The GPS Classroom

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The GPS Classroom is a 2-day course that provides participants with the basic knowledge of a GPS, what it is and how it works. Participants will observe practical lesson ideas, based upon Core Curriculum standards, incorporating a GPS into the classroom and get hands on practice using a GPS in a classroom project.

Class Objectives
- Understand how GPS ties in with multiple subject areas of the State Core Curriculum.
- Understand many uses of the GPS in the classroom.
- Understand the basics of how GPS receivers work.
- Be able to transfer the waypoints from the computer to the GPS.
- Create a curriculum based lesson plan incorporating GPS.

Course Outline

What is GPS?

What is GPS?

GPS stands for Global Positioning System. It consists of a network of satellites that continuously transmit data, making it possible to precisely identify locations on Earth by measuring distances from the satellites.

This network of twenty four satellites constantly circles the globe, transmitting very low power radio signals. Anyone with a GPS receiver can access the radio signals to help them to determine their location anywhere on Earth.

The satellites were launched by the U.S. Department of Defense for use in military operations, but were opened up for all public access by President Bill Clinton in 2000. There is no cost to the users of the

satellites (since the upkeep for the satellite system has already been covered by your tax dollars!) so anyone and everyone can enjoy.

How does a GPS work?

With GPS, location is everything. In order for a GPS receiver to work, it needs to know two important pieces of information: Where the satellites are in their orbit (location), and how far away they are from the receiver (distance).

The GPS receiver utilizes both satellites and ground monitor stations to locate where the satellite signals are coming from. As the satellites transmit data to Earth, the GPS receiver reads and stores the approximate position of the satellites in to its memory.

Since satellites can occasionally travel slightly out of orbit, ground monitor stations keep track of the satellite orbits, altitude, location, and speed. These ground stations send the correct data up to the individual satellites which is then sent back to the GPS with the right position information.

Once the GPS receive knows the approximate position of the various satellites, it still needs to know how far away the satellites are from Earth. This is how the GPS calculates your approximate position on the Earth. Your distance from a given satellite object equals the velocity of the transmitted signal multiplied by the time it takes the signal to reach you (Velocity x Travel Time = Distance).

Using this basic formula to determine distance, the receiver already knows the velocity. It's the speed of a radio wave – 186,000 miles per second (the speed of light).

Now the GPS receiver needs to determine the time portion of the equation. To find the time, a GPS needs to read the coded signals that are transmitted by the satellites. The signal being sent by a satellite is received and compared against the data stored in the GPS receiver. The difference between the signal received and the stored data is called delay time (or shift). The delay time (or shift) is multiplied by the speed of light to get the distance.

This is an abbreviated summary of how the GPS works and should not be considered as the authoritative source on all things GPS. For more information about how GPS works visit:

http://www.garmin.com/manuals/GPSGuideforBeginners_Manual.pdf

Why use GPS?

There are a multitude of various uses for the GPS receiver. From outdoor adventuring to classroom investigations the GPS can help individuals learn more about ins and outs of personal navigation.

Using GPS in the Classroom or School:

Does your school have a GPS that you and/or your students can use? Many schools are investing in these devices because of the usefulness in education. The following are just a few ideas on how you can use a GPS receiver in you classroom or school.

- Curriculum Supplement
    - Enhance Fieldtrips - Help students find and learn about interesting or lesser known areas in their communities. A GPS can lead students in directions you've never thought possible.
    - Create assignments using GPS coordinates or waypoints. Have students engage in a curriculum based scavenger hunt to find clues about assignments or topics. Build interest in any subject by having student engage in an educational treasure hunt!
    - Gather data such as: distance, speed, area, perimeter, etc. to use in formulas or calculations for a given project.

- Student Projects
    - Students can create their own educational scavenger hunts.
    - Students can plan the route for the next classroom fieldtrip.
    - Students can use software such as Google Earth or GIS to create global data presentations.
    - Have students use the GPS to locate items in their environment that reinforce concepts learned in class, i.e. examples of geographic patterns.
    - Students can use digital cameras to capture and identify species found around the school and in our local environments.
    - Have students make a local history of the cities or town they live in by identifying and marking local landmarks.

- o Students can use the GPS as a method for gathering data for experiments or math problems.

- Assessment
    - o Collect data of student performance using the GPS (i.e., speed or distance traveled in a P.E. class).

- Support
    - o Collect data for your community using GPS receivers (i.e., mark out fire hydrants, identify local wildlife areas, etc).

Classroom Examples:

- **Expanded Form and Place Value of Numbers using GPS**
  http://www.uen.org/Lessonplan/preview.cgi?tid=84793&LPid=12621

- **Geocaching/Video Productions**

  http://www.uen.org/Lessonplan/preview.cgi?LPid=12680

- **Introduction to the French Revolution**

  http://www.uen.org/Lessonplan/preview.cgi?tid=89838&LPid=12605

- **GPS in Gym**

  http://www.uen.org/Lessonplan/preview.cgi?tid=56455&LPid=12854

- **Utah Plants**

  http://www.uen.org/Lessonplan/preview.cgi?tid=67079&LPid=13880

More examples can be found at the following GPS activity page:

