



**USAID**  
FROM THE AMERICAN PEOPLE

# INCORPORATING GEOGRAPHIC INFORMATION INTO DEMOGRAPHIC AND HEALTH SURVEYS: *A FIELD GUIDE TO GPS DATA COLLECTION*

## Demographic and Health Surveys Methodology

This document is part of the Demographic and Health Survey's *DHS Toolkit* of methodology for the MEASURE DHS Phase III project, implemented from 2008-2013.

This publication was produced for review by the United States Agency for International Development (USAID). It was prepared by MEASURE DHS/ICF International.



[THIS PAGE IS INTENTIONALLY BLANK]



# **INCORPORATING GEOGRAPHIC INFORMATION INTO DEMOGRAPHIC AND HEALTH SURVEYS:**

## **A Field Guide to GPS Data Collection**

**May 2013**

This publication was produced for review by the United States Agency for International Development (USAID). It was prepared by Clara R. Burgert, Blake Zachary and Josh Colston, MEASURE DHS, ICF International.

---

**INCORPORATING GEOGRAPHIC INFORMATION  
INTO DEMOGRAPHIC AND HEALTH SURVEYS:**

**A Field Guide to GPS Data Collection**

---

**Clara R. Burgert**

**Blake Zachary**

**Josh Colston**

**ICF International**

**Calverton, Maryland USA**

**May 2013**

## **Acknowledgements**

This manual was based on an earlier versions produced by Nicholas Hill, Livia Montana, John Spencer, and Andrew Inglis.

This manual was produced by ICF International, Calverton, Maryland USA. The worldwide MEASURE DHS project is funded by the U.S. Agency for International Development (USAID). The opinions expressed in this report are those of the authors and do not necessarily reflect the views of USAID.

Additional information about the MEASURE DHS project may be obtained by contacting ICF International, 11785 Beltsville Drive, Calverton, Maryland 20705, Telephone: (301) 572-0200 Fax: (301) 572-0999 Internet: [www.measuredhs.com](http://www.measuredhs.com)

Information requests can be sent to: [gpsrequests@measuredhs.com](mailto:gpsrequests@measuredhs.com)

Suggested citation:

ICF International. 2013. *Incorporating Geographic Information into Demographic and Health Surveys: A Field Guide to GPS Data Collection*. Calverton, Maryland, USA: ICF International

# CONTENTS

---

<b>Contents .....</b>	<b>iv</b>
<b>How to Use This Guide .....</b>	<b>v</b>
<b>Definition of Terms.....</b>	<b>vi</b>
<b>Introduction to Geographic Data and GPS.....</b>	<b>1</b>
Coordinate Systems.....	1
The Global Positioning System (GPS) .....	2
GPS Accuracy .....	2
Benefits of Collecting GPS Data .....	2
Drawbacks to GPS Data .....	2
Altitude Adjustment.....	2
<b>Planning and Managing GPS Data Collection.....</b>	<b>3</b>
Required Equipment.....	3
Guidelines for Selecting a GPS Receiver.....	3
Personnel Needs .....	4
Training of GPS Coordinator and Field Team .....	4
Suggested Training Components.....	5
<b>GPS Data Collection in the Field .....</b>	<b>6</b>
Determining the Appropriate Collection Approach .....	6
Collecting GPS Data .....	6
Establishing Naming Conventions.....	7
Collecting and Storing GPS Data .....	7
A Good GPS Location.....	8
Preventing Common Human Errors .....	8
<b>Processing GPS Data .....</b>	<b>9</b>
Materials and Equipment Needed:.....	9
Processing GPS Data.....	9
<b>Appendix 1: Checklist For Project Manager .....</b>	<b>11</b>
<b>Appendix 2: Checklist For GPS Coordinator .....</b>	<b>12</b>
<b>Appendix 3: Sample GPS Data Collection Form.....</b>	<b>13</b>
<b>Appendix 4: Field Guide for GPS Waypoint Collection Using eTrex Legend H.....</b>	<b>15</b>
<b>Appendix 5: Field Guide for GPS Waypoint Collection Using eTrex 10 .....</b>	<b>17</b>
<b>Appendix 6: Processing GPS Data Using GPS TrackMaker.....</b>	<b>19</b>
Install GPS TrackMaker.....	19
Download Waypoints from the GPS Receiver.....	19
Export GPS Waypoints from GPS TrackMaker and Email to MEASURE DHS.....	20

## HOW TO USE THIS GUIDE

---

This document is designed to be a start-to-finish guide to Global Positioning System (GPS) data collection in Demographic and Health Surveys (DHS), Malaria Indicator Surveys (MIS), and AIDS Indicator Surveys (AIS); which will be referred to generally as “DHS” in this document. This guide provides background information on GPS, how the technology works, how GPS data are collected, and how it is used in the context of the DHS. Checklists are provided to identify hardware, software, and training needs during the course of a survey.

