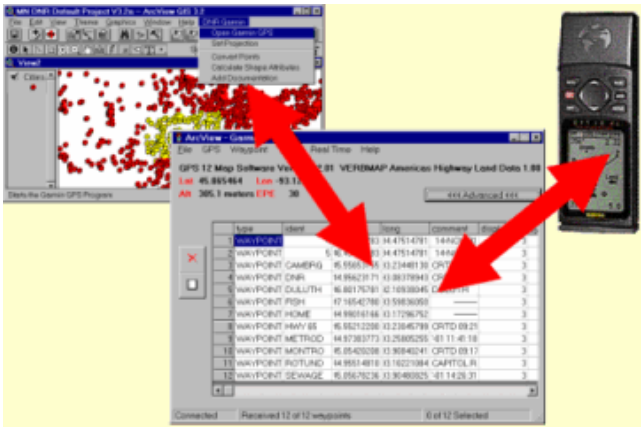
FOR 324 Natural Resources Information Systems

Lab #11
Data Acquisition and Accuracy Assessment Using GPS

Name: _____ Section:_____

Learning Objectives for this lab:

- To learn how to use a Global Positioning System (GPS) receiver to record and store point data (waypoints) and track data in a GPS
- To learn how to download GPS spatial data (waypoints and tracks) to a computer, and input the data into ArcGIS for later analysis
- To learn how to assess the locational accuracy of GPS spatial data



Task

- To download tracks and waypoints from a GPS receiver to a ArcGIS
- To assess the spatial accuracy of your GPS receiver.

Materials required:

- GPS receiver (Garmin eTrex Summit units will be provided for those students who do not own their own GPS unit)
- Computer with access to the internet, DNRGarmin™, and ArcGIS™

What to submit for this lab:

- Answers to all questions
- Map showing the relative precision of the GPS data for a single location
- Map showing the delineation of the SU and ESF quads based on GPS data.

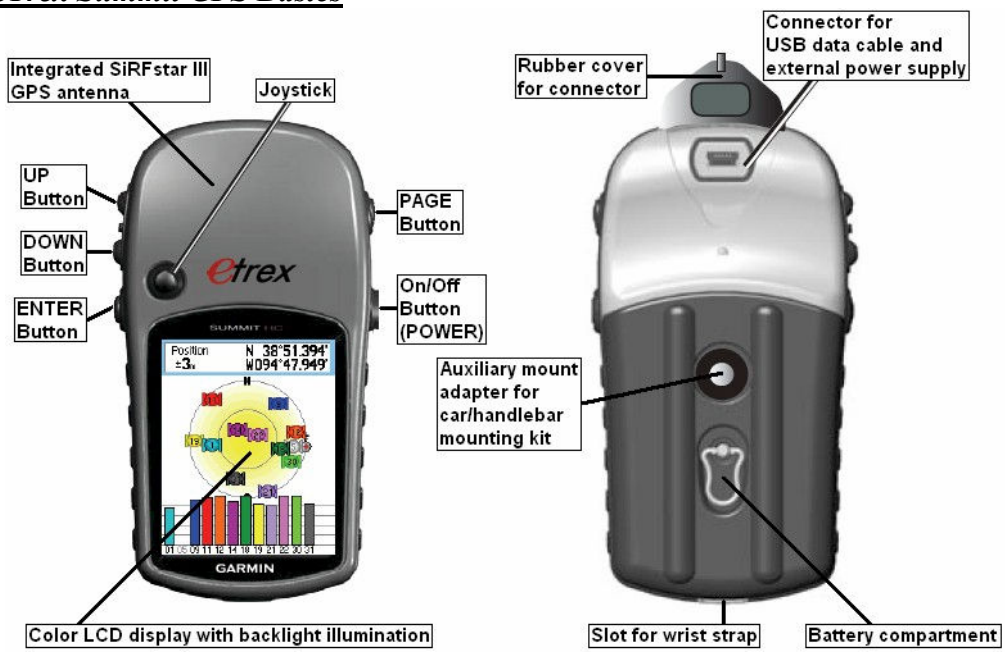
General Procedures

Read through the complete lab assignment (this document) before you go out in the field or sit down in front of a computer. Have the Garmin eTrex HC Series Owner's Manual handy at all times.

