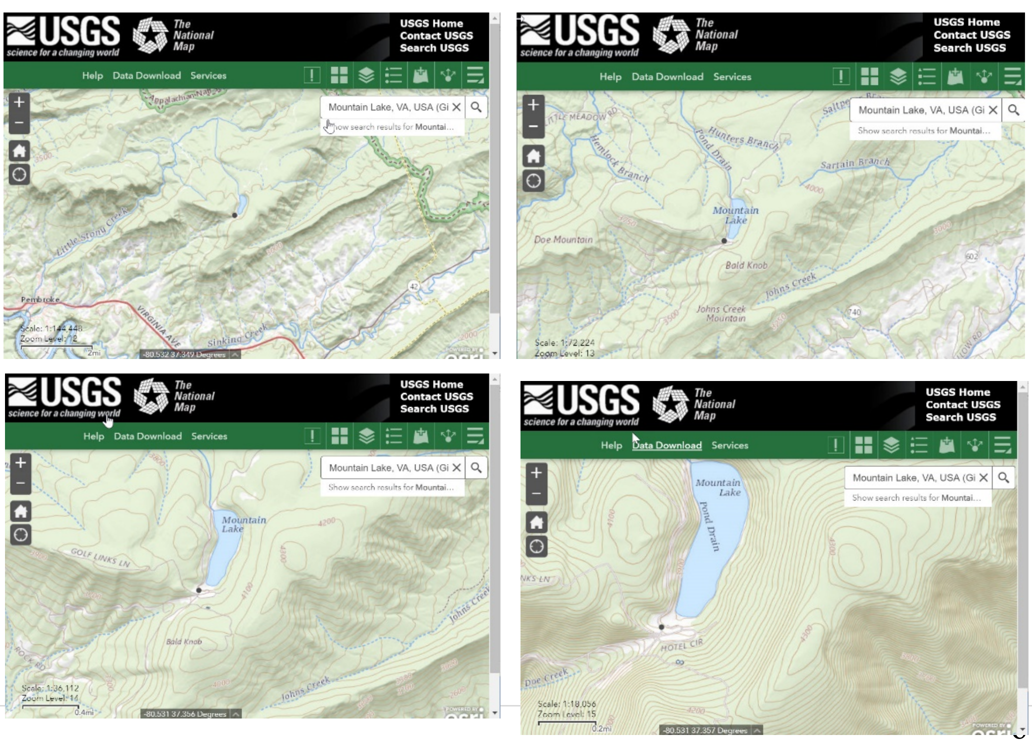
The USGS developed the National Map to describe the landscape of the United States and its territories. The National Map also provides access to fundamental mapping data (sometimes called framework data). Using the National Map, you can view and explore areas, and you can download data. Framework data includes data layers that are most often needed to provide basic information about the Earth's surface. Often, other data are geographically based off of existing framework map layers. Framework map layers often include:

Framework Data Name	**Framework Data Examples**
Hydrography	Rivers, lakes, streams, bays, wetlands, oceans
Transportation	Roads, railroads, airports, etc.
Ortho imagery	Remotely sensed imagery captured from airplanes, helicopters, and drones
Land cover	Land cover classification (urban, farmland, forested, water, etc.)
Elevation	Contours, digital elevation models, etc.
Addresses	Addresses of residences, companies, etc.
Boundaries	Boundaries (national, state, regional, & local)
Survey control	Survey monuments and other survey control that tie all of the above layers together in a geographic framework.

Let's explore the USGS National Map's topographic data. First, access the National Map (https://viewer.nationalmap.gov/advanced-viewer/). Once the National Map has loaded, search for an area of interest (Grand Canyon, Smokey Mountain National Park, Burt's Garden, VA) n using the Search Bar. In the example below, we searched for Mountain Lake, Virginia.



Start slowly zooming into your area of interest.



1. Compare the topographic maps of the different zoomed in levels of your area of interest using the USGS National Map viewer (an example is provided in the figure above).

    a. Do you maps have quadrangle names (similar to the paper maps)?

    b. What happens to the features on your image as you zoom in?

    c. What happens to the contour line on your image as you zoom in (and out)?

    d. Are the contour intervals the same on all images or different?

    e. Are there features that are visible on the 'zoomed out image' that is not clear on the 'zoomed in' image? What are they?

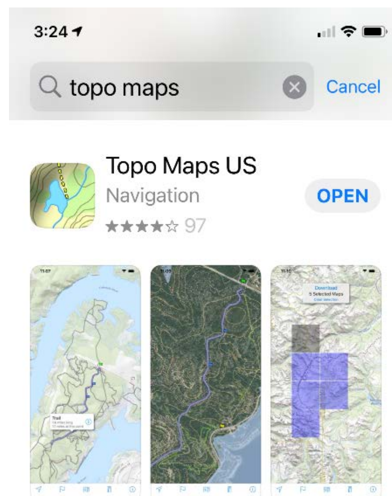
    f. Are there features visible on the 'zoomed in image' that are not visible or clear on the 'zoomed out' image? What are they?

    g. What are some advantages of using the USGS National Map over a paper topographic map?

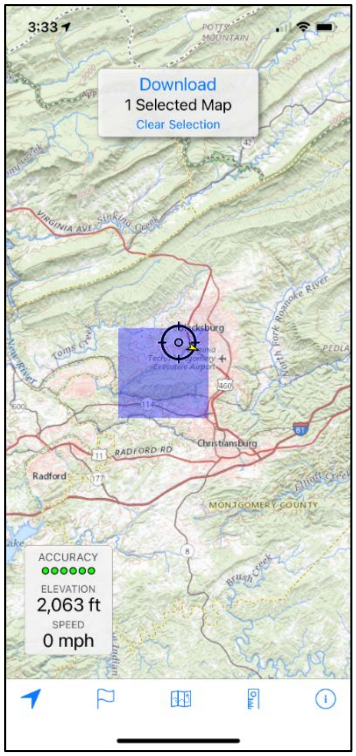
h. What are some advantages of using a paper topographic map over the USGS National Map?

i. Can you locate any other framework data layers using the National Map viewer? If so, what are these layers?

Activity 3: Exploring topo maps on a mobile device



1. Mobile connect option: We recommend completing this part of the exercise with at least one paper map, as well as exploring these map elements on your downloaded maps on Topo Maps USA. Consult the leader's guide if you need help downloading the Topo Maps USA app or the map for your region. Maps aren't pre-loaded (but they are free), so it is important that you download the topo maps from the Topo Maps USA app.
    a. Navigate to the region where you want to explore (the Town of Blacksburg for example)
    b. You will notice that if you zoom too far in to the map on Topo Maps USA, the map data disappears all together. This is because only cursory level data has been included with the Topo Maps USA app. You will need to download a more detailed topographic map for your area.
    c. To download more detailed topographic maps, use your finger to select different areas on the map. These areas are then highlighted in blue. Then hit the "Download" button on the screen. Warning: Do not download too many topographic maps, as they are kind of large and will take time to download. You should only download 1 map (see image below).



1. With the map open, you can now zoom in and out (by pinching your fingers in or out) and pan (by swiping the map). If your current location is on the map, you can locate yourself on the map by clicking the navigation arrow icon (3) at the bottom of the screen.

2. What would be some advantages to using this mobile app to view and work with topographic maps? What would be some disadvantages?

Lesson 2: Contours

Key Concepts:

- What is a contour line?
- Understanding contour intervals
- Identifying key relief features on maps and in the field

Activities:

- Activity 4: Modeling and mapping elevation activity with play dough
- Activity 5: (Mobile connect option): Identifying contours in the field

Introduction: Contours

A **contour line** is a line on a map that connects all points that have the same elevation. It allows us to visualize the relief of three-dimensional terrain (reality) on a flat piece of paper (a map). A **contour interval** is the frequency with which a contour line is modeled. For example, a contour interval of 20 feet means that for every 20 feet of elevation gain or loss, a new contour line is drawn on the map.

Activity 4: Modeling and understanding contours

To understand the concept of contour lines and contour intervals, and how they are used to create topographic maps, we will be creating our own 3D model from play dough and creating a small topographic map. Your leader will guide you through this exercise.

Discussion Questions:

What does each "slice" of your mountain represent? ________________________________

Which direction (uphill or downhill) do the points on the stream "V's" point? How could you use this to interpret topo maps?