http://www.uen.org/utahlink/activities/view_activity.cgi?activity_id=15969

GPS Receivers

Learning the basics of a GPS receiver will help you understand the different features available and how to find the information you're looking for. Let's take a look at the average GPS receiver. For this example we'll use an eTrex Vista.
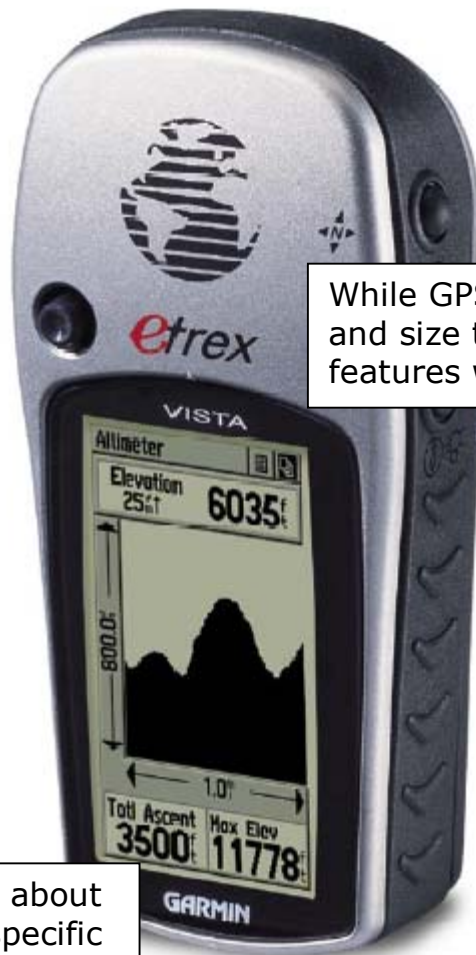
While GPS receivers vary in shape and size they have some similar features we'll look at in this example.
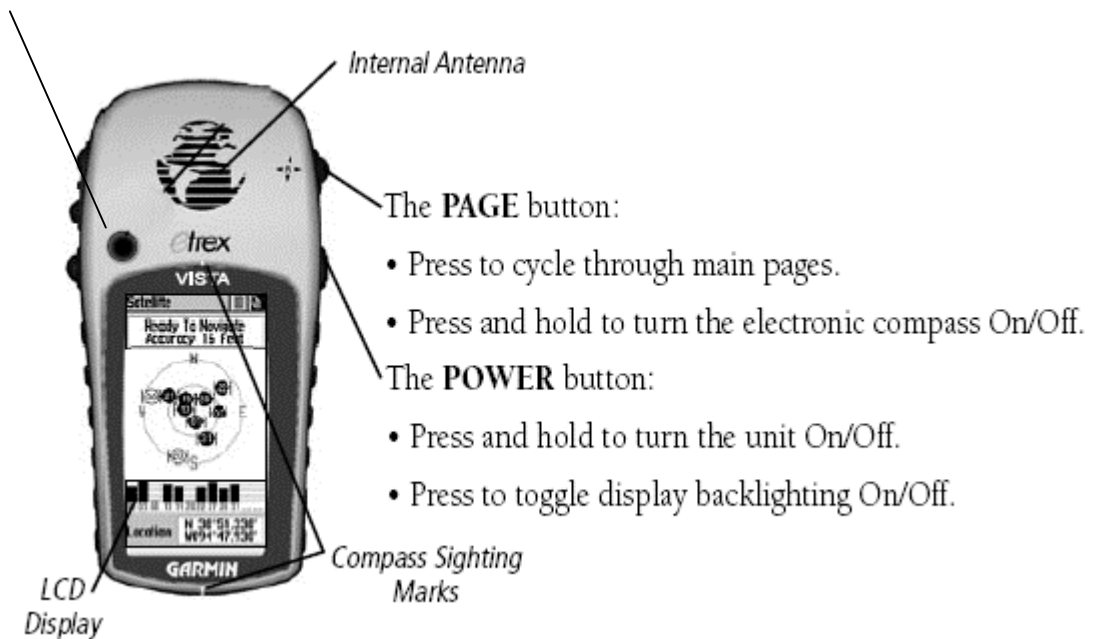
For more information about purchasing or other specific features, visit:
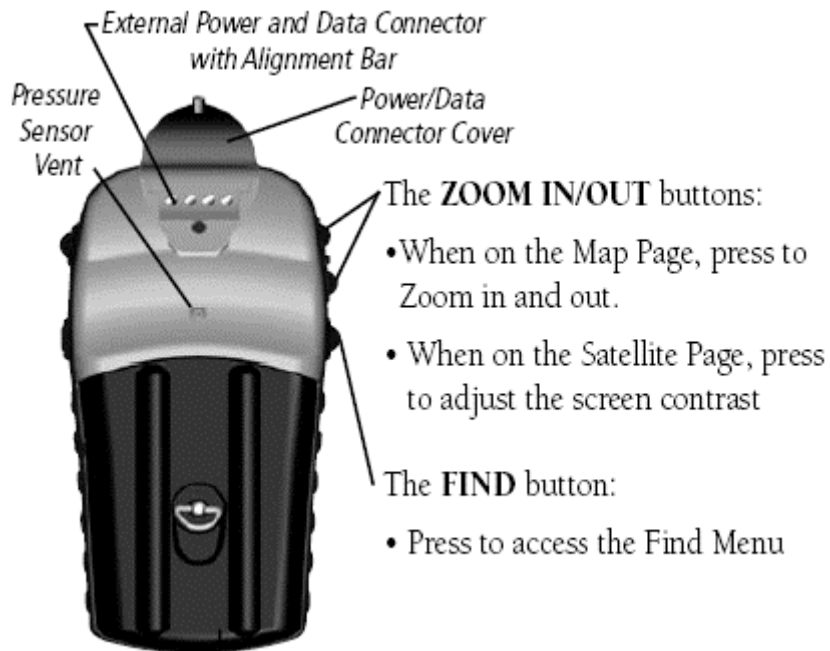
www.offroute.com

Getting Started

There are a few things to pay particular attention to when operating a GPS receiver. There are five major buttons and a thumb stick that helps you navigate through different screens and perform specific operation in your GPS. The buttons include: the power button, the page button, the zoom in/out buttons, and the find button.