Specific skills you be introduced to in this lab:

- GPS receiver
  - How to move between screen pages, and learning their functions
  - How to setup the receiver and modify its configuration (e.g., change the datum, projection, etc).
  - How to setup the receiver to track movement (Tracks)
  - How to store single point locations (WayPoints) for later input into a GIS
  - What you will **NOT** be taught during this lab
    - How to use a GPS to navigate to a known location (e.g., geocaching)
- GPS software (i.e., DNRGarmin)
  - How to setup and modify the configuration for the Data Table (e.g., set projection)
  - How to download waypoints and tracks from the GPS receiver
  - How to save waypoints and tracks as shapefiles for input into ArcGIS.

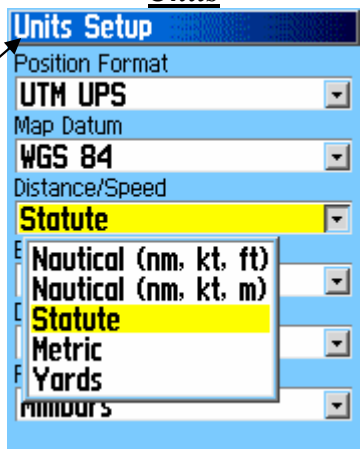
Garmin eTrex Summit GPS Basics



Main Menu

Setup Menu

Units



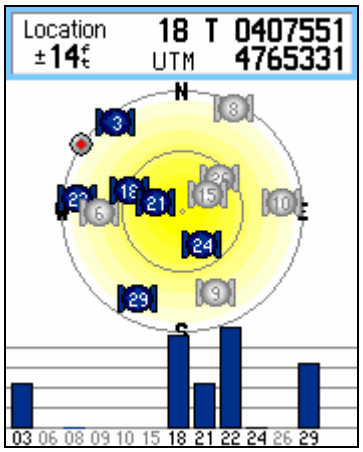
Field Procedures

1. SPATIAL ACCURACY ASSESSMENT

a) Decide on a feature on campus which you feel will be easy to view on a 1-ft resolution orthoimage available from the NYS GIS Clearinghouse site (e.g., flag pole, road/sidewalk intersection, bridge leading to Moon Library, etc.).

b) Go to that location and stand on the spot.

c) Turn on you GPS receiver. The opening page will be the *Satellite Status* page. Wait for the receiver to lock-in to at least 4 satellites.



d) Use the ***Page*** button to switch to the *Main Menu* and scroll to the *Tracks* page on the unit. Tracks allow the user to log their movements on a predefined time or distance travelled interval.

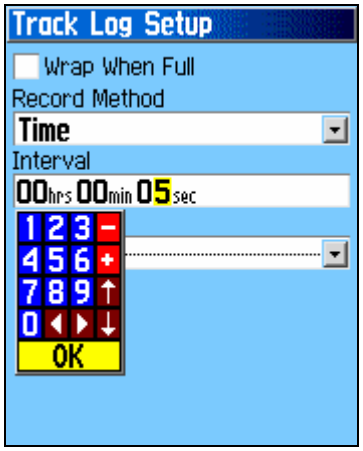
e) Clear all pre-existing tracks before you start a fresh track. Scroll to the CLEAR button, press ENTER, select YES at the prompt

f) Scroll to the SETUP and press ENTER

i) Highlight the RECORD METHOD field, press ENTER, select TIME, and press ENTER.

ii) Highlight the INTERVAL field, press ENTER again, then change the time to 5 seconds, and press ENTER.

g) Press the *Page* button to get back to the *Tracks* screen.



h) Once you're ready to start record, scroll to the ON radio button at the top of the *Tracks* page and press ENTER. The Tracking function has been activated, the GPS unit will store in memory, every 5 seconds, point coordinates of that location. Collect a series of coordinates for a total of at least 5 minutes (should provide 12 points/minute x 5 minutes = 60 points, enough to conduct some assessment of spatial accuracy). When you have tracked for at least

5 minutes, go back to the TRACK SETUP and set the Track Log to OFF. Then scroll to the SAVE button and save this portion of the lab's field data to memory. You can change the track name if you wish. When done, click the OK button.

i) Turn off the GPS unit by pressing and holding the ON/OFF button for 2 seconds.