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What other strategies can you use to determine uphill and downhill on a topographic map?

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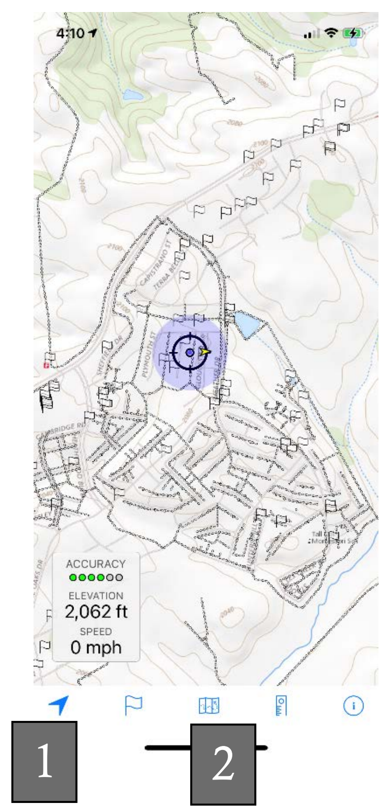
Activity 5: Identifying contours in the field

1. Open the Topo Maps USA app. If you have not already done so, download the topographic map for your current location and open (zoom in) to this topo map.

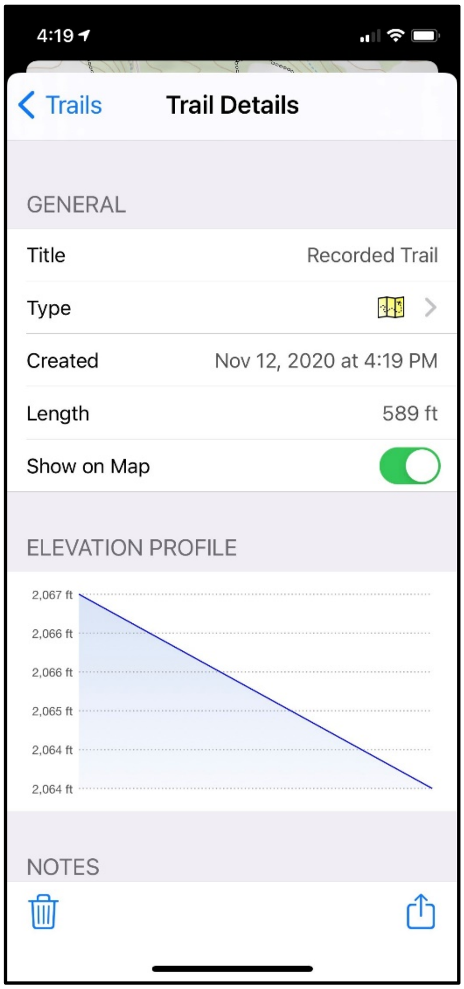
2. Find yourself on the map by clicking the navigation arrow icon (1).

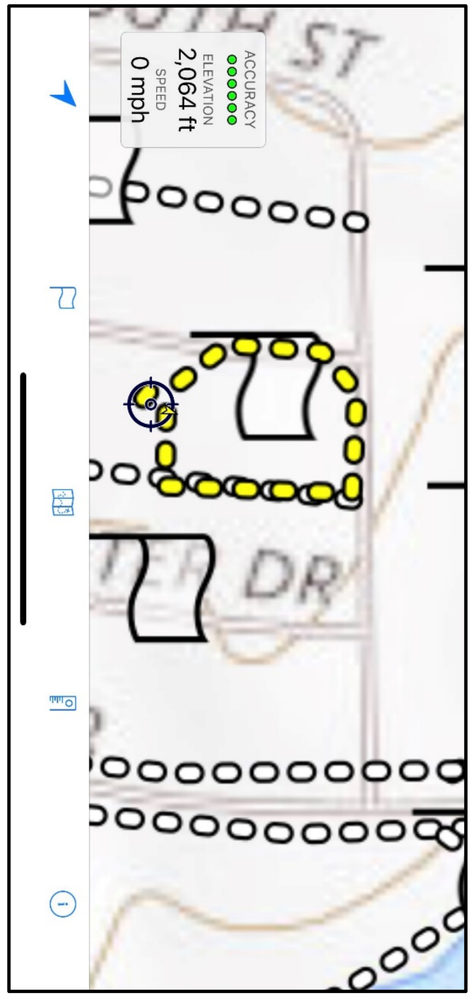
   Take note of the contour lines around where you are currently standing, remembering what you learned about contours in activity 3. Scan the horizon - can you see any hills or other terrain features around you? Locate them on the map and see if you can connect the shape of the contours on the map with what you see in front of you.

3. If you haven't already, zoom in to your current location by pinching and dragging on the screen. Create a new GPS track by going to the Map menu (2) and select *Start Recording Trail*.and try to walk along a contour (unless you are in a very hilly area, you won't be able to connect it). See if you can follow between two contour lines without crossing them. Be sure to click *Stop Recording Trail* when you are finished.



When you are finished, you are presented with an elevation profile of the area that you just walked. Your map also shows the track points that were collected as you walked (highlighted in yellow).





Lesson 3: Coordinates

Key Concepts:

- Types of Coordinate systems represented on USGS topos
- How to find coordinates for a point on a map
- How to plot points based on given coordinates

Activities:

- Activity 6: Exploring the Public Land Survey System (PLSS)

- Activity 7: Coordinate Scavenger Hunt
- Activity 8: (Mobile connect option): Finding coordinates and setting waypoints

Introduction: Why Are Coordinates Important?

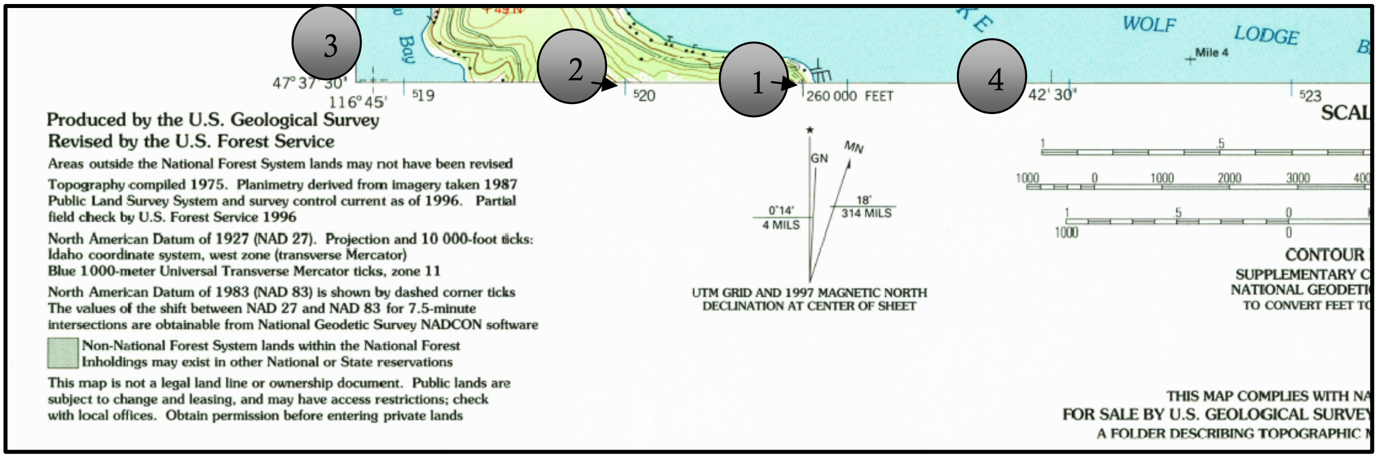
"Where is the public boat launch for Round Lake, Idaho?"

This question could be answered in many ways – by giving driving directions, giving a vague description of what the boat launch looks like, or possibly, by using coordinates. **Coordinates** allow us to communicate information about location on the earth's surface. They are usually given in pairs – one coordinate giving location along an X axis (or east-west) and another coordinate giving location along a Y axis (north-south).There are many, many different **coordinate systems**, or methods of communicating coordinates. Coordinate systems vary from one another by things like distance units, the survey system used as a basis of measurement (datum), and regions, such as states or continents.

There are four common coordinate systems that can be found on standard USGS topographic maps: **latitude/longitude**, **UTM**, **State Plane**, and in western states, the **Public Land Survey System (PLSS)** (township /range/section). We will practice both finding and giving coordinates in each of these systems. For definitions of each system, see Appendix A.