The **THUMB STICK** (Five Position Switch)

• Press to enter highlighted options and to confirm messages

• Move Up/Down or Right/Left to move through lists, highlight fields, on-screen buttons, icons, enter data or move the map panning arrow

• Press and hold for two seconds to mark your current location as a waypoint

Internal Antenna

The **PAGE** button:
• Press to cycle through main pages.
• Press and hold to turn the electronic compass On/Off.

The **POWER** button:
• Press and hold to turn the unit On/Off.
• Press to toggle display backlighting On/Off.

LCD
Display

Compass Sighting
Marks

External Power and Data Connector
with Alignment Bar

Pressure
Sensor
Vent

Power/Data
Connector Cover

The **ZOOM IN/OUT** buttons:

• When on the Map Page, press to
Zoom in and out.

• When on the Satellite Page, press
to adjust the screen contrast

The **FIND** button:

• Press to access the Find Menu

To get started, you'll need to install two AA batteries according to
following diagram:

To install batteries:

1. Remove the battery cover on
   the back of the unit. Turn the
   D-ring 1/4 turn counter-clock-
   wise & pull away clockwise.

2. Insert batteries
   observing the
   polarity.

3. Reinstall the
   battery cover
   by turning the
   D-ring 1/4
   turn.

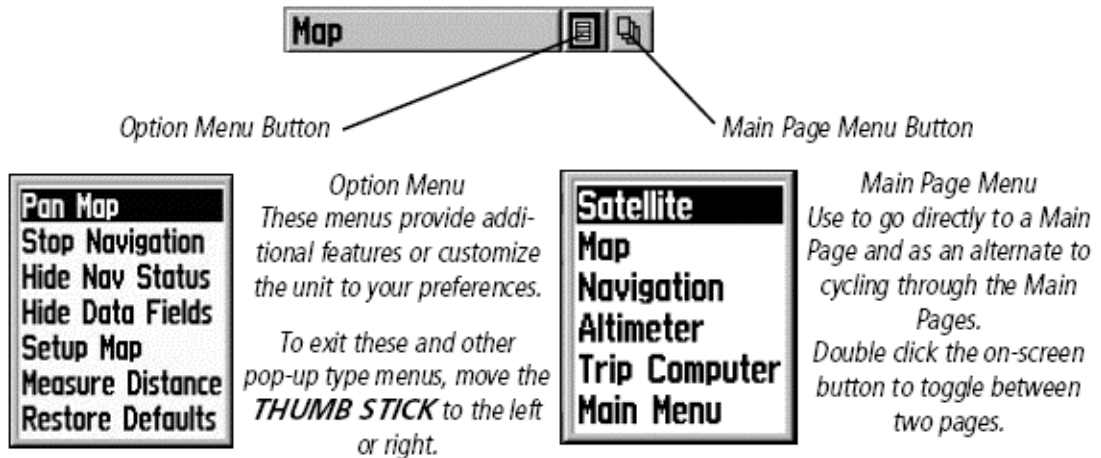AA

AA

Battery Compartment

D-ring

Battery Cover

Main Pages

The average GPS receiver contains 5 or 6 main pages which contain valuable information for the user. These pages include: the satellite page, the map page, the navigation page, the altimeter page, the trip computer, and the main menu.
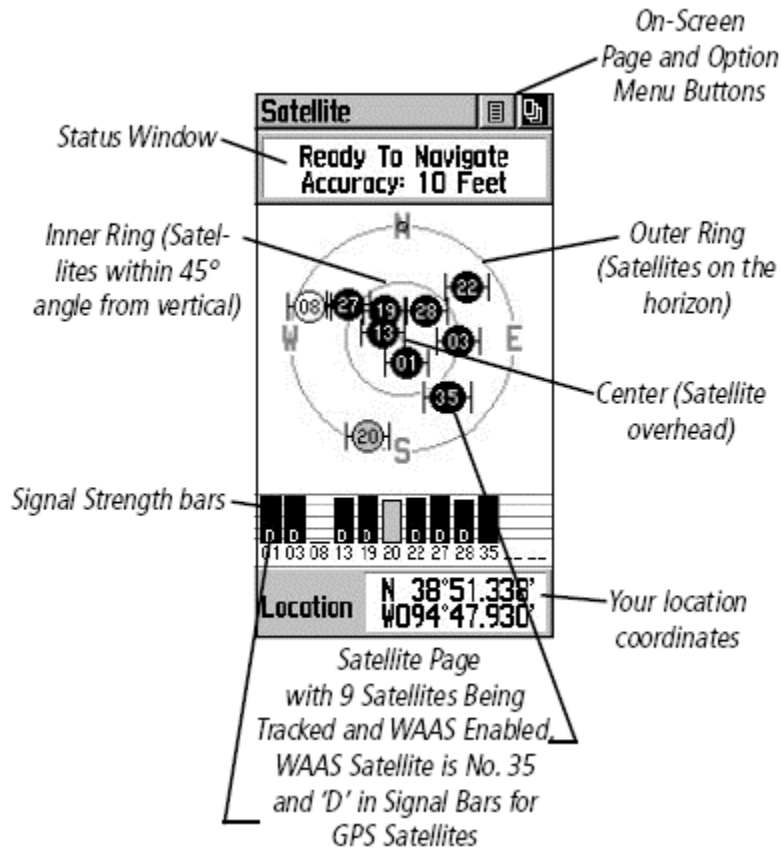