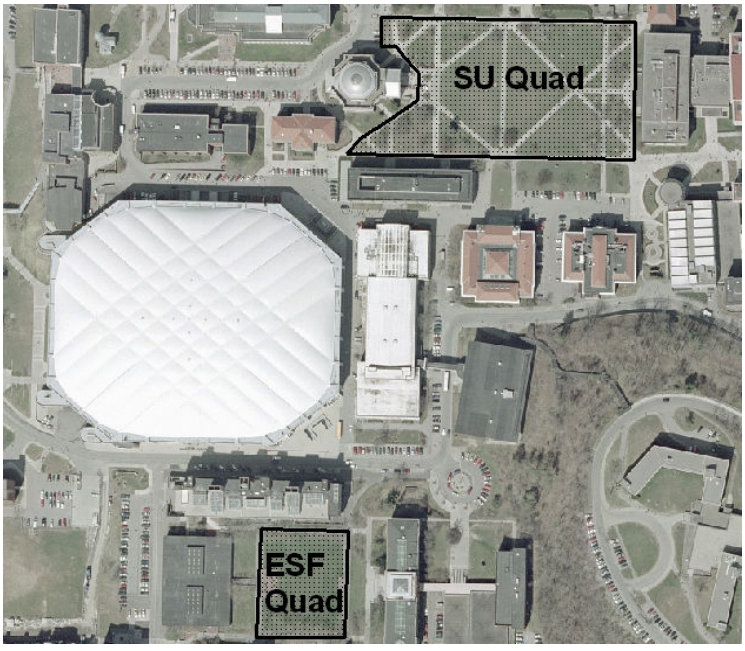
2. POLYGON DATA:
Using Tracks to map the boundaries of both the SU and ESF quads

a) Go to one of the corners of the SU quad (see map below). Stand in the middle of the path.
   i) Turn ON your GPS receiver. The opening page will be the *Satellite Status* page. Wait for the receiver to lock-in to at least 4 satellites.
   ii) Page over to the *Main Menu* and then *Tracks* page on the GPS receiver.
   iii) Scroll to the SETUP and press ENTER
   iv) Highlight the INTERVAL field, press ENTER again, then change the time to 1 second, and press ENTER.
   v) Press the Page button to get back to the Tracks screen.

b) Once you're ready to start record, scroll to the ON radio button at the top of the Tracks page and press enter. The Tracking function has been activated, the GPS unit will store in memory, every second.
   i) Collect a series of coordinates while you walk around the boundary of the quad.
   ii) When you have returned to your original starting point, go back to the TRACK SETUP and set the Track Log to OFF.

c) Turn off the GPS unit by pressing and holding the ON/OFF button for 2 seconds.

d) Go to the ESF quad and repeat the same procedures as Step (a) to (c) above.



Lab procedures

1. Create a new folder named LAB11 within the C:\WORKSPACE directory of the hard disk for computer you are using (i.e., C:\workspace\lab11)

2. Start up **ArcMap**. Set the Coordinate System for the **Data Frame** to UTM Zone 18. For now, minimize the program and just have it running in the background.

3. Turn on the GPS receiver and, using the communication cable provided (note, we only have a limited number of cables available, so you will need to be patient as we share the cables among your classmates), plug the GPS receiver into the USB port of the computer. You *may* get a prompt to install the driver for the GPS unit. If you do, simply press the 'NEXT' button for the series of dialog boxes that open up until driver installation is completed. Ask the instructor or TA for assistance, if needed.

