MERIT BADGE SERIES

GEOCACHING

BOY SCOUTS OF AMERICA

How to Use This Pamphlet

The secret to successfully earning a merit badge is for you to use both the pamphlet and the suggestions of your counselor.

Your counselor can be as important to you as a coach is to an athlete. Use all of the resources your counselor can make available to you. This may be the best chance you will have to learn about this particular subject. Make it count.

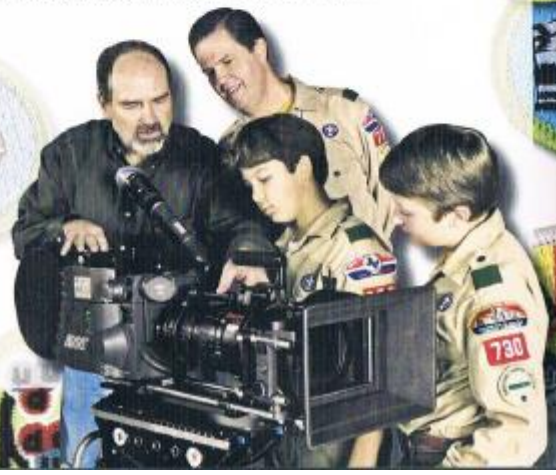
If you or your counselor feels that any information in this pamphlet is incorrect, please let us know. Please state your source of information.

Merit badge pamphlets are reprinted annually and requirements updated regularly. Your suggestions for improvement are welcome.

Send comments along with a brief statement about yourself to Youth Development, S209 • Boy Scouts of America • 1325 West Walnut Hill Lane • P.O. Box 152079 • Irving, TX 75015-2079.

Who Pays for This Pamphlet?

This merit badge pamphlet is one in a series of more than 100 covering all kinds of hobby and career subjects. It is made available for you to buy as a service of the national and local councils, Boy Scouts of America. The costs of the development, writing, and editing of the merit badge pamphlets are paid for by the Boy Scouts of America in order to bring you the best book at a reasonable price.



BOY SCOUTS OF AMERICA
MERIT BADGE SERIES

GEOCACHING

BOY SCOUTS OF AMERICA®

Requirements

1. Do the following:
   a. Explain to your counselor the most likely hazards you may encounter while participating in geocaching activities, and what you should do to anticipate, help prevent, mitigate, and respond to these hazards.
   b. Discuss first aid and prevention for the types of injuries or illnesses that could occur while participating in geocaching activities, including cuts, scrapes, snakebite, insect stings, tick bites, exposure to poisonous plants, heat and cold reactions (sunburn, heatstroke, heat exhaustion, hypothermia), and dehydration.
   c. Discuss how to properly plan an activity that uses GPS, including using the buddy system, sharing your plan with others, and considering the weather, route, and proper attire.
2. Discuss the following with your counselor:
   a. Why you should never bury a cache
   b. How to use proper geocaching etiquette when hiding or seeking a cache, and how to properly hide, post, maintain, and dismantle a geocache
   c. The principles of Leave No Trace as they apply to geocaching
3. Explain the following terms used in geocaching: waypoint, log, cache, accuracy, difficulty and terrain ratings, attributes, trackable. Choose five additional terms to explain to your counselor.
4. Explain how the Global Positioning System (GPS) works. Then, using Scouting's Teaching EDGE, demonstrate to your counselor the use of a GPS unit. Include marking and editing a waypoint, changing field functions, and changing the coordinate system in the unit.

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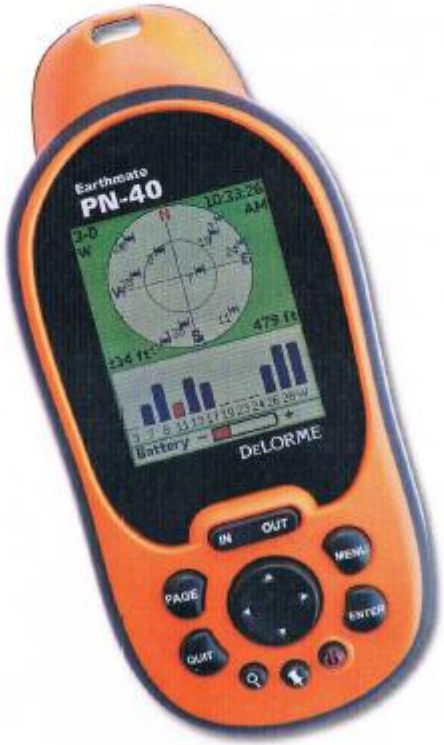
5. Do the following:
   a. Show you know how to use a map and compass and explain why this is important for geocaching.
   b. Explain the similarities and differences between GPS navigation and standard map-reading skills and describe the benefits of each.
   c. Explain the UTM (Universal Transverse Mercator) system and how it differs from the latitude/longitude system used for public geocaches.
   d. Show how to plot a UTM waypoint on a map. Compare the accuracy to that found with a GPS unit.
6. Describe to your counselor the four steps to finding your first cache. Then mark and edit a waypoint.
7. With your parent's permission*, go to www.geocaching.com. Type in your zip code to locate public geocaches in your area. Share with your counselor the posted information about three of those geocaches. Then, pick one of the three and find the cache.
8. Do ONE of the following:
   a. If a Cache to Eagle® series exists in your council, visit at least three of the locations in the series. Describe the projects that each cache you visit highlights, and explain how the Cache to Eagle® program helps share our Scouting service with the public.
   b. Create a Scouting-related Travel Bug® that promotes one of the values of Scouting. "Release" your Travel Bug into a public geocache and, with your parent's permission, monitor its progress at www.geocaching.com for 30 days. Keep a log, and share this with your counselor at the end of the 30-day period.
   c. Set up and hide a public geocache, following the guidelines in the *Geocaching* merit badge pamphlet. Before doing so, share with your counselor a six-month maintenance plan for the geocache where you are personally responsible for the first three months. After setting up the geocache, with your parent's permission, follow the logs online for 30 days and share them with your counselor.

*To fulfill this requirement, you will need to set up a free user account with www.geocaching.com. Before doing so, ask your parent for permission and help.

d. Explain what Cache In Trash Out (CITO) means, and describe how you have practiced CITO at public geocaches or at a CITO event. Then, either create CITO containers to leave at public caches, or host a CITO event for your unit or for the public.

9. Plan a geohunt for a youth group such as your troop or a neighboring pack, at school, or your place of worship. Choose a theme, set up a course with at least four waypoints, teach the players how to use a GPS unit, and play the game. Tell your counselor about your experience, and share the materials you used and developed for this event.