How to use "tick" marks: latitude/longitude, UTM, State Plane, and PLSS:

Somewhere along the bottom of your USGS topo there should be something that looks like this:



First, look at the typed information in the lower left margin. This gives us information about what datums and coordinate systems we find on the map. For this map the Idaho coordinate system, west zone is symbolized with 10,000 foot ticks (1) and the Blue 1000 meter ticks (2) are for the Universal Transverse Mercator, zone 11 coordinate system.

Latitude/Longitude: Looking up at the lower left corner of the map (3) you will also see a set of latitude/longitude coordinates for that corner. Note that the lat/long ticks are black ticks, set *inside* the map bounds, while the other two sets of ticks are set *outside* the map bounds. Also note that lat/long is in degrees (^{0}), minutes ('), seconds ("). Something you will see often with reading coordinates are abbreviations. Note that the full degrees/minutes/seconds coordinate is given in the corner of the map, but at the next tick mark, only minutes/seconds are given (4). The degrees remain the same.

UTM: It is important to note that on newer topographic maps, UTM 1000-meter lines are set out as a grid, instead of ticks. This is why it is crucial that you examine the margins and coordinates for your particular map – not all topographic maps are the same! You will note on the above section of map that UTM is given with the abbreviation ^{5}20 (2). If we examine the rest of this map margin (below), you'll notice that we see the full Easting coordinate as ^{5}27^{000}m E (5), which means an Easting coordinate of 527,000 meters. Since the last three digits (000) do not change between ticks, and the first digit rarely changes, we can use this abbreviation. So it follows that ^{5}20 is an abbreviation for 520,000 meters. Sometimes there are only blue tick marks, but no coordinates. We know that the tick marks occur every 1000 meters, so we can count over from the nearest known coordinate (^{5}20) and know that the next tick mark over

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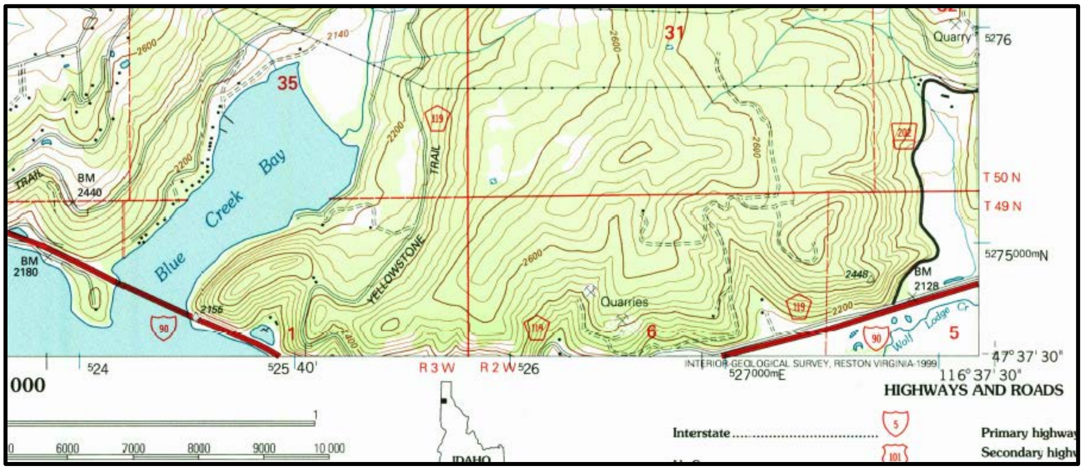
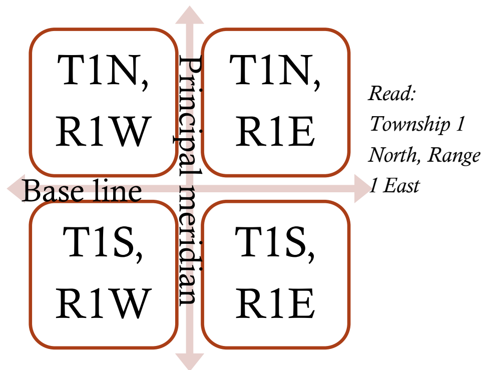
would be 521,000 meters.



State Plane: On this map, the black tick marks set every 10,000 feet represent the state plane coordinate system. We only see numbers written out on the left lower margin (260,000 FEET) (1); however, we do see black tick marks set crossing the boundary of the map (6) and we know from reading the information in the margin that these occur every 10,000 feet.

Reading township/ range / section (Public Land Survey System): This method of surveying land parcels was used in most Western and Midwestern states and can often be found on topographic maps. The end result is not a coordinate pair but rather a 1-square mile section number.

Background: For each state or other large land area, a line denoting the principal meridian (stretching North – South) and base line (stretching East-West) form the starting point of a grid. Along these lines, ***Ranges*** (measuring distance East or West from the principal meridian, in 6 mile increments) and ***Townships*** (measuring distance North or South from the base line, again in 6 mile increments) are used to give position. Within a Township/Range block, there are 36 equal ***sections***, each 1 square mile in area.



On topographic maps, the grid lines for this system are commonly in **red** and use abbreviations such as T3N (township 3 North) or R5W (range 5 West). The smallest unit of measurement for this system shown on topo maps is typically sections, which are outlined in red lines with the section number in the center. Changes in Township/Range typically have solid red lines, while individual sections are outlined in dashed red lines. In the example map margin above, number (7) denotes Section 31, Township 50N, Range 2W.

Activity 6: Exploring the Public Land Survey System (PLSS)

1. Open the National Map Viewer (https://viewer.nationalmap.gov/advanced-viewer).

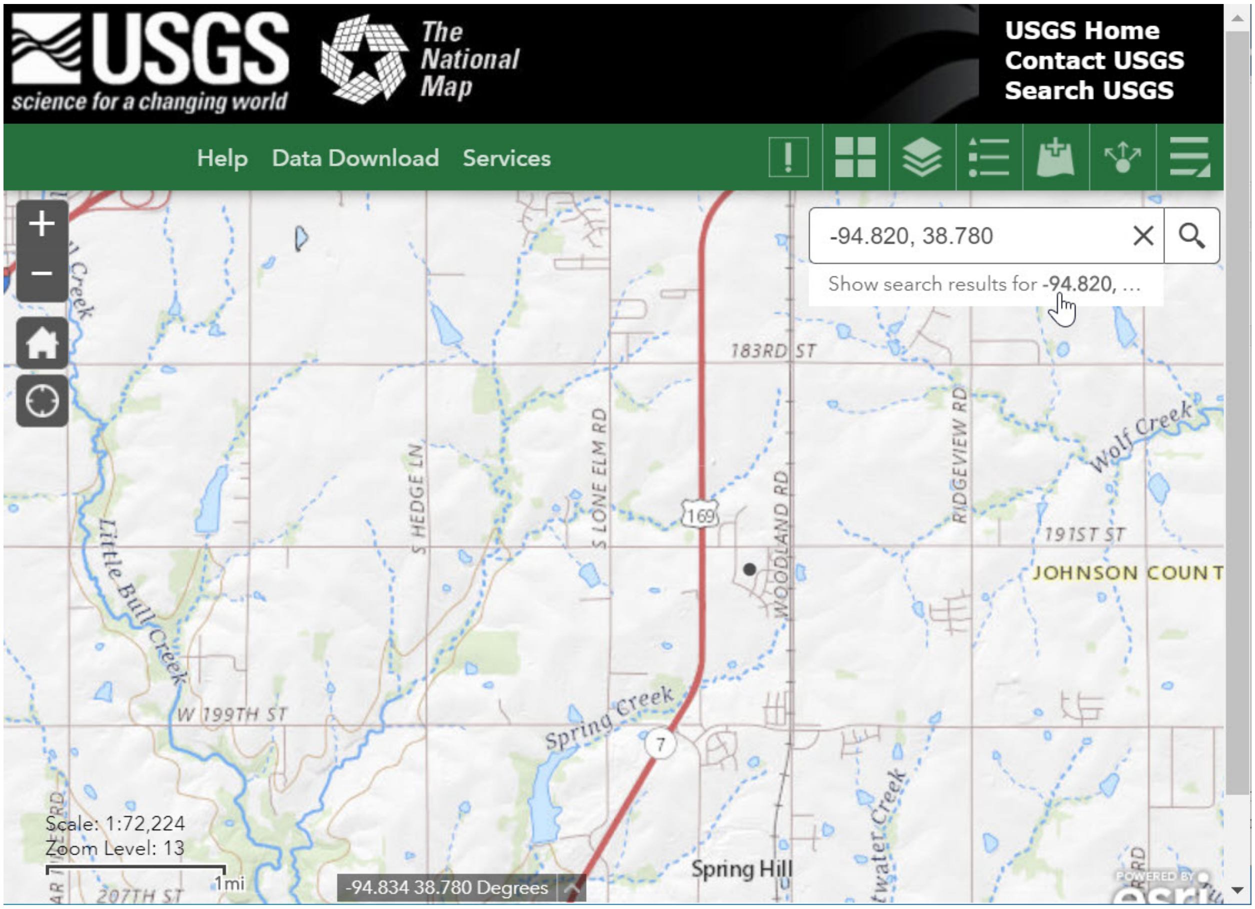
2. Use the search tool and zoom into the following latitude and longitude coordinates (these coordinates are expressed in decimal degrees): `-94.820, 38.780` (and note that you may need to zoom in or out a bit to get the viewer to refresh after entering the coordinates)