Satellite Page   Map Page   Navigation Page   Altimeter Page   Trip Computer   Main Menu
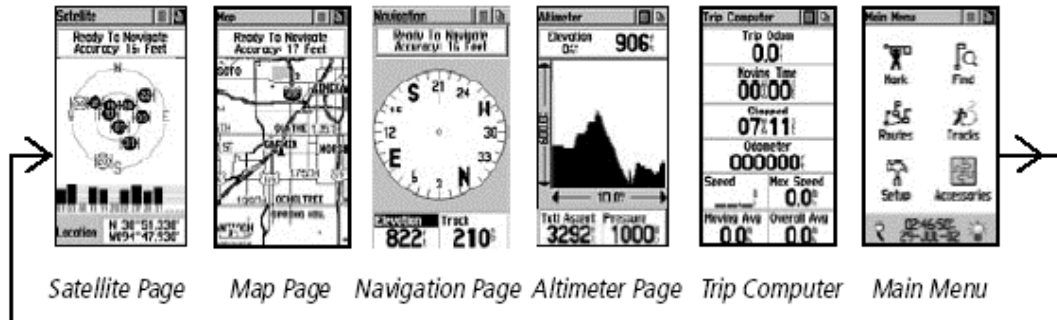
Each page can be found by using the page button (located on the right side of the unit) or by using the thumb stick to select the drop down page menu (across the top of any page).

Option Menu Button   Main Page Menu Button

Option Menu
These menus provide additional features or customize the unit to your preferences.

To exit these and other pop-up type menus, move the THUMB STICK to the left or right.

Main Page Menu
Use to go directly to a Main Page and as an alternate to cycling through the Main Pages.
Double click the on-screen button to toggle between two pages.

The pages all contain an options menu, which allows you to find or adjust specific information on that page. To access this menu, use your thumb stick.

Satellite Page

The Satellite Page is designed to help you find your current location. Also contained on this page is a quick reference to find out about satellite coverage in that location. Remember in order to find your current location you'll need to be tracking signals from at least **four** satellites.


On-Screen Page and Option Menu Buttons

Status Window

Inner Ring (Satellites within 45° angle from vertical)

Outer Ring (Satellites on the horizon)

Center (Satellite overhead)

Signal Strength bars

Your location coordinates

Satellite Page with 9 Satellites Being Tracked and WAAS Enabled. WAAS Satellite is No. 35 and 'D' in Signal Bars for GPS Satellites

A good way to save your batteries is to select "Use with GPS Off" from the option menu on this page. This is particularly useful while using your GPS indoors.

Satellite Page Options Menu Highlight the on-screen button at the top of the page & press in on the THUMB STICK.

Map Page

The Map Page contains a basic street map provided by the GPS manufacturer. These maps provide not only street maps of the U.S., but identify some remote roads and landmarks as well. More details maps are available for purchase for your GPS and these maps generally start and around $100. The maps can only be downloaded onto GPS units that have internal storage capability.
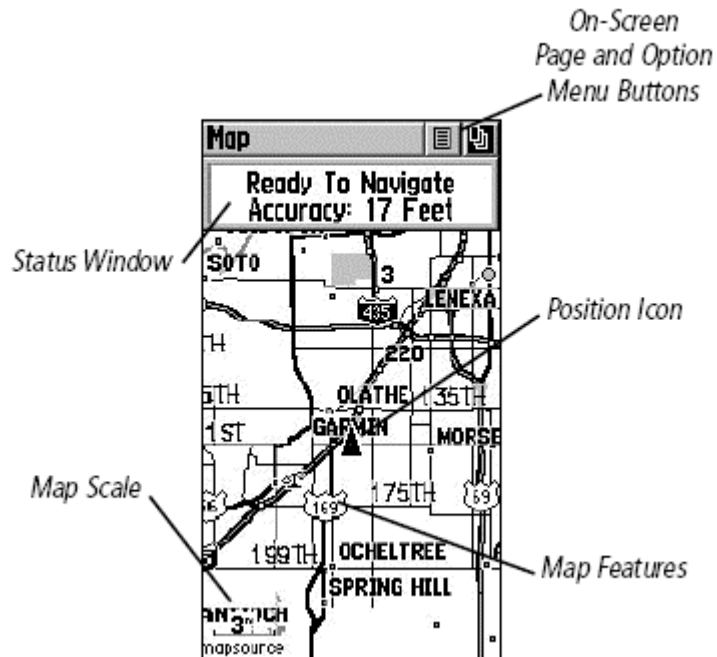

Using the Map Page is an excellent idea while traveling or looking for a waypoint in an unfamiliar area. You can follow your movement by finding and tracking the triangle in the map. Most GPS receivers have a "track back" feature, which allows the user to follow the path he/she has traveled. The track back feature has been referred to as the "bread crumb trail," as it helps you find your way back to where you've come from.

To better use the Map Page you'll want to become familiar with the zoom in/out button on your GPS receiver. You can zoom in on the map to a scale of feet or zoom out several miles to get a better view of your destination.