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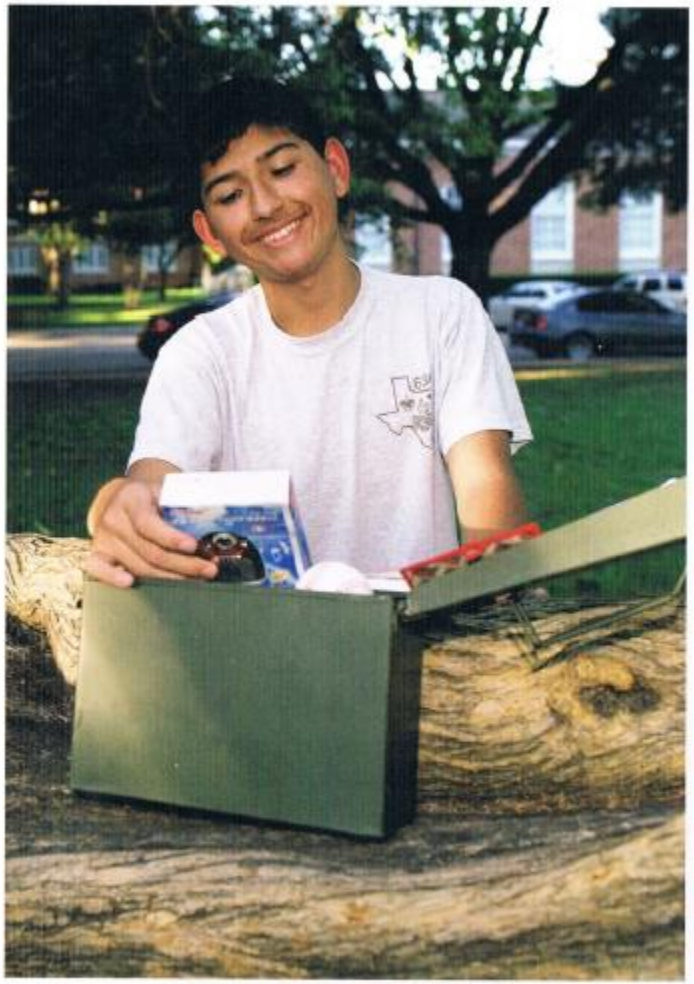


What Is Geocaching?

The word *geocache* is a combination of "geo," which means "earth," and "cache," which means "a hiding place." *Geocaching* describes a hiding place on planet Earth—a hiding place you can find using a GPS unit. A GPS (Global Positioning System) unit is an electronic tool that shows you where to go based on information it gets from satellites in space.

The History of Geocaching

On May 1, 2000, President Bill Clinton announced that a limitation called "Selective Availability" would be removed from the U.S.-sponsored GPS satellite system. This meant that civilian users of the Global Positioning System would be able to pinpoint locations up to 10 times more accurately than they did before.

GPS enthusiasts celebrated, because now anyone with a GPS receiver could, as the White House put it, "precisely pinpoint their location or the location of items left behind for later recovery."

Two days later, on May 3, a GPS enthusiast named Dave Ulmer set out to test the accuracy of the upgraded navigational technology. He hid a bucket of trinkets in the woods outside Portland, Oregon, and announced the bucket's location in an Internet posting.

Dave called the idea the "Great American GPS Stash Hunt." The idea was simple: Hide a container outdoors and note the coordinates with a GPS unit. Then invite people to locate the container, using only their GPS receivers. The rules for the finders were equally simple: "Take some stuff, leave some stuff."

Think of setting off on a treasure hunt and using a GPS device to find the location of the hidden prize or "cache."

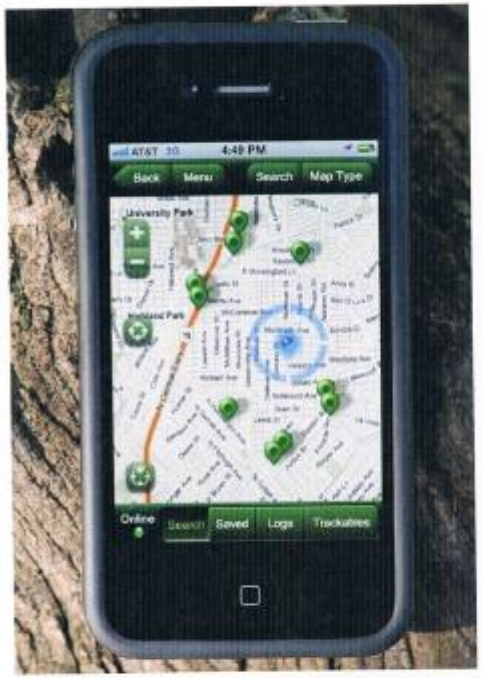
This first high-tech treasure hunt began a hobby that is still active today, including the basic parts of geocaching: a container, a logbook for the finders to sign, and the concept of a prize with the "take something-leave something" guideline.

The original cache (then called a "stash") was quickly found, and more caches were hidden in California, Kansas, and Illinois that same week. Within a month, a cache had been hidden as far away as Australia, and geocaching was soon a worldwide sport. Today there are more than a million caches hidden around the world in over 200 countries.

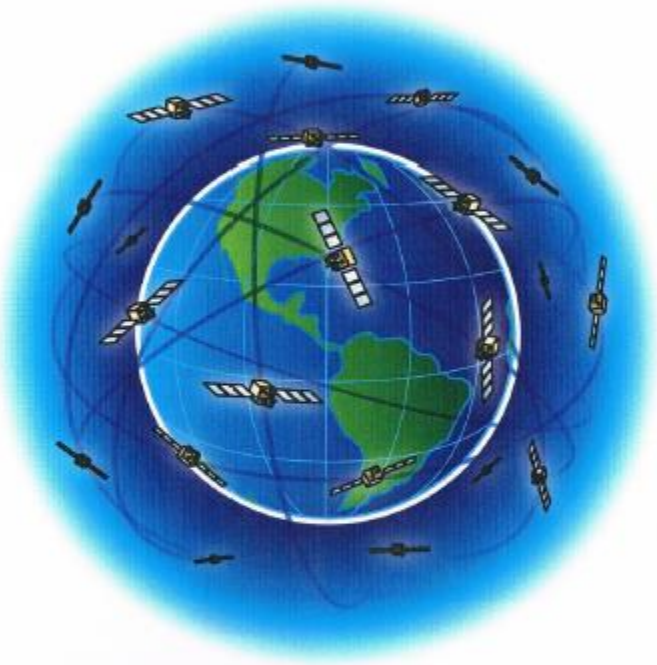
Here is Dave Ulmer's original posting:

```
From: Dave (news2yousNOneSPAM@hotmail.com.invalid)
Subject: GPS Stash Hunt... Stash #1 is there!
Newsgroups: sci.geo.satellite-nav
Date: 2000/05/03

Well, I did it, created the first stash hunt stash
and here are the coordinates:

N 45° 17.460
W122° 24.800

Lots of goodies for the finders. Look for a black
plastic bucket _ Take some stuff, leave some stuff!
Record it all in the log book. Have Fun!
```


So many public geocaches are hidden now that you are likely to find caches close to your troop meeting location. Geocaches may be hidden in your neighborhood close to where you live. The search for many of these will take you on beautiful hikes and may give you challenging puzzles to solve to find the treasure.