    a. Does -94.832 refer to the latitude or longitude value?

    b. Why is this value negative?

    c. Does 38.780 refer to a latitude or longitude value?

    d. Why is this value positive?



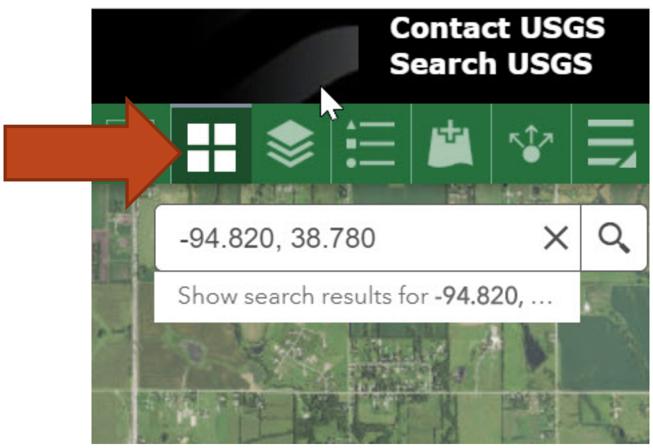
3. Your viewer should look similar to the image above.
    a. What kind of features are evident to you in this image?

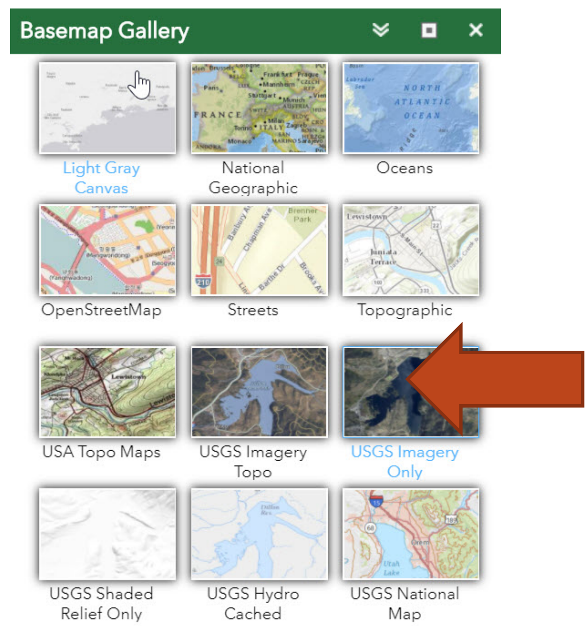
    b. What do you notice about the patterns of roads?

    c. Why do you think these roads are in this particular pattern (hint, reference the PLSS illustration on the previous page)?
    d. Can you identify any topographic lines? Based on the distribution of the topographic lines, how would you describe this landscape?

e. What state are these coordinates located?

4. Let's turn on some additional data layers to continue our exploration of the PLSS and the National Map Viewer. Navigate to the icons at the top of the viewer and select the *Basemap* icon (refer to the left image below) to open the Basemap Gallery window. Then turn on the *USGS Imagery Only layer.*





a. What do you notice about the landscape that appears in the USGS National Map Viewer after turning on the USGS Imagery basemap (using the same coordinates: -94.820, 38.780)? How would you describe this landscape?

b. By looking at the landcover, are you able to detect evidence of the Public Land Survey System (PLSS) boundaries?

c. Explore other basemap options using the USGS National Map Viewer. What other information can you discover using these basemaps?

5. Explore other areas of the western U.S. and see if you can identify boundaries of the Public Land Survey System (PLSS).

   a. -101.918, 38.824

      i. Can you identify the PLSS boundaries?

      ii. What are all of these circular patters and why are they in a circle (as opposed to a rectangle)?

      iii. What state is this located?

      iv. Use the measuring tool to measure the radius of the largest circle. Using this value, can you estimate the area of the circle (remember, Area = πr^2)

   b. -94.820, 38.780

      i. Can you identify the PLSS boundaries?

      ii. Use the measure tool in the USGS National Map Viewer to estimate the area of one of the larger fields (remember, A = L x W).

6. Let's explore some areas of the Eastern U.S. using the USGS National Map Viewer. Use the Search tool to navigate to these coordinates: -76.962, 36.710

a. Can you identify the PLSS boundaries in this area of the country?

b. Measure one of the larger fields, using the measure tool on the USGS Map Viewer. What is the area of this field?

7. Going the Extra Mile: What are the primary differences between agricultural land in the eastern U.S. and agricultural land in the western U.S.

Activity 7 Coordinate Scavenger Hunt

1. Answer the following questions for your map by examining the map margins and edges, using the example above. Remember that many of the coordinate symbology changes between maps – reading your map margins is vital!

   A. What coordinate systems are represented on your map?

   B. How is each coordinate system symbolized?

   C. How are the units of measurement abbreviated?

   D. Which coordinate system do you think would be easiest to use to communicate specific locations when you are in the field? Why?

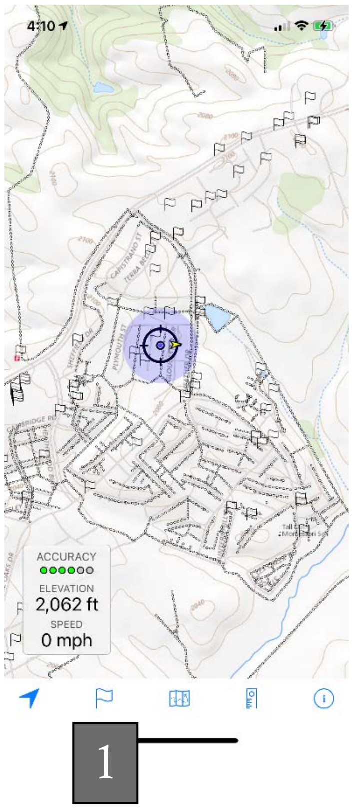
2. Now, using a ruler or straight edge and a pencil, complete the coordinate scavenger hunt worksheet given by your instructor to test your coordinate-reading ability. Use the straight edge to line up with the coordinates you are reading or to align the point of interest for which you are trying to find coordinates with the margins.

Activity 8: (mobile connect) Setting waypoints and finding coordinates

1. Setting waypoints: When working with a GPS or other mobile device, a waypoint refers to a point with known coordinates that we can navigate to or assign information to. To set a waypoint in the Topo Maps USA app:
    a. Be sure you have your current map open as outlined in Activities 2 and 4.
    b. Note that on your map, there is a set of faint gray crosshairs in the center of the map area. This is the location where waypoints will be added.
    c. You can add a waypoint by
        i. entering in coordinates (under the Location heading)
        ii. navigating to the location, and having Topo Maps USA enter the lat./long of your location.
        iii. assigning a photograph that you have taken. Photographs often have a lat./long tag associated with them (captured through GNSS).
    d. Click the waypoint (*Add a Flag*) button. Now you can assign your waypoint has a generic name and a colored place marker.

e. You can change the name of your waypoint (Title), as well as add notes or even photos. You can change these things by clicking and typing on the *Add Flag* screen.

f. Now, walk around and add 3 to 5 points of interest as waypoints/placemarks.