Map Scales

Navigation Page

The navigation page contains several pieces of useful information. Once selected on a given waypoint or destination, the navigation page will help guide you to the given location through the compass feature. On this compass, you'll find a bearing pointer which shows the right direction to travel. Above the compass is a data field which displays the name of your destination, as well as the total distance to that location.
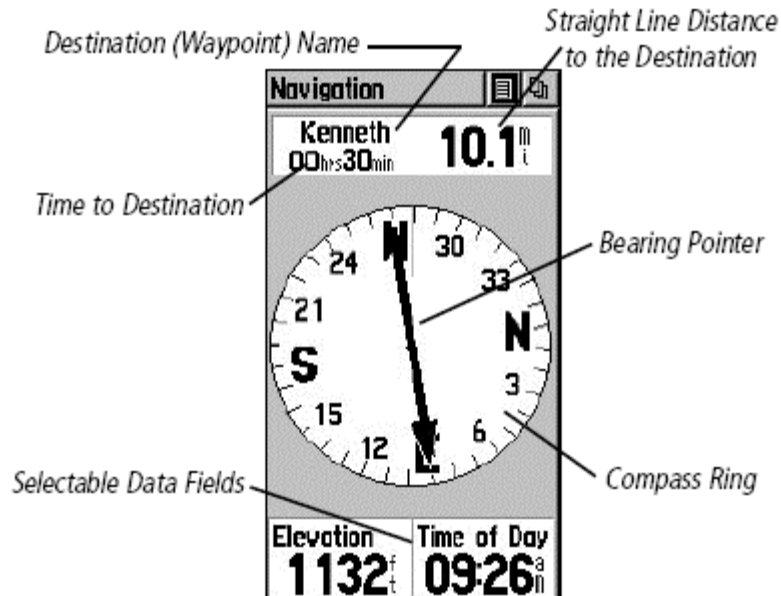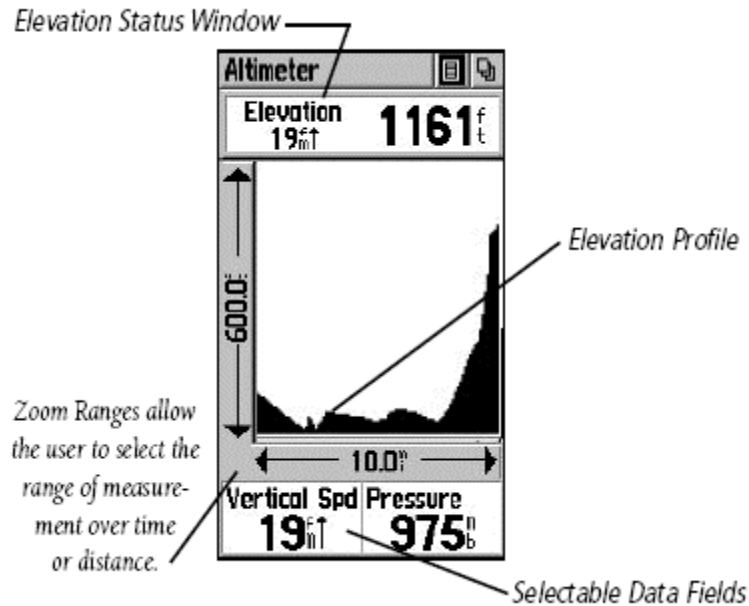

Also included on the Navigation Page are selectable data fields which allow you to track various data while traveling. Some of the more useful data fields include: Heading, GPS Accuracy, Speed, etc. To change the data fields, use the thumb stick to select the current data field and then navigate down to your desired data field.
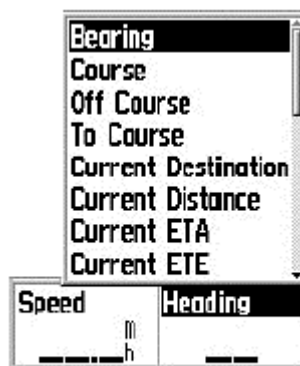
Map Data Fields
with Options Menu

Altimeter Page

The Altimeter Page provides the user with the current elevation, rate of ascent/descent, a profile of elevation changes over time, or a profile of pressure changes over time.


Elevation Status Window

Elevation Profile

Zoom Ranges allow the user to select the range of measurement over time or distance.

Selectable Data Fields

A key element before using the Altimeter features on the GPS is to calibrate the altimeter. Since your GPS relies upon barometric pressure calibrating your altimeter will help your GPS maintain its accuracy.

To manually calibrate the altimeter:

1. Use the **THUMB STICK** to access the Options Menu.

2. Highlight the 'Calibrate Altimeter' option and press the **THUMB STICK** to display the Calibration Page.

3. At the message stating "Do You Know The Correct Elevation?" highlight the on-screen 'Yes" button and press in on the **THUMB STICK**.

4. On the number keyboard, use the **THUMB STICK** to enter the new elevation, then highlight 'OK' and press it in to return to the Altimeter Page.

Trip Computer Page

The Trip Computer Page displays up to eight different types of navigation data and can be programmed by the user. Some of the more useful fields of information include: an odometer, a speedometer, and a stop watch. This page can be very useful for gathering data for experiments and for tracking physical exertion.