Geocaching is great for fun and exercise. You can use this sport to liven up troop meetings, to encourage others to join Scouting, and for public service. It's a sport that's a perfect fit for Scouting, and it's a great way for Scouts and non-Scouts to share their enjoyment of the outdoors. Use your Scout skills and follow the Scout Oath and Scout Law as you embark on this new pastime.



The Global Positioning System

The Global Positioning System (GPS) is an electronic navigation network that uses signals from satellites orbiting Earth to determine specific locations on or near Earth's surface. GPS technology can be used anywhere in the world 24 hours a day because the system of satellites circles Earth all the time, and some number of them are always above you. The system works in any kind of weather and does not require any setup fee or subscription charge.

Basically, GPS lets you determine your location and find other locations on Earth, and helps you navigate to and from those places.

How Does a GPS Receiver Work?

A GPS receiver (GPSr) calculates its position by carefully timing the signals sent by the 24 to 30 GPS satellites high above Earth. At any given time, there are usually several satellites over any given place on Earth. Each satellite continually transmits data that indicates its location and the current time. All GPS satellites transmit signals at the same instant. But the signals arrive at a GPS receiver at slightly different times. The farther the receiver is from a satellite, the longer the signal takes to reach the receiver.

The receiver uses the arrival time of each signal to measure the distance to each satellite. Once the receiver has detected signals from a minimum of four satellites, the GPSr can calculate the receiver's location and altitude and display these coordinates on the GPSr screen. The more satellites the receiver has tracked and acquired, the better the accuracy of the GPSr calculations.

You can also enter a location into the GPS receiver, and the unit will calculate how far you are from that point as well as what direction you need to travel to reach that destination. Many GPS units have a screen that serves as an electronic map to show the user's location or where the final destination is.

What Can Go Wrong?

If anything blocks or interferes with the satellite signals reaching the GPS receiver, or GPSr, can give inaccurate information or just not work at all. Trees, buildings, canyons, or valleys can affect the signal strength or modify the time it takes for signals to reach the receiver, thereby degrading the ability of the GPSr to calculate the location accurately.

In addition, no civilian GPS receiver has 100 percent accuracy. A GPSr will rarely lead you to the "exact spot." This means that you get close but not quite on target most of the time, even if the GPSr says you are within a foot of the hidden geocache that you are seeking.

A common error for beginning geocachers is to try to get the number in the GPS unit's "distance" field to go to zero. It almost never does, and even then it's unlikely to be correct. The accuracy is often at least a 20-foot radius, and sometimes greater, which means the geocache could be 20 feet or more from you in any direction. Quite a bit of searching for "ground zero" or the exact final spot is required in most cases. As new geocachers soon learn, it's necessary to use your head at that point and begin searching.

A basic GPS receiver (the simple, handheld type typically used for geocaching) gives you the shortest route of travel. It does not look at topography or at rivers, roads, or other obstacles you may come across on the way. This is one reason that a map is helpful in geocaching. Maps give you the big picture of the area.

Like any electronic device, a GPS receiver will not work if it loses power. A GPSr also depends on you to input correct information. A small mistake when entering coordinates can send you a few miles—or hundreds of miles—off course.

A Scout is trustworthy. Your GPS unit is not! Be aware of the pitfalls and be prepared.

Always remember these things about your GPS receiver:

- The GPS compass arrow points to a direction that may not be the best route. Look where you are going and what is ahead of you to choose the best way to get there.
- You may lose the signal from the satellites.
- Your unit's accuracy may be very low due to interference.
- Your unit's batteries can be low or die.
- You may have input the wrong information.

Types of GPS Units

Among the many different types of GPS units, some cost as little as $50, or up to $10,000. Some are better for geocaching than others. Several GPS receivers are dedicated to the sport.

When you consider all of the uses you may find for a GPS receiver, you may decide you want a general navigation tool that is useful beyond geocaching and practical for other outdoor purposes. Think of all the things you may want to do with your GPS unit and buy accordingly. While an inexpensive, no-frills unit is fine for geocaching games and for public geocaching, you do want the ability to quickly download data from your computer. You may also want to create custom geocache courses.

The most important features in any GPS receiver are basic functionality and ease of use. Advanced features are tempting and helpful, but they can be expensive. A unit with a color screen and lots of maps can cost hundreds of dollars, so think about how often you will use these features.

There are many entry-level GPS receivers that have a wide variety of functions. Many good GPS units can be found at sporting goods retailers and discount stores. With your parent's permission and assistance, you may also find good deals on used or discontinued models from online sources.

If you are planning to buy a GPS receiver, first decide which type you need: a car navigation system or handheld outdoors device?

Automobile GPS units are useful for driving and routing by car. However, they are often not what you want for geocaching, as they tend to route you onto major roads and freeways, and they don't have the compass and arrow capability needed to zero in on the cache.

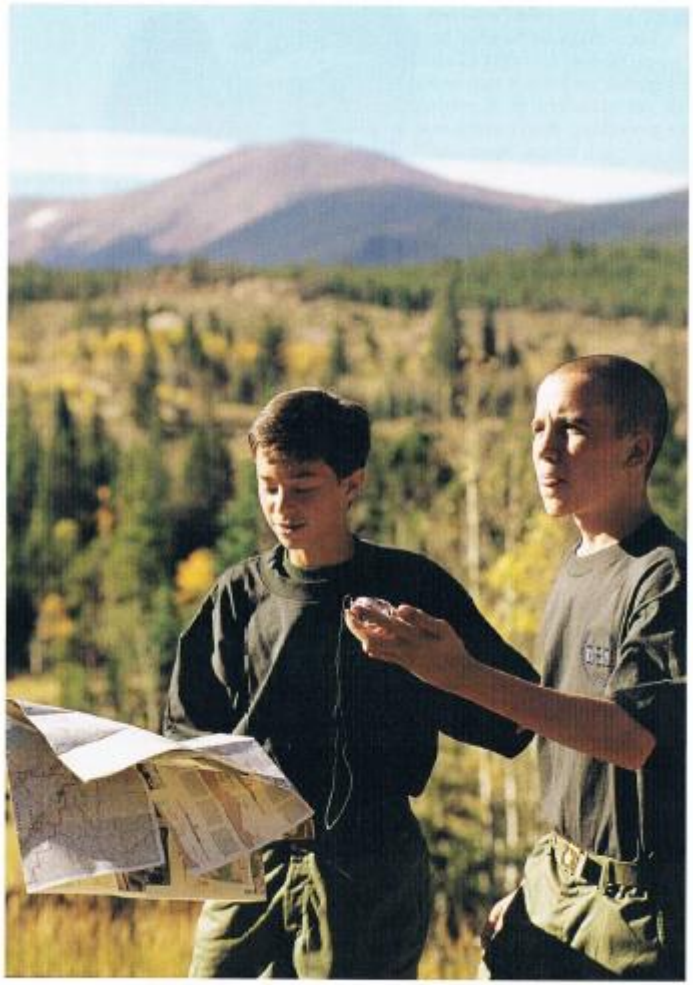
Handheld outdoors devices are designed to be lightweight and rugged for outdoor use for hiking, camping, and geocaching. These are good for Scouting activities. Most geocaching can be done with an inexpensive, simple, handheld unit.