2. Finding Coordinates with Topo Maps USA: We can also find points given coordinates in Latitude/Longitude, decimal degrees format by using Topo Maps USA. To do this, go to the Flags page (Flag icon), and type your coordinates into the search bar. Give the Flag / waypoint a name (title) and assign it a color. Save it. Next, select the saved name in the Flags window. This will take you back to your map page and you and Topo Maps USA will automatically center the map on your entered waypoint coordinates.

   a. Find the coordinate pairs given by your leader. What are the names or land features at each of these locations?

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b. What are the benefits of using an app like Topo Maps USA to find and give coordinates? What are the limitations, when comparing to use of a standard paper topo map?

Lesson 4: Using a Compass

Key Concepts:

- Parts of a compass
- Adjusting for declination; what is declination?
- Taking a direction in the field and plotting it on a map
- Taking a direction from a map and following it in the field

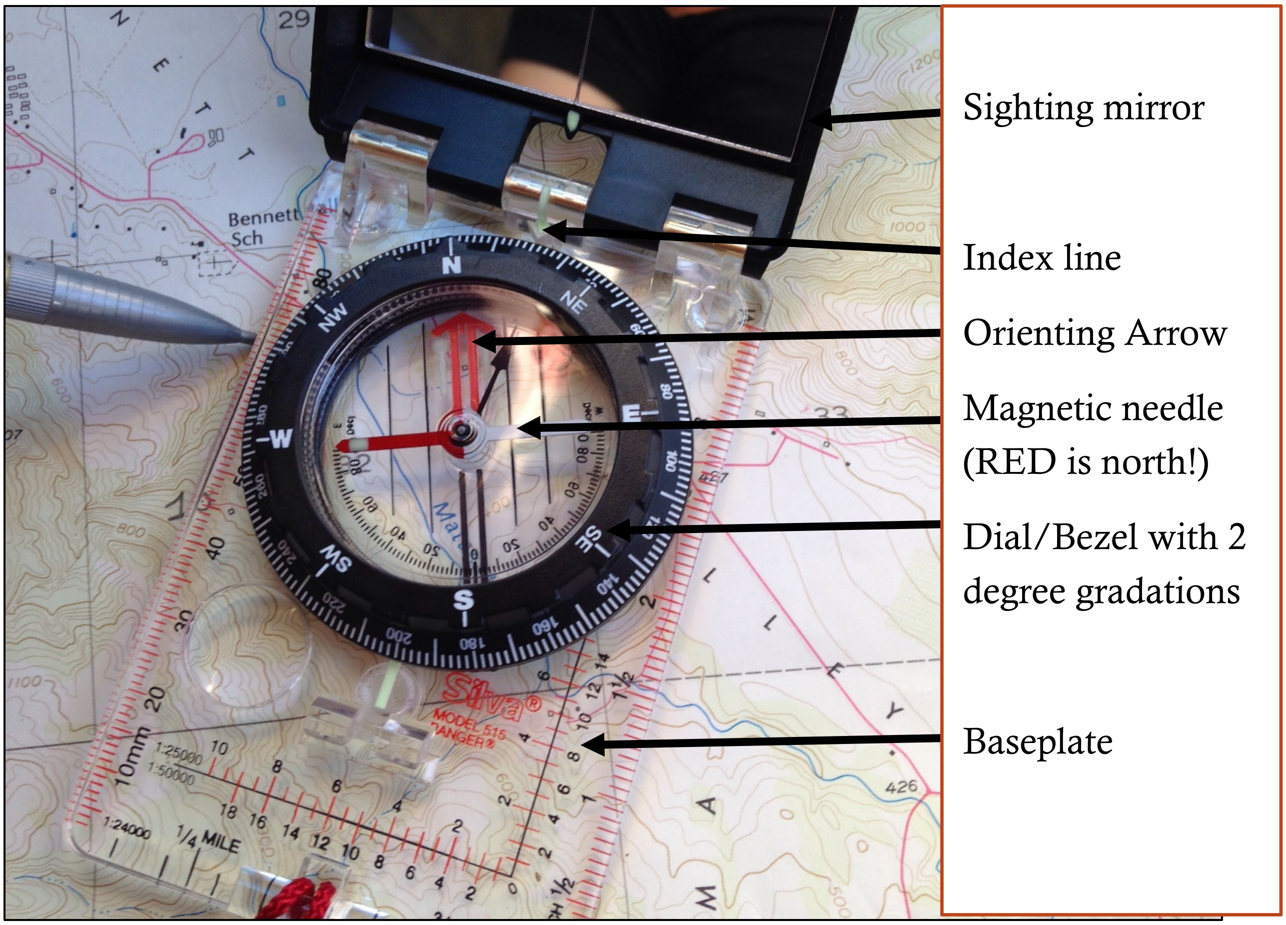
Activities:

- Activity 8: Using a compass and taking and giving bearings
- Activity 9: (Mobile connect option): Magnetic declination app

Introduction: Compass basics

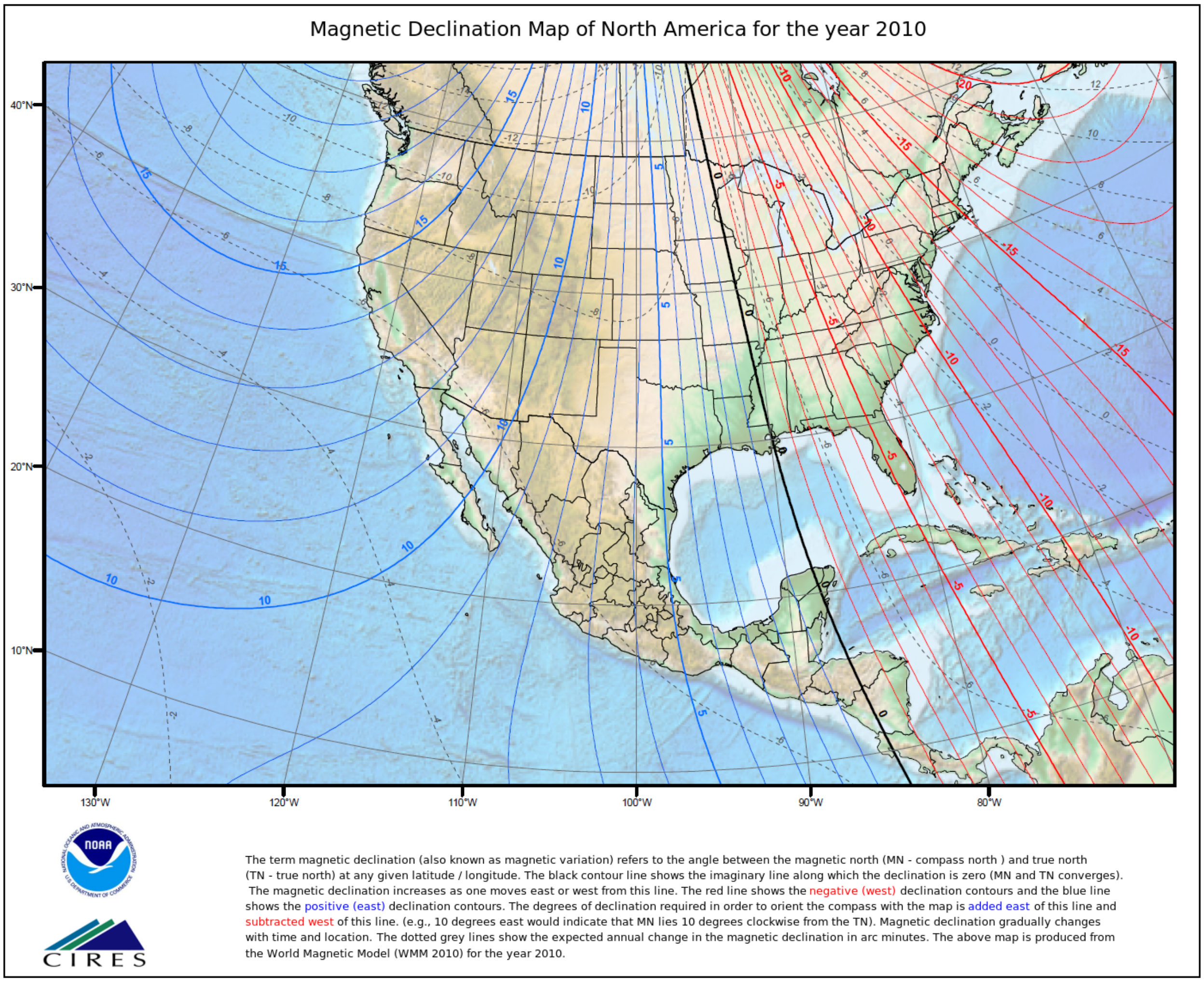
You are probably familiar with the idea of orienting yourself in space using the cardinal directions: North, South, East, and West. A magnetic compass, combined with navigation skills, allows you to find your way using a topographic map in a very precise way using **bearings** (technically called azimuths, but the familiar term is bearings) instead of simple cardinal directions. A bearing is a direction, measured in degrees (out of 360 degrees). In this section we will become familiar with magnetic compasses, reading and using bearings, and using them in tandem with topographic maps.