Selectable Data Fields
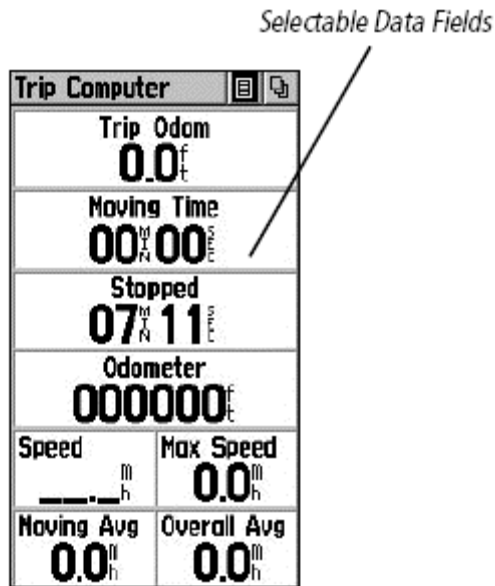
One of the useful options on the Trip Computer Page is the ability to reset the data fields. By using the reset option you can accurately chart the necessary fields you're tracking.

Reset Options Menu
Useful when starting a new trip
to clear old data.

Main Menu Page

From the Main Menu Page you can mark and create new waypoints; find map items such as cities, interstate exits, addresses, points of interest, etc.; create routes; save tracks; setup system operating features; or access and use unit accessories.
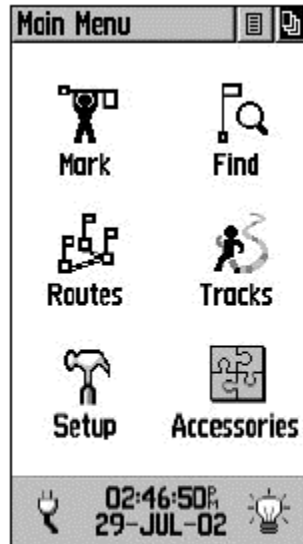
*Main Menu with Feature Icons
and Power, Date/Time, and
Backlight Status Window*

Since this page is so full of useful information and various menu options I'll break down the main features in more detail. Let's look at the Mark Waypoint Page first.

Mark Waypoint

The Mark Waypoint Page allows you to mark record your current location as a waypoint. This waypoint will appear with a graphic name block (the little man with the flag) that displays the assigned number for that waypoint and a waypoint symbol.

   You will need to mark a waypoint if you're trying to enter in coordinates by hand. Use the thumb stick to select the location data field and manually change the latitude and longitude.

Mark Waypoint Page

Find Menu

The Find Menu allows you to find stored locations or waypoints and other map items (ie., cities, exits, etc.). They can be found by name or you can search for waypoints closest to your current position. In addition to using the find icon on the Main Menu page, you can also search for waypoints using the button on the lower left side of your GPS. Both search methods are excellent in helping you locate the objects you're looking for.
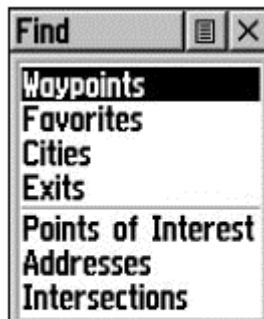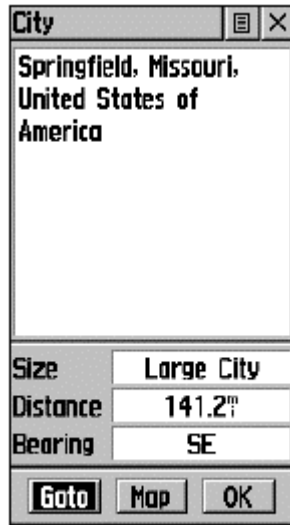

Find Page using your current location as a point of reference
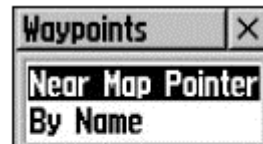
'Near Map Pointer' or 'By Name' Prompt displays when using Map Pointer

Once you've selected the appropriate waypoint, you'll need to click the Goto button, located on the lower left side of your screen. This will bring up the navigation page so you can use the compass to locate the waypoint you desire.
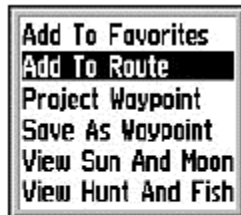
Information Page
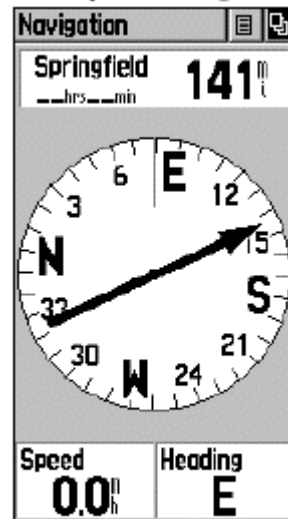
Navigation Page

Routes

Have you ever found yourself traveling along and you can't remember the path you took the last time you went to your destination. Using your GPS you can create a route, or a sequence of intermediate waypoints which lead you to your final destination.

You can store up to 20 routes, with each route containing a maximum of 50 waypoints.

Once you've create a route you still have the opportunity to edit or add waypoints to your path. This can help you to improve your accuracy and overall travel time to a given destination.