Many smart phones have GPS and geocaching capabilities. Several geocaching applications are available for the iPhone, BlackBerry, Palm Pre, and other smart phones. While they do not have all of the features of a dedicated GPS unit and could be less accurate, they can be used for casual geocaching. Note, however, that you may have to have Internet service or a data plan for this function to work. A smart phone with GPS may be useless if you can't connect to the data network—and a good connection is not always available. For a Scout or a troop, a dedicated GPS receiver is generally a better choice than a smart phone. A GPSr is more durable and has many additional functions that are useful for Scouting activities.

Before you buy, decide what functions or features are essential to you. In a car system, for example, spoken navigation instructions may be essential, but this feature is not needed for geocaching. People who run or bicycle might want a fitness and cycling GPS device that can track the wearer's speed, distance, and calories burned. That type of GPS unit is not really useful for geocaching, however. It lacks the compass and arrow feature of a dedicated geocaching unit. For a hiker or backpacker, rugged construction, small size, light weight, and backlighting for nighttime viewing are important features.

Note the types of batteries the unit can use. Does it come with its own special rechargeable battery? Can you convert to regular batteries if necessary?

Enthusiasts who do a lot of geocaching find that having a unit that can download detailed information such as cache type, hints, and logs from www.geocaching.com is a real plus. This allows "paperless caching" and avoids the need to print out descriptions and clues from the Geocaching.com listings. (The kinds of cache information that are posted at Geocaching.com are covered in detail in "Getting Started With Public Geocaching" later in this pamphlet.)



Using Your GPS Receiver

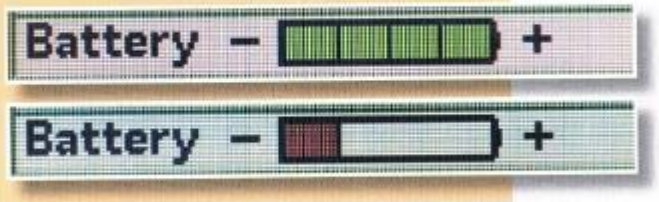
To list all the functions of every GPS receiver on the market would be impossible. The overview in this section covers the basic functions of a generic GPSr. Each GPS unit comes with detailed instructions to help you, but much of your knowledge will come from giving the various screens and buttons a try.

Be sure to read the manual that comes with your GPS unit.

Basic Functions of a GPS Receiver

Basic geocaching will require you to be able to switch between different function screens, to enter coordinates, to mark a waypoint, and to know how to use the compass screen and its data fields.

After locating the device's on/off button, next learn where the battery-level indicator is, and how to either recharge or change the batteries. Then you can begin to explore the features of your GPS receiver. Always check your battery levels before going geocaching or setting up a geocaching event. It's also a good idea to carry an extra set of fresh batteries—just in case.



The Basic Buttons

Your unit will likely have an *ESCAPE* or *BACK* button, a *PAGE* button, an *ENTER* button, a *GOTO* button, a *MARK* button, and a series of buttons or a toggle key for moving left and right and up and down within the GPS receiver's functions. Using your manual, learn where these buttons are and what they do. Some of the function buttons may be on the face of the unit; others are on the side. Touchscreen GPS receivers have few physical buttons on the device—most navigation and other functions are accessed through tapping touch-sensitive icons on the screen display.

The *NAV* or *PAGE* Button. Next, look for the *NAV* (navigation) or *PAGE* button or other means to change from screen to screen. Most GPS receivers have several screens: a screen to show how many satellites the GPSr can see and has acquired (meaning it has picked up the satellite signal), a compass screen, a screen with a map display, and perhaps a screen that displays fields of information.

The *ENTER* Button. The *ENTER* button allows you to accept or select an option or a menu choice.

The *ESCAPE* or *QUIT* or *BACK* Button. The *ESCAPE* (or *QUIT* or *BACK*) button has a simple function: You use it to leave the screen you are on (and the functions you are using) to return to the previous screen and function. Pushing *ESCAPE* repeatedly scrolls you through the GPS receiver's various functions.

The *UP, DOWN, LEFT,* and *RIGHT* Buttons. The *UP, DOWN, LEFT,* and *RIGHT* buttons usually are located on the face or side of a GPSr or within its screen displays. These buttons allow you to move around within your GPS receiver's various functions or menus to accomplish such tasks as naming, choosing, creating, editing, and deleting waypoints, routes, landmarks, etc.

The *MARK* Button. *MARK* is a useful function key that records where you are—data the GPS receiver will store, variously, as positions, fixes, landmarks, or waypoints. To mark a position accurately, your unit needs satellite contact. This means you need to be outdoors with a clear view of the sky.

The *ZOOM* Buttons. The *ZOOM* buttons allow you to zoom in or out while viewing the map screen. Usually a map will display finer levels of detail the more you zoom in on it.

The *MENU* Button. The *MENU* button displays a list of options for functions and configurations that usually allow for customizing the GPS receiver.

The *GOTO* or *FIND* Button. The *GOTO* or *FIND* button lets you search your programmed waypoints or geocache locations that are stored in the GPS unit's memory. This function may give you the option to display the listings alphabetically or by the listing nearest your current location.

A *waypoint* is a location recorded in a GPS receiver. Waypoints are extremely useful as you set out in search of a geocache and as you return home.

- Pencil your route on a topographic map. (See "Using Your Map and Compass" in the next section.) Mark several waypoints—trail intersections, stream crossings, hilltops, etc. Determine the coordinates of the waypoints and enter those coordinates into your GPS receiver. Then bring up the waypoints on the GPSr screen as you travel. These will guide you along your route.
- During a trip, stop at recognizable landmarks (a large tree, a cabin, a bridge, etc.) and use your GPS receiver to determine your location. Program that spot into the GPS unit's waypoint memory. On your return journey, those GPS waypoints will provide guidance so you can find your way even if visibility is poor or your memory of the route is unclear.