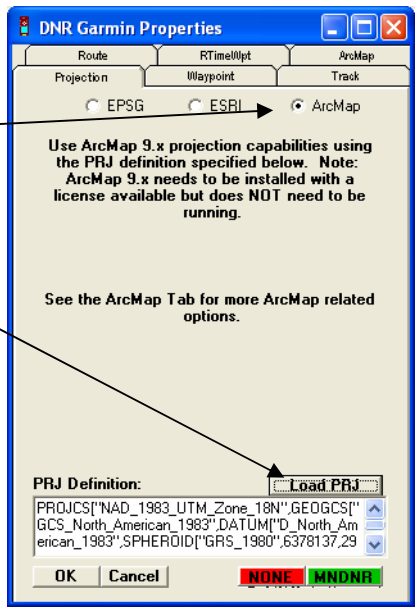
4. Start up the **DNR Garmin**™ program (***Start➢All Programs➢DNRGarmin➢DNRGarmin***) (NOTE: if you want to download this free program to your home computer, goto the Minnesota Dept. of Nat. Resources (DNR) website at: http://www.dnr.state.mn.us/mis/gis/tools/arcview/extensions/DNRGarmin/DNRGarmin.html).

   a) By default, the DNRGarmin software is set to project coordinates using UTM Zone 15N (default for Minnesota, where the software was developed). This needs to be reset for the current location.

   b) Set the projection for the coordinates to NAD 83, UTM Zone 18N
      (1) Select ***File ➢ Set Projection***.

      (2) In the dialog, click on the **ArcMap** radio button

      (3) Click on the Load PRJ icon, and navigate through the folders until you find the ***UTM Zone 18N*** projection for the **NAD 83** Datum



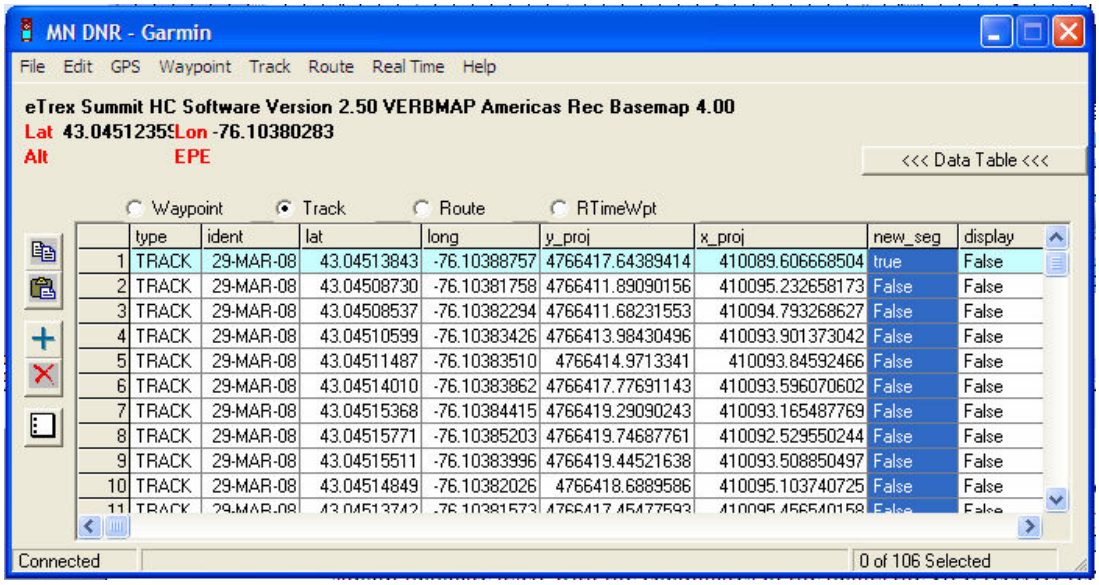
   c) Once started, the software should recognize that the GPS receiver is connected to the computer. If DNRGarmin does not recognize the GPS unit or you get an error message, select ***GPS ➢ Set Port ➢ USB***, followed by ***GPS ➢ Open Port.*** Contact the instructor or TA for assistance if you are having difficulties.