Basic parts of a compass:



Become familiar with the other parts of your particular compass by looking at the owner's manual or asking your instructor – for example, the scales represented on the base plate, and where and how to adjust magnetic declination.

The compass needle uses the magnetic fields of the earth to point to **magnetic north**. Maps, however, typically use **true north** (geographic north) as their north reference. The difference between magnetic north and true north is called **magnetic declination**, and it is measured in degrees – negative declination for areas that are west of true north; positive for areas that are east of true north.



Map image source: National Geodetic Data Center

It is important to adjust our compasses for declination when we are using them in tandem with a topographic map oriented to true north. You may remember from Lesson 1 that your topographic map contains declination information in the margin. However, declination changes with time, and a more up-to-date declination for your area may be available at the magnetic field calculator at: http://www.ngdc.noaa.gov/geomag-web/#declination. Always use the most up-to-date declination possible.

With your instructor's help, set the declination on your compass if it has that feature (not all compasses have adjustable declination). Each compass works slightly differently, but there is typically a key to turn on the compass baseplate and a small set of numbers for declination. As you turn the key, you will see that the orienting arrow is now offset to adjust for declination.

If your compass does not have adjustable declination, your instructor will help you align tape on the baseplate of your compass to account for declination, and explain how to use this offset.

Activity 8: Orienting with the compass and working with bearings

1. Orienting your map: The best way to start to get a feel for our compass is to orient a map of our current area. To do this:
    a. Turn your compass dial so North (0 degrees) is aligned with the index line.
    b. Align the baseplate of the compass along a N-S line on the map (shown with an arrow below).

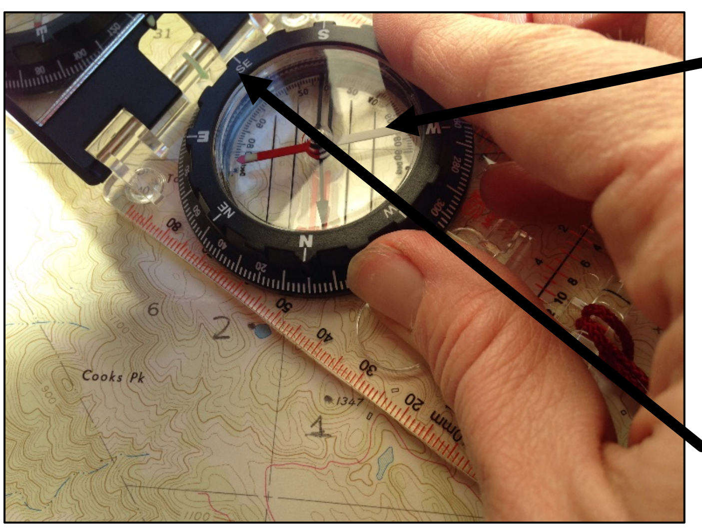
c. Turn the map and compass until the magnetic needle is completely within the orienting arrow ("red Fred is in the shed"). Be sure the red end of the needle is pointing up!

d. Find your location on the map. Take a look at the features of the landscape around you. Can you see how your map is now oriented North? How might this help you find your way?

2. In addition to orienting the map, there are four things you need to be able to do with your compass: take a bearing on a map, follow a bearing on a map, take a bearing in the field, and follow a bearing in the field (Cox, 2003). Let's start with **taking a bearing on the map, or "What is the direction of travel from here to there, on the map?"**

    a. Use the base plate of the compass to connect the two points of interest given to you by your instructor. Be sure to go in the proper direction: from point 1 to point 2.

b. Line up the north-south lines on the base of the compass with the north-south lines on the map by turning the dial

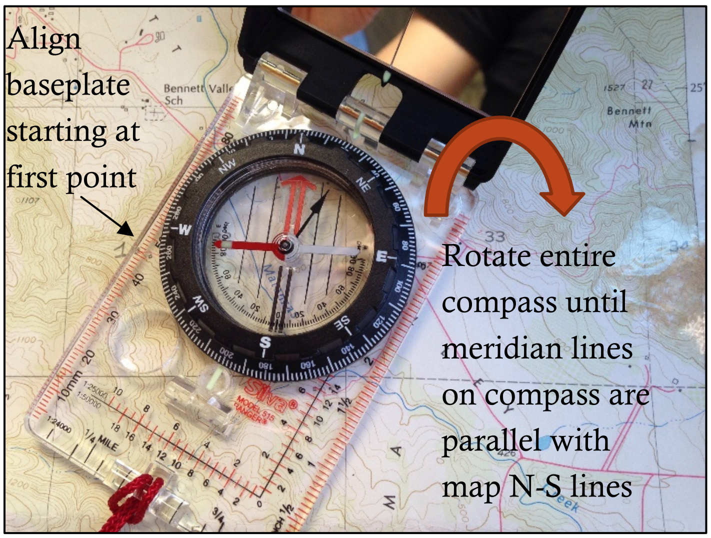


Align these meridian lines to be parallel with north-south lines on the map beneath

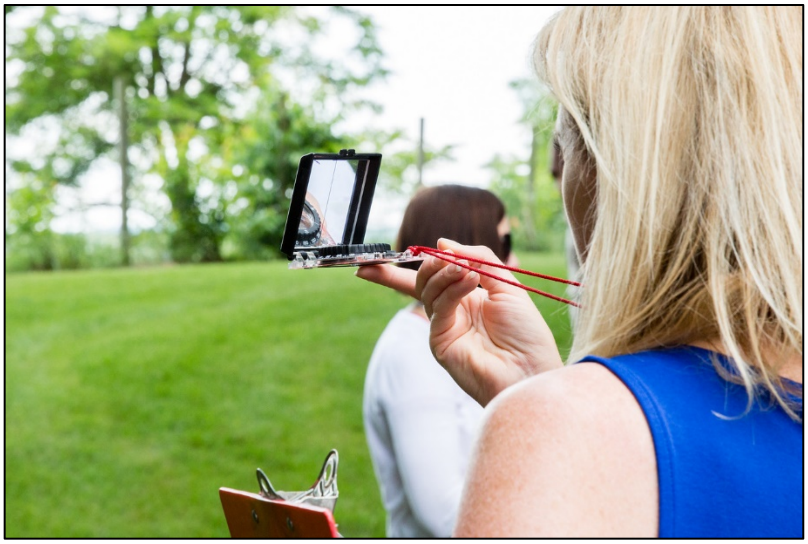
Read your bearing at the index line

c. Your bearing, in degrees, reads at the index line of the compass.

   d. Did you use the magnetic arrow or orienting arrow for this exercise? It's important to remember that when working *with the map*, you won't use the magnetic arrow or the orienting arrow.
3. **Following a bearing on a map, or "Where is the line of travel on the map, from here to there?"** This is reversing what you have just done. Given a bearing (from your instructor) and a start point, you will plot a line on the map indicating the direction of travel.
   a. Turn the dial of the compass so the given bearing is reading at the index line.
   b. Put the edge of the compass on the map, at the location of your starting point.
   c. Turn the whole compass (not the dial!) so the north-south lines on the compass are parallel to the north-south lines on the map.



   d. Once again, note that the magnetic arrow and the orienting arrow of the compass were not used. These are only used when taking or following a bearing *in the field*.
4. **Taking a bearing in the field, or "If I'm standing here, what is the direction of travel when I'm heading there?"**
   a. Hold the compass flat in your hand, while facing the point of interest you want to travel to. If you have a sighting mirror, use it to help you hold the compass level while still viewing the dial. Point the direction of travel arrow directly at the point of interest.



b. While holding the compass level, rotate the compass dial and line up the magnetic needle with the orienting arrow (or declination line, if you used tape) – put "Red Fred" (red end of the magnetic needle) "in the Shed" (the orienting arrow).

c. Your bearing reads at the index line.