Using a Garmin eTrex®

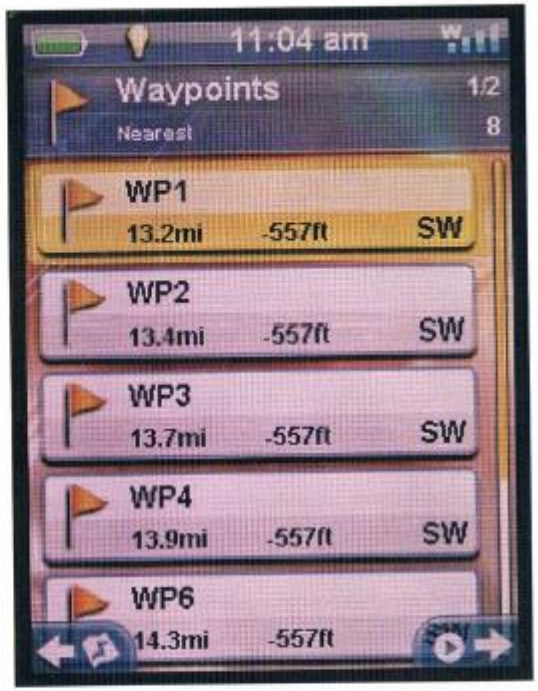
With so many different kinds of GPS units available, it is impossible to describe how to program and use each brand and model. This section details one basic model that is a common entry-level unit for geocaching and other outdoor use.

Basic units like these handheld GPS receivers work well for the beginner geocacher. There are many others, so do your research and shop around to find the one that meets your needs and fits your budget.

Directions for the Garmin eTrex®

1. **Turn it on.** The *POWER* button is on the right side of the unit. Be sure you have installed good batteries.
2. **Locate the *ENTER* button and the *UP* and *DOWN* buttons** on the left side. These are used to change the menus and screens.
3. **Push the *PAGE* button repeatedly** to get to the "menu" page. The *PAGE* button is on the right side of the unit.
4. **Press the *DOWN* button** and highlight *WAYPOINTS*.
5. **Press *ENTER*.** The "waypoints" page appears.
6. **Press *ENTER*** and the highlight should move to a waypoint. You may need to enter a few waypoints if your unit is brand new. You can do this using the "mark" function. Read your unit's instruction manual for more information on your specific unit.
7. **Press *ENTER* again** and then highlight goto.
8. **Press *ENTER* again** and the "pointer" page should appear for the waypoint.

Not all units come with preprogrammed waypoints.

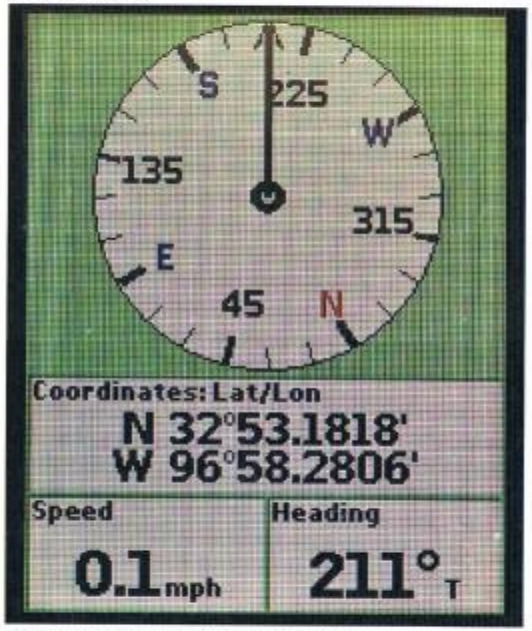


The screen should have the waypoint's name or number at the very top. The default waypoint "name" is a number—001, 002, etc. Waypoints are numbered in the order they are marked. The numerical designation can be changed, if desired, to letters or words: CAMP, LAKE, CABIN, etc.

Immediately below the waypoint's name or number, you will see the distance to that destination, given in feet or miles. Below that, a compass ring should be displayed with an arrow pointing in a particular direction.

You may be able to set up your GPSr so that it provides an estimated time of arrival.

You then follow the arrow and change direction as it changes direction. **The arrow will change direction only when you begin moving.** This is important. If you are standing still, the compass arrow will not be pointing in the correct direction. You must move at least 10 to 20 feet before the arrow will swing around to the correct direction of travel. At that time, you start walking the way the arrow points until the distance gets close to zero.



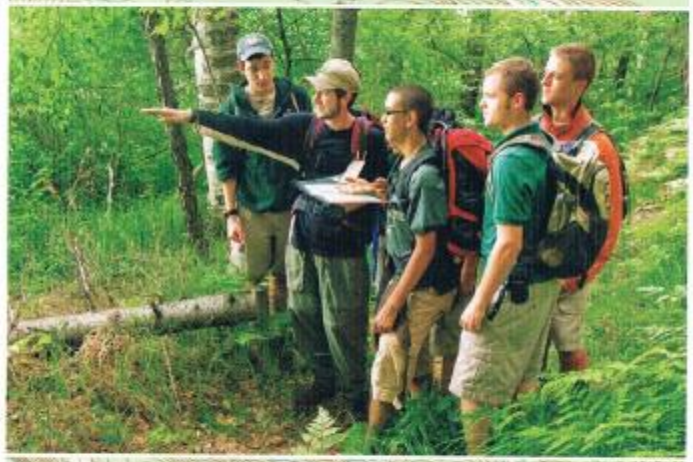
The pointer arrow moves only when you do.

Many GPS units do not have a built-in electronic compass. A GPS receiver's compass will *not* point north like a magnetic compass. The GPSr can only determine your direction of travel by comparing your calculated location with the location just calculated a second ago. In other words, the compass will not display the correct direction of travel *until you are moving.*

Be sure to hold the GPS unit just like you would hold a regular magnetic compass, level and with the top of the GPS receiver pointing straight ahead (see the picture). Otherwise it will think it is going backward. When the arrow is pointing straight ahead, you are on the correct track.

At some point the arrow may begin to flip, first one direction and then another. This means you are close to your destination. At this point, ***stop moving and start hunting.*** Use your eyes and brain instead of your GPS receiver.