5. Assessing the accuracy of the GPS receiver.

   a) The **DNRGarmin** software has a built-in function that allows a user to calculate the *Circular Error of Probability* (CEP) for the current records in the Data Table. This functionality can help determine the accuracy of your GPS Unit at a given location and a given time.

   b) You first need to populate the Data Table with multiple GPS positions (i.e., coordinates) for a single ground location. Step 1 of the **Field procedures** describes the steps you used to collect this data. To download these points, select ***Track ➢ Download***. The Data Table should populate itself with the coordinates of the points the GPS receiver recorded while you were standing at a single location. Scan through the track data points.

   c) Each time you turn the tracking ON and OFF with the GPS unit, a tag is inserted in the data set which identifies the new segment. When tracks are downloaded in **DNRGarmin**, the attribute '*new_seg*' records these tags and are highlighted in light blue.



	type	ident	lat	long	y_proj	x_proj	new_seg	display
1	TRACK	29-MAR-08	43.04513843	-76.10388757	4766417.64389414	410089.606668504	true	False
2	TRACK	29-MAR-08	43.04508730	-76.10381758	4766411.89090156	410095.232658173	False	False
3	TRACK	29-MAR-08	43.04508537	-76.10382294	4766411.68231553	410094.793268627	False	False
4	TRACK	29-MAR-08	43.04510599	-76.10383426	4766413.98430496	410093.901373042	False	False
5	TRACK	29-MAR-08	43.04511487	-76.10383510	4766414.9713341	410093.84592466	False	False
6	TRACK	29-MAR-08	43.04514010	-76.10383862	4766417.77691143	410093.596070602	False	False
7	TRACK	29-MAR-08	43.04515368	-76.10384415	4766419.29090243	410093.165487769	False	False
8	TRACK	29-MAR-08	43.04515771	-76.10385203	4766419.74687761	410092.529550244	False	False
9	TRACK	29-MAR-08	43.04515511	-76.10383996	4766419.44521638	410093.508850497	False	False
10	TRACK	29-MAR-08	43.04514849	-76.10382026	4766418.6889586	410095.103740725	False	False

   d) To select specific records from the data table, click on the left most column containing record number and drag down to include all the records on interest.

   e) Go through the data table, locate and select *only those points* that relate to positional accuracy assessment of the GPS receiver.

      (1) How many data points did you record using the TRACK option? _____

   f) Once the data points have been selected, select ***Edit ➢ Calculate CEP…***.
   The CEP option uses a reference point, either supplied by the user or by calculating the average of all the points, to generate a series of circles that represent the 50%, 90%, 95% and 98% circular error of probability. Since you don't have the true location of your point, have the program calculate the average coordinate. Click on the *Average XY* radio button, and then click on *CALCULATE*.

g) Record the CEP you obtained for your data in the following table.

	Lat	Long	UTM Easting	UTM Northing
MEAN XY:				
Standard Deviation:				

	CEP (m)
50%	
90%	
95%	
98%	

(1) Give you interpretation of what the CEP values represent.

h) Visual assessment of *Circular Error of Probability*.

(1) To save these coordinates so that you can view them in ArcGIS, again, locate and re-select only those points that relate to positional accuracy assessement of the GPS receiver. Then select ***File ➢ Save To ➢ ArcMap ➢ Shapefile layer***, locate the LAB11 folder, and give the data an appropriate file name (e.g., GPS_ACCURACY.shp). Define the shapefile as a *point* layer.

(2) Minimize **DNRGarmin** and maximum **ArcMap**.

(3) **DNRGarmin** should have automatically added the point shapefile to the Data Frame in **ArcMap**. Note how clustered or spread out the individual points are.

(4) To get a good sense of the accuracy of the GPS points, you will need to overlay your GPS data positions on a georeferenced data layer, such as 1-ft resolution Orthoimagery covering the college campus.

(a) Download and extract the LAB11_ORTHOPHOTOS_SYRACUSE.ZIP file from the course website. This file contains the six (6) orthophotos covering most of the campus and the immediate university neighborhood.