"Add To Route" option from the Find Menu Information Pages

Tracks

The track feature of you GPS can help answer one of life's most difficult questions: "Where did we park the car?" Today's GPS units draw an electronic bread crumb trail on the Map Page as you travel along. This bread crumb trail is known as the 'Track Log.' It contains information about points along its path, including time, and position. The GPS uses this information to allow you to navigate using the saved track.
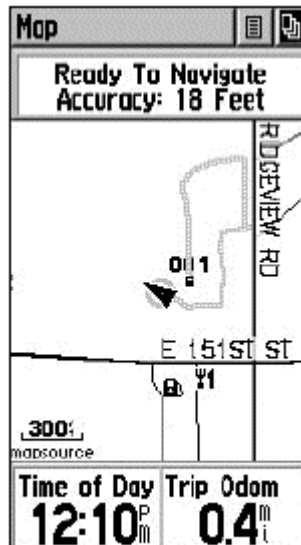

Track on Main Map Page

You can save a total of ten tracks in the unit's memory. The Track Log starts recording as soon as the unit gets a satellite location fix and the Track Log feature is turned on. If you want to clear the Track Log use the options menu.
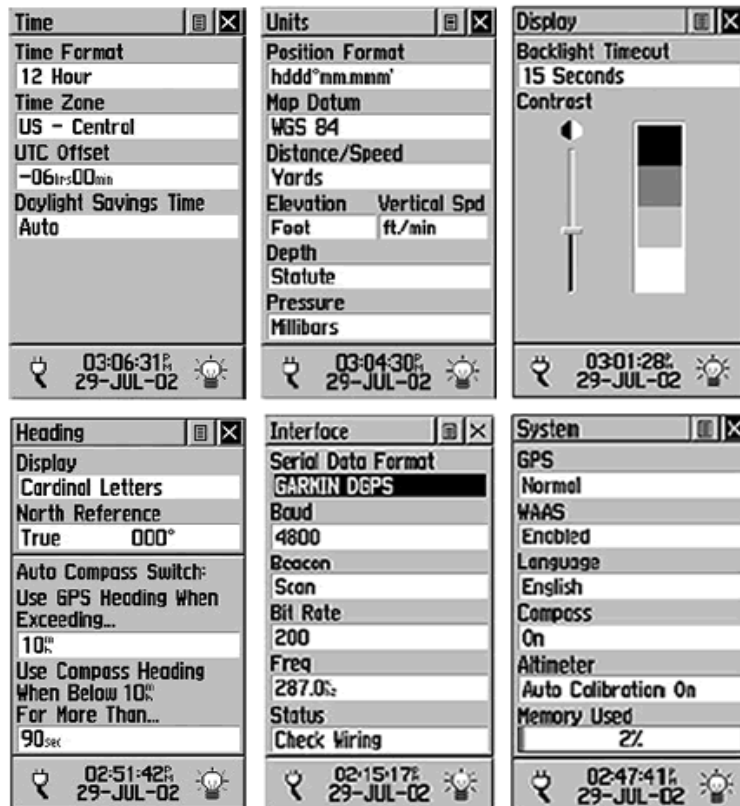
Setup Menu

The Setup Page allows you to customize your GPS to your personal preferences. You can choose time settings, units of measure, display backlighting and contrast settings, heading measurement, interface options, and system operating mode.
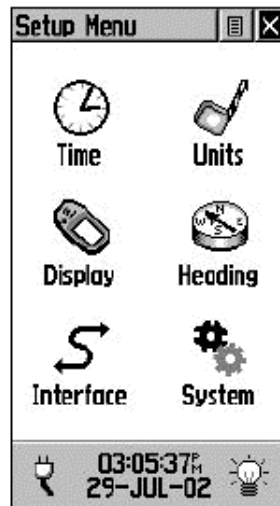
Setup Menu

You can adjust any of these settings using the thumb stick and selecting the menu option.

Most of the different settings are adjustable based upon your preferences; however, there is a setting that will greatly improve your GPS receiver's performance. On the system screen, you'll want to make sure that your **WAAS** is enabled. WAAS or Wide Area Augmentation System is designed to improve your GPS accuracy. Having this enable generally takes your accuracy from around 20-30 ft. to somewhere around 9-15 ft.

Accessories Page

The Accessories Page provides you with several additional features to maximize your GPS receiver's potential. You can find out about the patterns of the Sun and the Moon, tracking both the sunrise and sunset. There are also calendar and calculator features on the accessories page. If you are a hunter/fisherman you can use the Hunt & Fish option on your GPS to find out the best times to go out and find animals or fish. Last, you can find out the area of a given location using the Area Calculator. This can be particularly useful when gathering data for a problem.

From Computer to GPS

In order to download waypoints from Geocaching.com to your GPS receiver you'll need to download some additional software. A free software download is available at www.easygps.com (PC only – Mac users need to visit   http://www.macsimplegps.com for a compatible software). To use easygps follow these instructions.

Go to www.easygps.com and click on the link for downloads.

On the downloads page click the link for the EasyGPS installer and follow the instruction listed there.

Download EasyGPS

To install EasyGPS:

1. Download the **EasyGPS installer**. Save the file to your desktop.
2. On your desktop, find and double-click the SetupEasyGPS.exe icon.
3. After installing EasyGPS, you can delete SetupEasyGPS.exe from your desktop.
4. To run EasyGPS, click Start, click Programs, and click the EasyGPS icon.