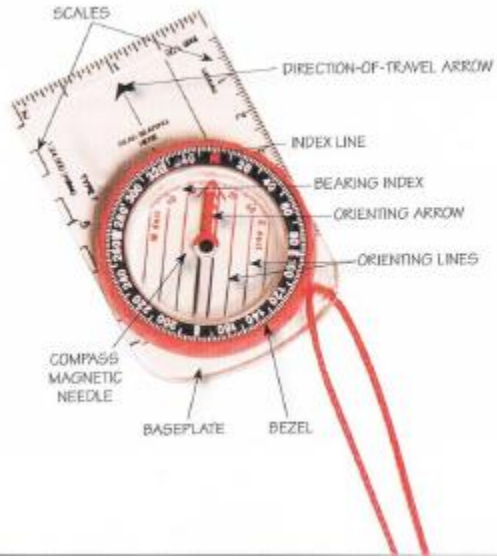
Your GPS unit will only get you so close. The rest is up to you. The hunt is the exciting part of the game, because YOU are required to do the final search and discovery.



Using Your Map and Compass

Why do you need to know how to use a map and compass when the GPS receiver's arrow tells you where to go? **Because your GPS unit can—and will—fail, and it won't tell you what is between you and your objective.**

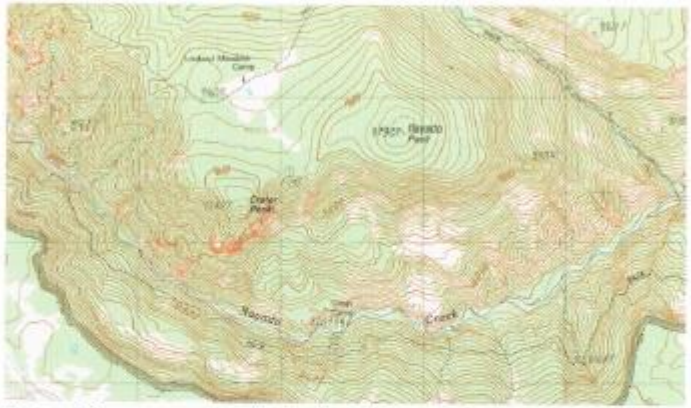
Many things can go wrong. Your batteries may die. You may be in a location where you can't get good satellite reception. Heavy tree cover, nearby power lines, tall buildings, a narrow canyon—all of these can reduce your satellite reception to such an extent that your GPS unit simply does not work. Or you might accidentally program in the wrong coordinates and be heading in the wrong direction entirely.



Carry a map and compass and know how to use them, especially if you are out in the wilderness. See the *Boy Scout Handbook* and the *Orienteering* merit badge pamphlet.

Topographic Maps

Remember, the GPS unit is only going to tell you how far you need to go and in what direction. It is not always going to tell you about the obstacles that may lie between you and your destination. Can you imagine the frustration and disappointment after a three-mile hike when you find yourself 200 yards from a cache that sits on the other side of that swamp or hundred-foot gorge in front of you?

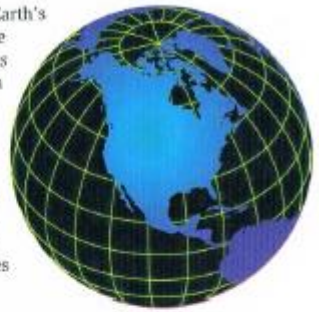


Topographic maps use contour lines to show elevation and colors to represent water, forested areas, roads, and other features. A map provides precise details and a large view of the area.

Using a topographic (topo) map of the area can help you plan your best route. Most GPS receivers today offer the option to upload topographic maps directly to the unit. If your device does not, you can find several sources online from which to print a map of the area. Sporting goods shops and camping stores also often sell topo maps.

A good topographic map, or quadrangle map, is needed in the backcountry, just as a street map is essential in the city. What about that freeway that runs between you and the cache? For the best route, look at the big picture.

The Latitude/Longitude Coordinate System



A convenient way to describe a position on Earth's curved surface is with the system of reference lines called *parallels of latitude* and *meridians of longitude*. You are probably familiar with a standard globe representing Earth and with the series of lines on the globe that show latitude and longitude.

Most GPS receivers come out of the box preset to use latitude/longitude (lat/lon) coordinates. Therefore, most new GPS users start out using lat/lon coordinates and need to understand how to relate those coordinates to points on a map.

Latitude

Lines of latitude circle the globe in a horizontal direction and measure north-south position between the poles. The equator is defined as 0 degrees, the North Pole is 90 degrees north, and the South Pole is 90 degrees south. Lines of latitude are all parallel to each other and are often referred to as parallels.

Longitude

Lines of longitude, or meridians, run vertically, dividing Earth into segments that meet at the North and South Poles. Meridians measure east-west position. The prime meridian, which runs through Greenwich, England, is assigned the value of 0 degrees. Meridians to the west of the prime meridian are measured in degrees west; those to the east of the prime meridian are measured by their number of degrees east.

To show precise locations, each degree of longitude and latitude is divided into 60 minutes, and each minute of longitude and latitude is divided into 60 seconds. Here are the symbols used for units of measure:

° = degrees ' = minutes " = seconds

A position on the globe is stated latitude first, followed by longitude. For example, the coordinates of latitude and longitude for the summit of Baldy Mountain in New Mexico may be given as 36°37'45" N, 105°12'48" W.

Common Formats

For expressing latitude and longitude, here are the three most common formats:

DDD° MM' SS.SS"	Degrees, minutes, and seconds
DDD° MM.MMMM'	Degrees and decimal minutes
DDD.DDDDD°	Decimal degrees

Degrees and decimal minutes **(DDD° MM.MMMM')** is the format most commonly used with GPS devices and is the format used by default on Geocaching.com, which shortens the format to DDD MM.MMM. In this format, the coordinates of the Boy Scouts of America national office are 32° 53.137' N, 096° 58.218' W.

Degrees, minutes, and seconds **(DDD° MM' SSS")** is the most common format used to mark maps. In this format, the BSA national office is at 32° 53' 08.27" N, 096° 58' 13.13" W. This format can be cumbersome to work with; just remember that it is similar to telling time.

There are 60 seconds in a minute 60" = 1'
There are 60 minutes in a degree 60' = 1°

Be mindful of a few simple conversions between seconds and decimal minutes when working with maps that use degrees, minutes, and seconds:

- 15 seconds is one-quarter minute or 0.25 minutes
- 30 seconds is one-half minute or 0.5 minutes
- 45 seconds is three-quarters of a minute or 0.75 minutes

Decimal degrees **(DDD.DDDDD°)** is the format that most computer-based mapping systems display. Often the N-S and E-W designators are omitted. Positive values of latitude are north of the equator; negative values are to the south. Most often, negative values for longitude indicate a west longitude; a positive value is an east longitude. In the decimal degrees format, the BSA national office is located at 32.88563 -096.97031.