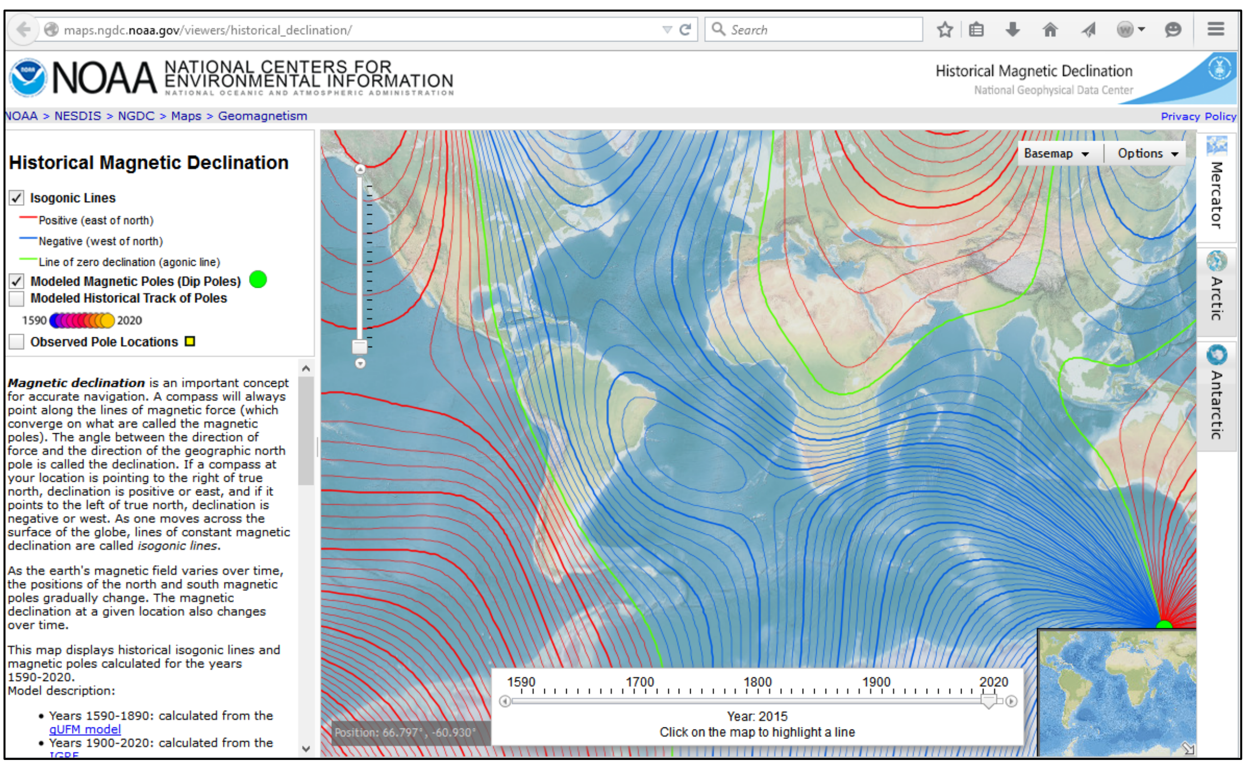
5. Following a bearing in the field, or "How am I going to travel from here to there?"

a. Now we reverse what you have just done – first, set the given bearing at the index line.
b. Holding the compass level in front of you, rotate your body until "red Fred is in the shed" – the magnetic needle (the red end!!) is inside the orienting arrow.
c. Follow the direction of travel line at the front of the compass. Try to "sight" an object in the line of your direction of travel and walk towards that. When you arrive, check your position with the map.

Activity 9: Magnetic Declination

We are going to take a quick look at magnetic declination.

Take your browser to the NOAA Historical Magnetic Declination interactive map at: http://maps.ngdc.noaa.gov/viewers/historical_declination/. You can simply use the search function and search for "NOAA declination viewer" to find this URL.



Use the time slider as well as the map legend items to view how magnetic declination changes over time. Be sure to note the line of zero declination (in green).

Lesson 5: Navigation

Key Concepts:

- Putting it all together: reading map contours, map information, and coordinate pairs to find hidden points in the field.

Activities:

- Activity 9: Mini orienteering course

Introduction: Putting it all Together

In this section, we will be tying together your new map-reading knowledge with your compass skills to complete a mini orienteering course. **Orienteering** is the sport of navigating with map and compass, and it's a great (and fun!) way to sharpen those navigation skills and become comfortable with maps.

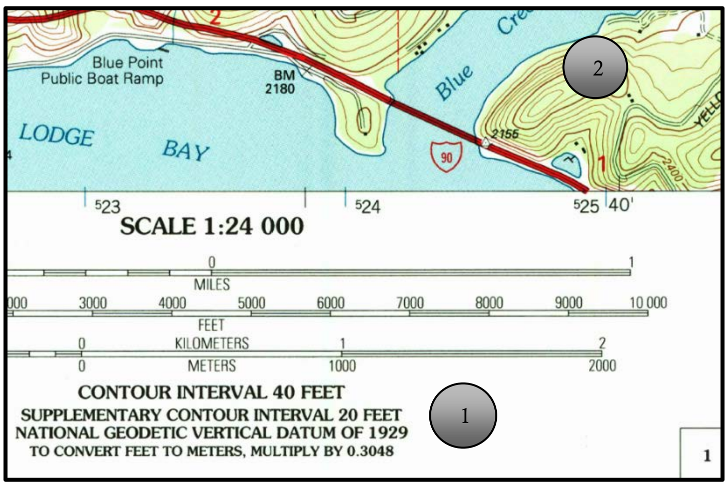
Activity 10: Mini Orienteering Course

Your instructor will give you a map and set of instructions to follow for the course. Refer to this guide as well as your instructor and classmates to help you complete the course!

Appendix A: USGS topo map terms

Contour line: A contour line on a map connects all points that have the same elevation.

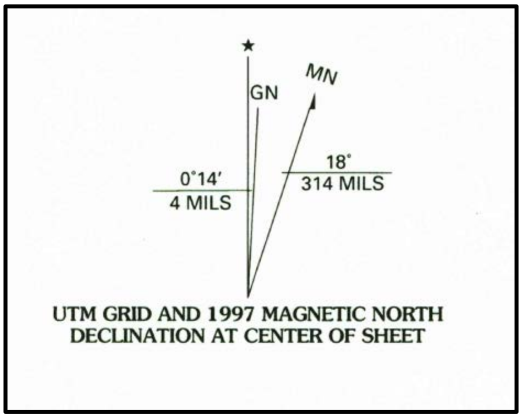
Contour interval: The contour interval is the difference in elevation between two contour lines next to each other on the map. This interval can be found on the map margin (1) and will vary depending on the terrain. In this example, there is a 40 foot elevation change between contour intervals (symbolized with brown lines), with some areas having supplementary lines showing 20 feet of elevation change (usually a dashed brown line), (2).



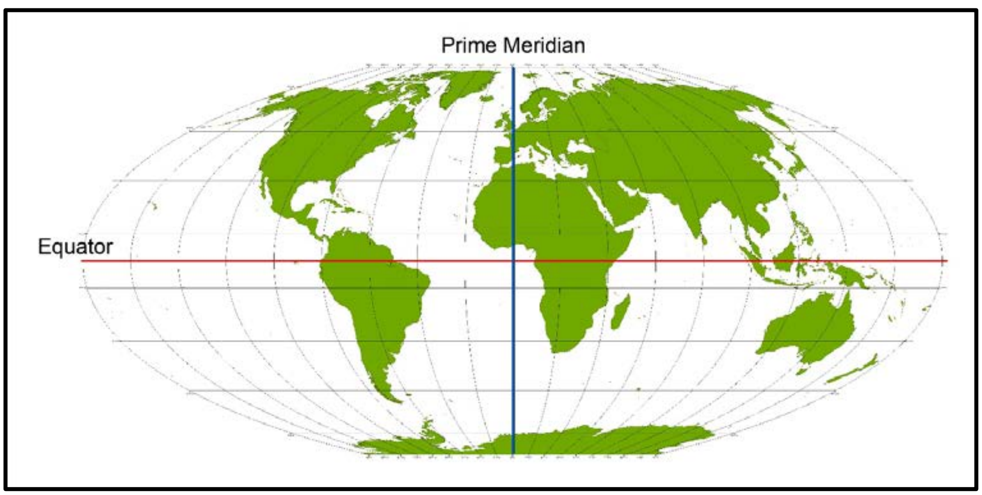
Datum: A datum is a basis of measurement for the earth's surface. This information is necessary to know when using a GPS to find coordinates. Some common datums are NAD83, WGS84, and NAD27.