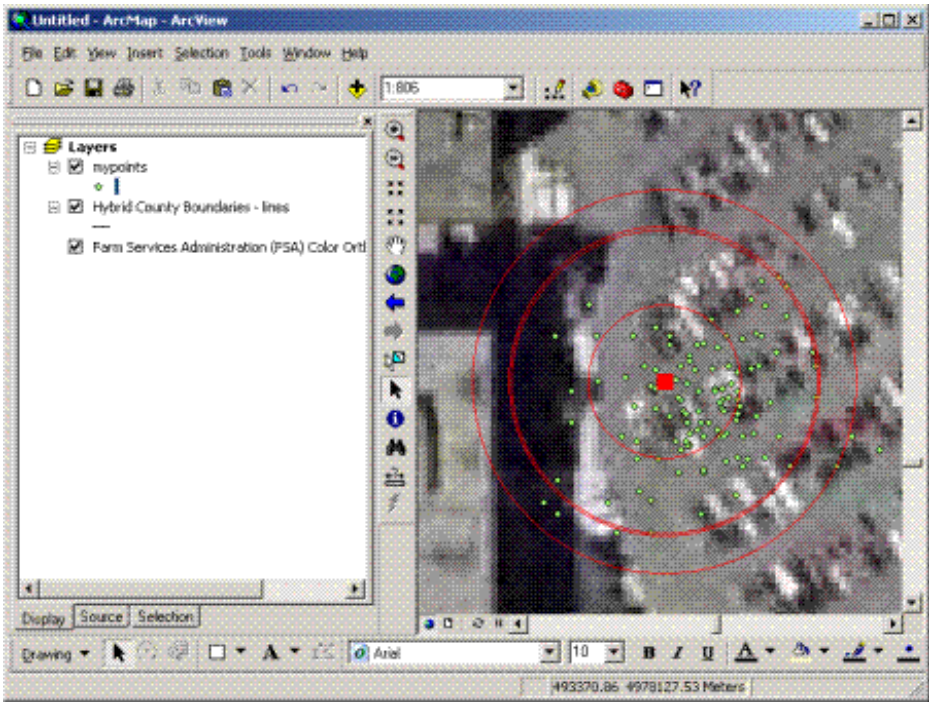
(b) Use the *Add Data*  button to add the six orthophotos to the Data frame.

(5) Use the *Measure* tool  found on the *Tools* toolbar to obtain a few measurements of the spread in the data points.

(a) How do these measurements compare to the CEP statistics derived with the DNR Garmin program?

(b) What is the distance between the mean location of the sample points and the true location based on your interpretation off the orthophoto?

(6) Go back to the **DNRGarmin** program and restart the CEP function. After you recomputed the CEP statistics, click on the *Plot –ArcMap* button. This feature will plot out the results on a map to give a visual explanation of the report



i) Save this ArcGIS project in the LAB11 folder in case you need it again.

j) Based on your analysis, write a summary paragraph describing your interpretation of the positional accuracy of GPS data and the significance of this error for most natural resource applications.

k) Print to a PDF file a map showing the accuracy assessment of the point location overlaying the orthophoto.

6. Campus quad polygon map (Polygon spatial data)

   a) In **ArcMap**, create a new blank project for the second part of this lab by selecting ***File ➢ New***, and selecting the *Blank Document* template.

   b) Go back to the **DNRGarmin** program. Go through the list of tracking points you downloaded in Step 5(b), and select only those points which form the boundaries of the two campus quads (Hint: if you scroll right in the Data Table, you will see a column labeled 'new_seg'. A value of 'True' is stored whenever you starting a new track. Locate the second 'True' value in the Data Table. This should be the first point for your polygon track.)

   c) To save these coordinates so that you can view them in ArcGIS, select ***File ➢ Save To ➢ ArcMap ➢ Shapefile layer***, locate the LAB10 folder, and give the data an appropriate file name (different from the tracking data in step 5.h)(1) above). Define the shapefile as a *polygon* layer.

   d) Minimize **DNRGarmin** and maximum **ArcMap**.

   e) **DNRGarmin** should have automatically added the point shapefile to the Data Frame in **ArcMap**. Using the same procedure you used in Step 5.h)(4), locate, download and add the orthoimagery containing the campus.

   f) Comment on how well the quad polygons collected using the GPS receiver agrees with their visual appearance on the orthoimagery. Discuss if you feel the positional error in polygon boundaries, if any, is significant enough to disregard the use of GPS receivers for use in boundary delineation.

   g) How might you improve the accuracy of the polygon data while still using a GPS receiver?

   h) Print to a PDF file a map showing your polygon features (transparent fill) overlaying the orthophoto.