EasyGPS was last updated on April 26, 2004. (Version 1.3.7)

Once you've installed EasyGPS you'll need to have some waypoints to send to your GPS. These files are generally .loc or .gpx files. If you are involved in Geocaching these files are found on the cache page for the geocache you're looking to find.
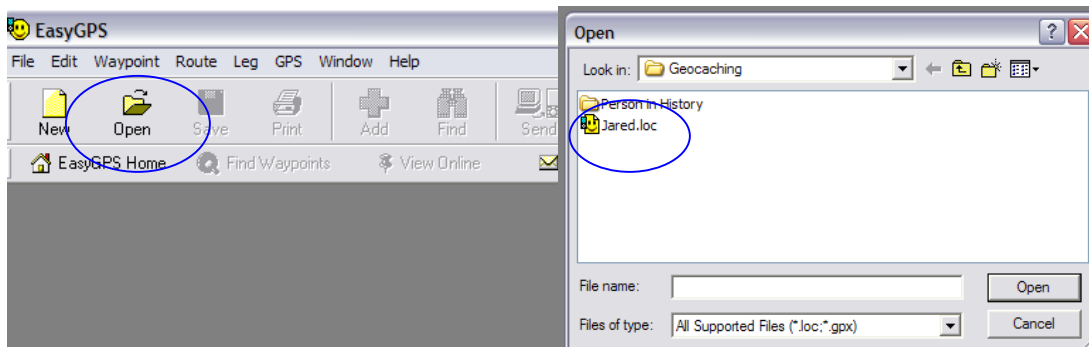
Now that you've selected the appropriate file you will be able to see all the waypoints associated with that file. Included will be the waypoint symbol, name, description, latitude, longitude, etc. In order to send the waypoints to your GPS receiver you'll want to click on the Send icon.
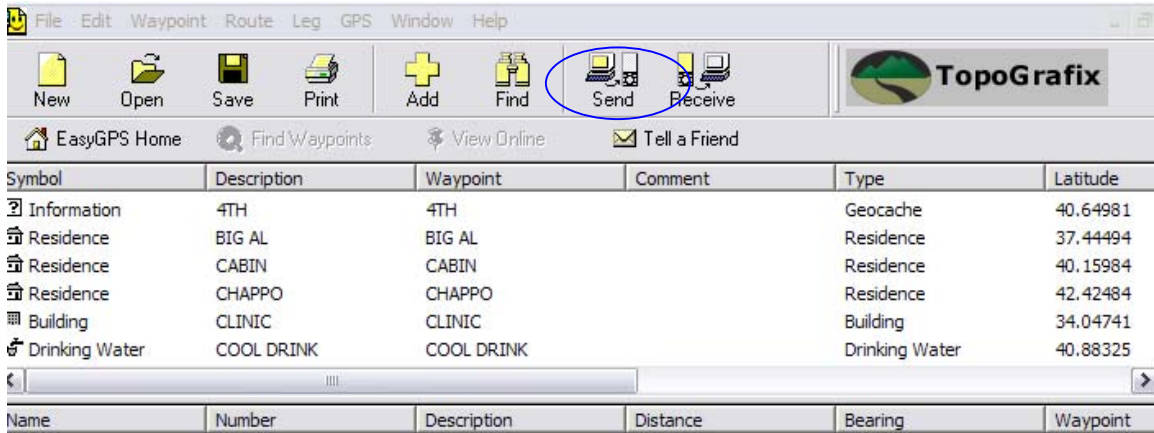
With your GPS receiver on and connected to a serial port on your computer, you'll click the OK button to send the waypoints to your GPS.
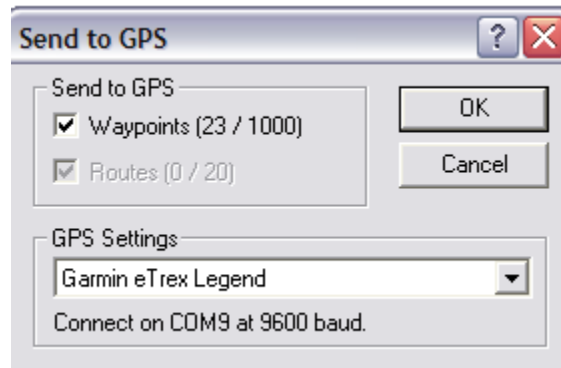
In addition to sending waypoints to your GPS from the computer you can also receive waypoints from your GPS receiver and store them on your computer. Make sure the GPS is connected to the computer using the serial cable and click the Receive button. Once you've received the waypoints in EasyGPS click the save button and you're done!

References and Resources

- **GPS Tutorial**
  http://www.trimble.com/gps/index.html

- **GPS Users Guide**
  http://www.garmin.com/manuals/GPSGuideforBeginners_Manual.pdf

- **Geocaching**
  www.geocaching.com

- **Geocaching for Kids**
  http://www.eduscapes.com/geocaching/kids.htm

- **EasyGPS Software**
  http://www.easygps.com/default.asp?rc=213pF

- **Mac Simple GPS Software**
  http://www.macsimplegps.com/

- **Serial to USB Cables for Mac**
  http://www.macgpspro.com/html/newhtml/datacables.html

- **GPS Lesson Plans**
  http://education.ssc.nasa.gov/fad/default.asp

  http://www.uen.org/utahlink/activities/view_activity.cgi?activity_id=15969

- **Degree Confluence Project**
  www.confluence.org

- **NASA World Wind Project**
  http://worldwind.arc.nasa.gov/

- **Google Earth**
  http://earth.google.com/

- **Garmin Website– Purchase GPS online**
  www.garmin.com

- **Magellan Website– Purchase GPS online**
  www.magellangps.com

- **GPSinformation.net– Product Reviews**
  http://gpsinformation.net/