

Activity A3: Communicating with the Satellites

Note: the procedures described below are for use with the yellow Garmin eTrex GPS receivers (the model supplied in the basic Virginia 4-H GPS Educational Kits). The instructions can easily be altered for use with other GPS receiver models.

Introduction:

Several factors affect the ability of GPS units to receive satellite signals. Some of these reduce the quality of the signal, resulting in reduced position accuracy. Others can totally block the signal, resulting in no position reading at all! Fortunately, many of these factors can be controlled by the user on the ground. In this activity, your students will explore some of these factors. They will also learn about stationary (waypoint) data and movement (track) data that can be created with a GPS receiver.

Materials Needed: GPS receivers; pens or pencils, data sheets (see below)

Time Involved: 50 minutes

Getting Started:

See “*Preparing GPS Receivers for Group Activities*”

Do the Activity:

Students will test the ability of receivers to maintain a connection with the GPS satellites and thereby the capability of collecting positional data. This activity is composed of three exercises, which can be done in sequence. Simple charts are provided for your students to record their observations - adapt and copy the attached “**GPS Experiments Worksheet**” as needed.

Most GPS units provide an accuracy estimate (a.k.a. estimated position error). In the eTrex receivers, this shows up as “Accuracy” on the Satellite page. This is the receiver’s estimate of effect of current satellite reception and geometry on its ability to calculate the true position. The estimated error is displayed as a distance (feet or meters). The larger the distance figure, the greater the predicted position error.

Your instructions to the students:

Exercise A. “In this activity, you will be exploring how the manner that you hold and handle your GPS receiver affects reading. To get good reception, move to an open area, away from trees and buildings. Test the five positions listed on your chart to see how each affects satellite reception. For each position, give your GPS receiver at least 30 seconds to adjust before recording your results.

| ACTION (Do these for at least 30 seconds each before recording your results) | DO YOU STILL HAVE A SATELLITE CONNECTION? | POSITION ACCURACY ESTIMATE (IF ANY) |
|---|--|--|
|---|--|--|

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| | | |
|--|--|--|
| 1. Hold the GPS receiver in a horizontal position (face up). | | |
| 2. Hold the GPS receiver in a vertical position (nose up). | | |
| 3. Cover the GPS antenna with your hand. | | |
| 4. Dangle the GPS receiver from your neck. | | |
| 5. Put the GPS receiver in your pocket. | | |

Exercise B. Before you start this activity, clear your track log. Keep your receiver powered-on as you travel. Look at the map page and zoom in as close as possible. You will see the tracks you make as you go. You use your track log data in the next exercise.

In this activity, you will move from place to place to see how satellite reception is affected by different surroundings. For each new surrounding, give your GPS receiver at least 30 seconds to adjust before recording your observations. Mark each new location as a waypoint and use the chart below to record your observations. Some places to try might include the following:

- Open outdoor area away from trees and buildings
- Next to a brick building
- Next to a wood frame building
- Under a large tree
- In a forest
- Under a picnic shelter or pavilion
- Inside a building

| LOCATION DESCRIPTION | SATELLITE CONNECTION? | ACCURACY ESTIMATE | WAYPOINT ID (if possible) |
|--------------------------------------|------------------------------|--------------------------|----------------------------------|
| Example: <i>BALL FIELD</i> | <i>YES</i> | <i>20 FEET</i> | <i>BF 1</i> |
| Etc. | | | |

Exercise C. Once you have completed Exercise B, you will have collected a lot of data with your GPS receiver. Some of it, you did intentionally, for example when you marked your waypoints; however, most of the data was recorded automatically by your GPS receiver. The track log is one type of data that is collected automatically. As you saw on your map page in Exercise B, the trail of your travels is shown on the screen as you move.

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You can save your tracks if you wish. Many types of GPS receivers will allow you to retrace your trip in either direction, following your saved tracks. Try this with your GPS receiver!”

Background Information

The ability to record stationary (waypoint) data and movement (track) data is an important skill for anyone using GPS technology. Although the receiver does most of the work, the user must understand how to position the GPS unit so that it can achieve and maintain contact with an adequate number and configuration of GPS satellites. The human body can block signals, as can buildings, trees, hills, and other objects. Sometimes these objects alter the signals, rather than block them, resulting in decreased accuracy.

Consumer level GPS receivers have either a *patch* antenna or a *quadrifilar helix* antenna. Check the specifications section in your owner’s manual to determine which type is in your GPS receiver. Patch antennas are designed to work best when held in a horizontal position; quad-helix antennas function better in a vertical position. In Exercise A, learners tested how handling the receiver could affect reception. In Exercise B, they tested how objects in their immediate surroundings affected reception.

Most GPS units provide an accuracy estimate (a.k.a. estimated position error). This is the receiver’s estimate of effect of current satellite reception and geometry on its ability to calculate the true position. The estimated error is displayed as a distance (feet or meters). The larger the distance figure, the greater the predicted position error.

As learned in previous activities, waypoints are specific locations, entered in a GPS receiver or on a digital map. A waypoint is typically identified by horizontal (x-y = latitude-longitude) and sometimes altitudinal (z = elevation) coordinates, plus an alphanumeric name and a symbol, both of which are selectable. Tracks are composed of a series of *automatically* recorded positions, known as *trackpoints*, which are linked together in sequence. The track log usually includes x, y, and z data, including distance and direction between trackpoints. Most GPS receivers record the data but do not display the actual trackpoints. Only the connecting track is shown, usually as a shaded or dotted line. However, some digital mapping programs will display trackpoints and other track log data. GPS tracks are useful for a variety of purposes such as wilderness navigation and area measurement.

The actual process of marking waypoints and saving track logs will vary according to the make and model of GPS receiver being used. Refer to the owner’s manual for specific directions. The manual also will explain where the waypoints and track logs are stored and how to retrieve them.

Note: Comments and suggestions regarding this activity and other components of the Virginia 4-H GPS curriculum are appreciated. Please contact Mike Clifford at: mjc4h@vt.edu / 804-561-5411 / 11131 Amelia Springs Rd., Jetersville, VA 23083

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GPS EXPERIMENTS WORKSHEET: SATELLITE RECEPTION

Exercise A. The ways that you hold and handle your GPS receiver can affect readings.

| ACTION (Do these for at least 30 seconds each before recording your results) | DO YOU STILL HAVE SATELLITE CONNECTIONs? | POSITION ACCURACY ESTIMATE (IF ANY) |
|---|--|-------------------------------------|
| 1. Hold the GPS receiver in a horizontal position (face up). | YES or NO | ___ FEET |
| 2. Hold the GPS receiver in a vertical position (nose up). | YES or NO | ___ FEET |
| 3. Cover the GPS antenna with your hand. | YES or NO | ___ FEET |
| 4. Dangle the GPS receiver from your neck. | YES or NO | ___ FEET |
| 5. Put the GPS receiver in your pocket. | YES or NO | ___ FEET |

Exercise B. Move from place to place to see how satellite reception can be affected by different surroundings. Mark a waypoint at each location. Clear your track log first.

| LOCATION DESCRIPTION | SATELLITE CONNECTION? | ACCURACY ESTIMATE (?) | WAYPOINT NAME or NUMBER |
|----------------------|-----------------------|-----------------------|-------------------------|
| | YES or NO | ___ FEET | |
| | YES or NO | ___ FEET | |
| | YES or NO | ___ FEET | |
| | YES or NO | ___ FEET | |
| | YES or NO | ___ FEET | |

Exercise C. Save your tracks, then TracBack to beginning location.