Declination: There is a difference between true North (geographic North) and magnetic North. Magnetic north is the direction that the red arrow on a compass will point. Magnetic north differs from true north because of magnetic fields on the earth. Declination changes from location to location, and it also changes over time. When navigating using a compass, declination must be accounted for. USGS topographic maps will show the amount of declination for the date of map production in the map margin.

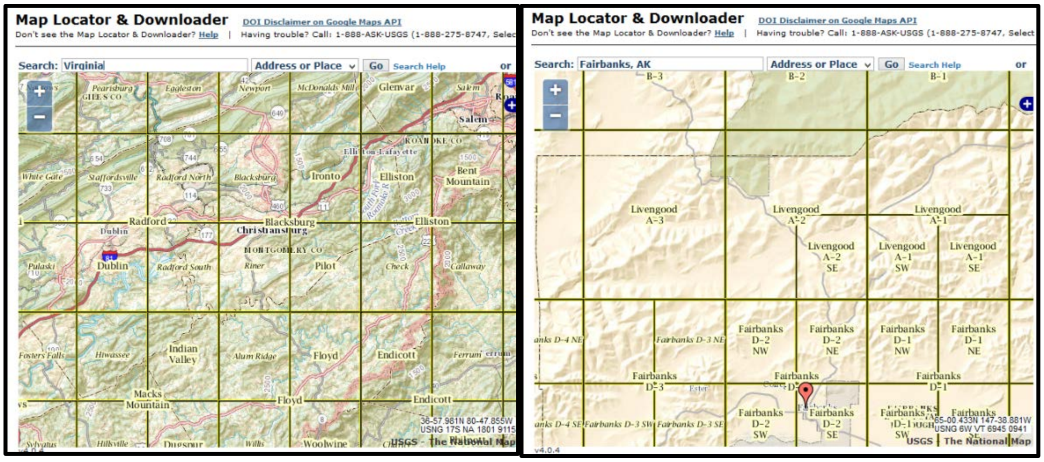
For more information on magnetic declination, including a historical map viewer and place to get up-to-date adjustments for declination, visit http://www.ngdc.noaa.gov/geomag/declination.shtml



Latitude and Longitude: A familiar coordinate system that we use to describe location. Latitude is the Y coordinate (North/South), measured as an angle from the equator; Longitude is the X coordinate (East/West), measured as an angle from the prime meridian.



Quadrangle: Standard USGS topographic maps are arranged in tiles, or quadrangles (commonly called quads). Each quad has a name. A standard topographic map covers a 7.5 minute area of latitude at a 1:24,000 scale. There are also standard topo maps that cover a 15 minute area of latitude at a 1:63,360 scale, typically in areas of Alaska.

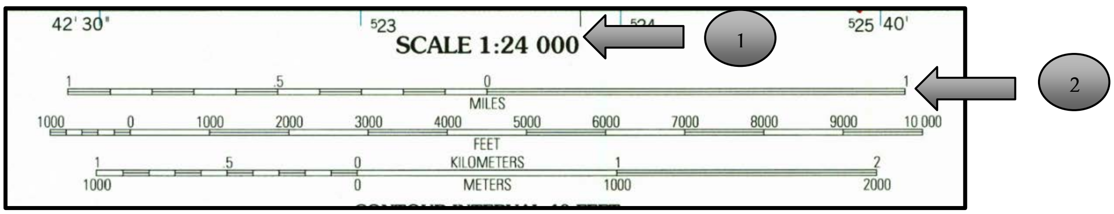


The yellow lines outline 7.5 minute quadrangle tiles (left) in Virginia and 15 minute quadrangle tiles (larger tiles, right) in Alaska. Source: USGS The National Map

Public Land Survey System: This is a system of land surveying used in the Western United States. Areas were divided into Sections, Ranges, and Townships when initially surveyed, and this system is still occasionally used today to share the location of a parcel of land. Section numbers are typically printed in Red on the map, with Township or Range information shown along margins or red lines.

Scale: There are two types of scale on a standard USGS topographic map: Fractional scale and Bar scale. Scale is the ratio of distance measured on a map to the distance of the same area measured on the ground (in "real life"), using the same units.

A fractional scale (1) is expressed as a ratio (such as 1:24,000): which means that for every 1 inch we measure on the map, that same area is 24,000 inches on the ground (or "in real life"). A bar scale (2) helps us compare measurements on the map to measurements in the real world, but using different units– for example, showing that 1 inch on the map is equal to one mile of real world measurement. A bar scale can be useful for taking quick measurements from a map and converting to ground units.



USGS: United States Geological Service, an agency of the Department of the Interior. Publishes standardized topographic maps for the United States.

UTM Zone: UTM stands for Universal Transverse Mercator, which is a type of projection (mathematically making the round earth "fit" into two dimensions) and also a coordinate system (giving us position information). UTM is built as a series of zones along the earth's surface, so it may be important to know your current UTM zone when using a GPS or finding coordinates.

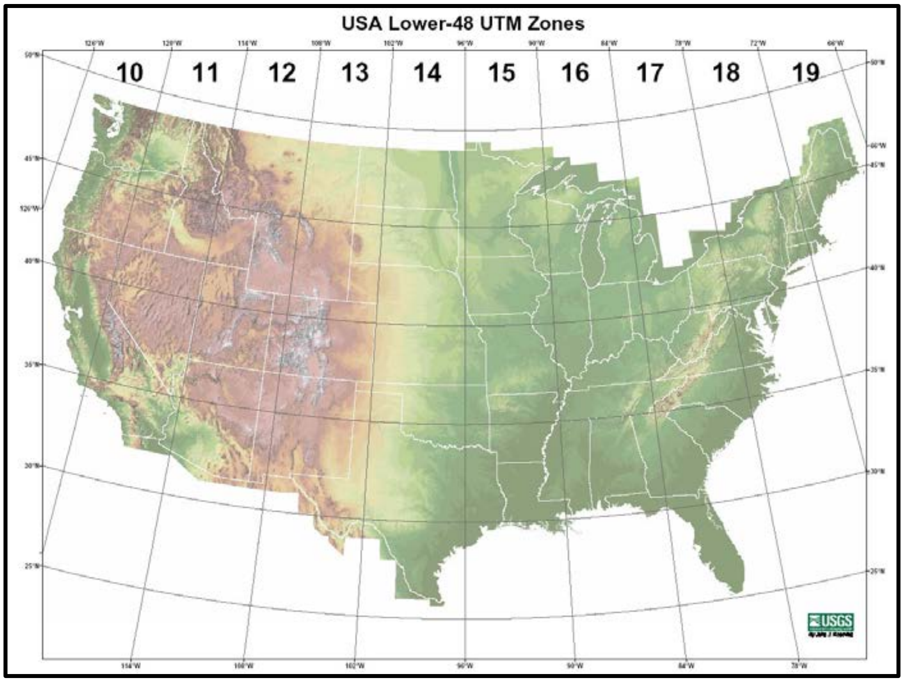


Image retrieved from http://www.nps.gov/gis/gps/UTM_Zones_USA48.jpg

UTM coordinates: When using the UTM coordinate system, coordinate pairs are given in meters as an Easting (distance in meters from the origin point for that zone) and a Northing. UTM coordinate pairs are commonly used by the military as well as surveyors. Knowing ground coordinates in meters (rather than degrees of latitude and longitude) makes land measurements and navigation simpler.

References

Cox, S. M. (2003). *Mountaineering: The Freedom of the Hills.* Seattle, WA: The Mountaineers Books.

All topographic map images are from the United States Geological Service, unless otherwise noted.

All screen shots are from the USGS National Map Viewer and / or from Topo Maps USA unless otherwise noted.