Coordinates for the Boy Scouts of America's national office in Irving, Texas, are 32° 53.137' N, 096° 58.218' W.

Most GPS receivers have a simple setting to switch between various coordinate systems.

Which Format Should You Use?

You can set a GPS receiver to display any one of these three formats. Locations can be entered into the GPS unit with the selected format, and then by switching the position format setting, you can view the coordinates in the different format.

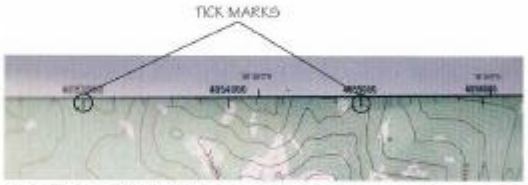
If your main GPS activity will be geocaching, then *degrees and decimal minutes* will be your preferred format. But if you are teaming up with other people who have agreed to use a different format, then you should probably use that format.

You will also want to look at the maps and lists of coordinates you are using. If you find a consistent format among them, using it will make your location-finding easier. Select a position format that matches the method in which your map coordinates are measured.

While most geocaching uses the latitude/longitude system, you can also change your GPS unit to display UTM coordinates. This allows you to directly compare your location between the GPS receiver and a map. Many maps show the UTM grid in great detail.

The Universal Transverse Mercator (UTM) Grid

The latitude/longitude system is used worldwide, and many different types of maps have lat/lon markings. However, Universal Transverse Mercator (UTM) coordinates also are widely used. For example, every month *Backpacker* magazine describes great hikes for your area along with the UTM coordinates to direct you.



UTM grids are shown by small blue tick-marks along the edges of topographic maps.

Map Projections

A map *projection* is a way to depict a round globe on a flat surface. The parallels of latitude and meridians of longitude usually appear as curved lines when flattened out to two dimensions. However, it is easier to work with a series of straight lines called a *grid*.

To simplify map use, cartographers overlay a rectangular grid on the map, a grid consisting of two sets of straight, parallel lines, evenly spaced, each set perpendicular to the other. This grid is designed so that any point on the map can be designated by its latitude and longitude or by other grid coordinates. A reference in one system can be converted into a reference in another system. Such grids are usually identified by the name of the particular map projection for which they are designed.

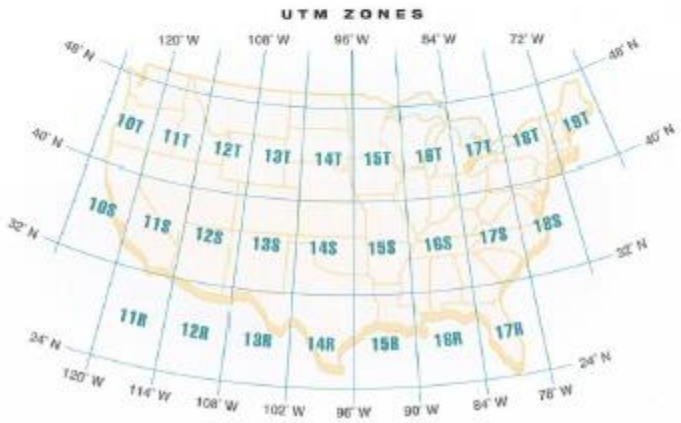
The Universal Transverse Mercator projection and grid system was developed to establish a worldwide, universal system for mapping. Because the UTM system uses meters instead of the degrees, minutes, and seconds that specify longitude or latitude, many map users have found that this grid system of coordinates is simpler to use than latitude and longitude.

Zones

The UTM system divides Earth into 60 zones numbered 1 through 60. Each zone covers 6 degrees of longitude (60 zones × 6 degrees = 360 degrees). The numbers start at the international date line in the Pacific Ocean and go eastward.

Each zone is further divided into horizontal bands that span 8 degrees of latitude. The bands are lettered from south to north, beginning with the letter *C* (at latitude 80 degrees south) and ending with the letter *X* (at latitude 84 degrees north). The letters *I* and *O* are skipped to avoid confusion with the numbers 1 and 0.

A square grid is superimposed on each zone, aligned so that vertical grid lines are parallel to the center of the zone, which is called the *central meridian*. Zones have horizontal and vertical grid lines every 1,000 meters. UTM coordinates are expressed in relation to the grid lines, using measurements called "easting" (meters to the east) and "northing" (meters to the north).



The UTM system covers the continental United States from zone 10 on the West Coast through zone 19 in New England. See what zone your home is in. The San Francisco Bay area, for example, is in UTM Zone 10 and UTM Band S. UTM coordinates include both the zone number and the band letter: Zone 10 S.

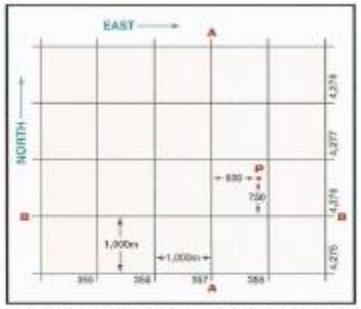
Eastings

UTM easting coordinates are measured relative to the central meridian (the centerline of the zone). The central meridian is assigned an easting value of 500,000 meters east. Grid values to the west of the central meridian are less than 500,000; to the east, they are more than 500,000. Eastings are on the horizontal (left to right) axis of the map.

Northings

UTM northing values are measured from the equator. For locations north of the equator, the equator has a northing value of zero. For locations south of the equator, however, the equator is assigned a northing value of 10,000,000 meters. This avoids having negative numbers.

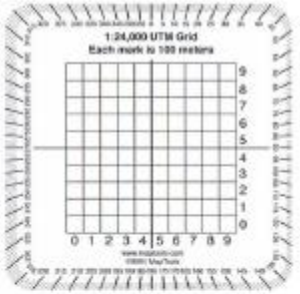
Intervals of 1,000 meters are indicated by full grid lines. You can use a UTM grid overlay on a map to subdivide the grid. (See "Using a UTM Grid Overlay Tool" later in this section.) Distances can be measured in meters at the map scale between any map point and the nearest grid-line to the west and south. The easting of the point is the value of the nearest grid-line west of it plus its distance east of that line; its northing is the value of the nearest grid-line south of it plus its distance north of that line.



The grid value of line A is 357,000 meters east, and line B is 4,276,000 meters north. Point P is 800 meters east and 750 meters north of the grid lines. Therefore, the grid coordinates of point P are east 357,800 meters and north 4,276,750 meters.

Using a UTM Grid Overlay Tool

Full grid lines mark intervals of 1,000 meters. To find your location with greater precision, you will need a tool that is marked in finer divisions than the grid lines on the map. One such tool is a grid overlay that has lines at 100-meter intervals. Place the grid overlay on the map with its edges aligned along the grid lines. Then you can determine and mark the position of a point on the map using the tool's additional precision.



A GPS unit might read: 14 S 0689865
3640435

This reading identifies a location in zone 14 (band S) that is 189,865 meters east of the zone 14 central meridian and 3,640,435 meters north of the equator. Using a notation similar to that found on a U.S. Geological Survey topographic map, this would be written as: zone 14 S 689865mE. 3640435mN.

Lay the transparent UTM grid overlay tool over the square containing the location of interest on your map. Always read coordinates "right, then up." This means you start from the left and read to the right (to the east). Then go from the bottom up (to the north). The numbers on the bottom increase from left to right ("read right"). The numbers on the right-hand side increase from the bottom toward the top ("read up").

Map Datums

Every GPS receiver has a datum setting. The datum is the survey reference data used to locate landmarks on a map. Modern-day maps reflect a standardized datum—the World Geodetic System 1984, or WGS 84. By comparison, most USGS topographic maps are based on an earlier datum called the North American Datum 1927, or NAD 27. The Global Positioning System uses WGS 84, so generally when geocaching you should set your GPSr to WGS 84. If you are using a GPSr along with a map for general navigation, the map you are using should list the datum used to create the map. Therefore, the datum setting for your receiver should match the paper map you are using.

Map and GPS Practice Exercises

Practice finding the coordinates for map locations of your choice. Similarly, take some given coordinates and tell what feature is located at that position on the map. A good exercise is to compare the GPS readings with the map. Go outside and follow your GPS receiver to a preset location using the UTM settings on the GPS unit. When you get there, see what you find.

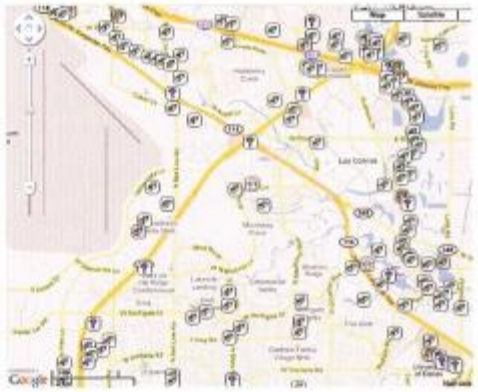
You can do the reverse of this activity by going to a predetermined map point and seeing whether the UTM reading on the GPS unit is the same as what you read on the map. This will allow you to experience how the GPS UTM readings correlate with map and compass.

You can draw a route to a destination on a paper map and then transfer the coordinates for each major point on the route into your GPS receiver.

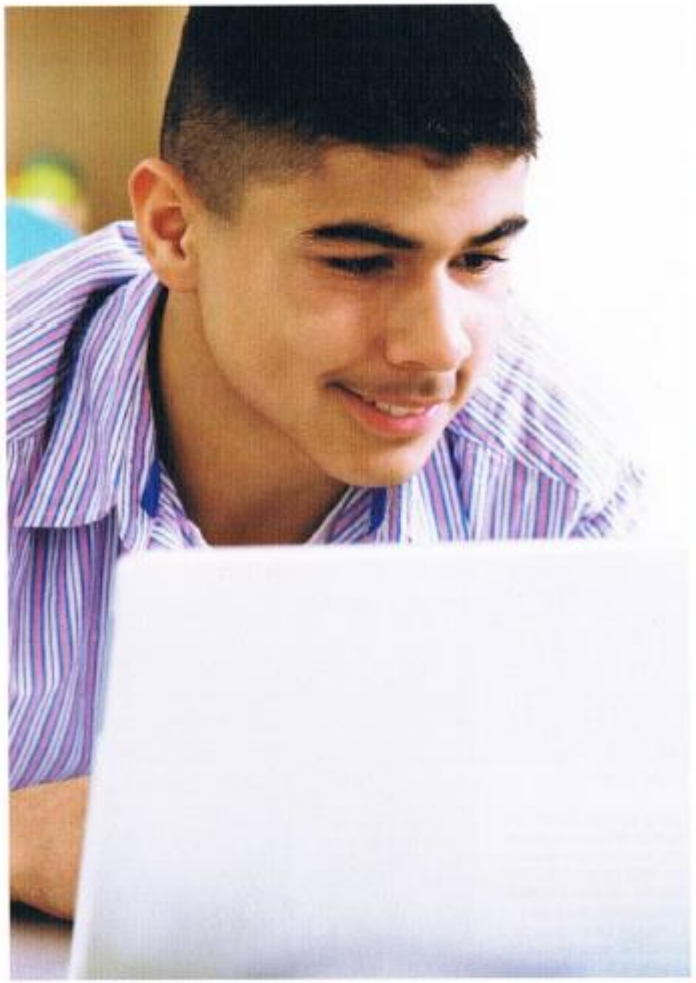
For information on USGS products and programs, visit (with your parent's permission) the website on mapping, geography, and related topics at http://egsc.usgs.gov/isb/pubs/pubslists.

Google Earth or Google Maps

"Following the arrow" on a GPS receiver may add "high tech" to a geocaching adventure, but another piece of technology lets you geocache even if you don't own a GPS unit. Google Earth and Google Maps allow you to put in coordinates and then zoom in for a detailed satellite view of the location. Using this technology, along with a description of the cache and other clues, is often enough to find a geocache. You can almost see the exact bush the cache is hidden under.



Using Google Earth or Google Maps is a novel way to combine geocaching with map skills. You can use both a detailed topographic map and a Google Earth map to bring the map symbols alive in a fun way.



Geocaching and the Internet

Since the very first geocache in May 2000, the Internet has played a major role in the sport. Several websites offer information about geocaching, and you can search for a wide variety of public geocaches. Just remember that no one controls the information put onto the World Wide Web. Much of what you see posted there may be incorrect or misleading. You should always consider the source of the information to help you evaluate how accurate it might be.

Basic Internet Safety

Internet use has its risks and requires common sense as well as parental permission. Follow these guidelines *and* use your noggin!

1. **Follow your family's rules for going online.** Respect any limits on how long and how often you are allowed to be online and what sites you can visit. Do not visit areas that are off-limits. Just as there are places you don't go to in real life, there are places to avoid on the Internet.
2. **Protect your privacy.** Never exchange e-mails or give out personal information such as your phone number, address, last name, your school, or where your parents work and their work phone numbers, without first asking their permission. Do not send anyone your picture or any photographs unless you have your parent's permission.
3. **Do not open e-mails or files you receive from people you don't know or trust.** If you get something suspicious, trash it just as you would any other junk mail.
4. **If you receive or discover any information that makes you uncomfortable, leave it and tell your parent.** Do not respond to any message that is disturbing or hurtful.