Project managers can refer to this guide to develop data collection protocols, identify personnel and equipment needs, and to conduct training. It is recommended that project managers review the introductory materials in the earliest stages of project planning. This will provide guidance on how to most efficiently incorporate GPS data.

The materials included in this publication can be freely redistributed; however the following citation must be included:

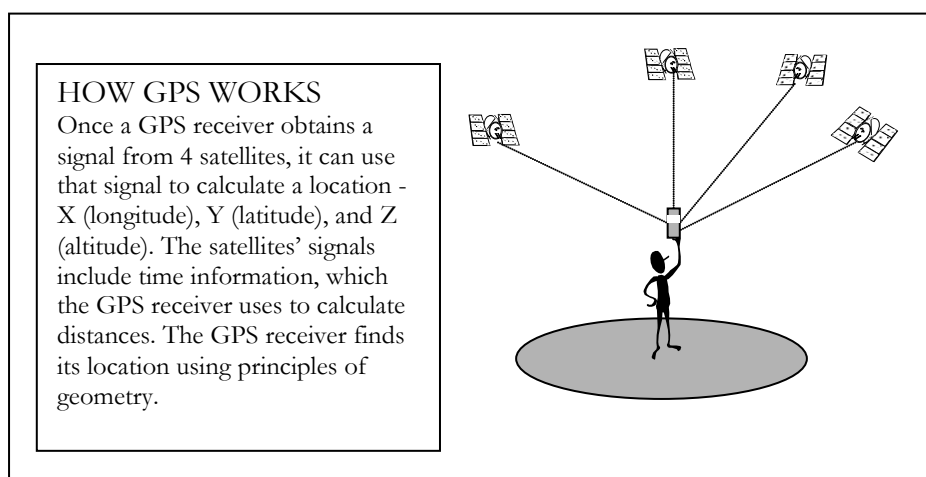
ICF International. 2012. *Incorporating Geographic Information into Demographic and Health Surveys: A Field Guide to GPS Data Collection* Calverton, Maryland, USA: ICF International

## DEFINITION OF TERMS

---

**BASE MAP** A reference map that contains one survey site. It shows limits of the Enumeration Areas (EAs), the principal physical features and land marks in the area such as mountains, rivers, roads, health facilities, schools and electric poles. In addition, it shows the location of the structures and the location of the structures selected for this survey.

**GLOBAL POSITIONING SYSTEM (GPS)** A satellite-based navigation system. A GPS receiver determines its position using satellites that orbit the earth. Each satellite's position, as well as the current time, is transmitted via radio signals. The GPS receiver obtains these signals and uses them to calculate its position on the earth. There are a variety of brands and models of GPS receivers.



**LATITUDE** A north/south coordinate measured from the equator. Combined with a longitude coordinate, it identifies an exact location on the earth's surface.

**LONGITUDE** An east/west coordinate measured from the Prime Meridian that runs through West Africa and Western Europe. Combined with a latitude coordinate, it identifies an exact location on the earth's surface.

**ALTITUDE** A measurement of height above sea level (also called elevation).

**WAYPOINT** A set of coordinates (i.e. latitude and longitude) that identifies an exact location on the earth's surface.

**STRUCTURE** A free-standing building that can have one or more rooms, for residential or commercial use. Residential structures can have one or more dwellings units (for example: single house, apartment building). In the case where one household inhabits several small dwellings, as in the rural area, all the dwellings together, whether they are fenced in or not, constitute a structure.

**DHS** Demographic and Health Survey. Provide data for a wide range of monitoring and impact evaluation indicators in the areas of population, health, and nutrition.



AIS	AIDS Indicator Survey. Provide countries with a standardized tool to obtain indicators for the effective monitoring of national HIV/AIDS programs.
MIS	Malaria Indicator Survey. Provides data on bednet ownership and use, prevention of malaria during pregnancy, and prompt and effective treatment of fever in young children. In some cases, biomarker testing for malaria and anemia are also included.

# INTRODUCTION TO GEOGRAPHIC DATA AND GPS

---

Researchers, policymakers, and program managers have long recognized location as an important factor in population and health outcomes. This is especially true of diseases like malaria that can be affected by environmental factors such as altitude, rainfall, and terrain. Knowing where a survey took place can add value to the data and allows for inclusion of outside data sources (e. g. rainfall, land cover, and vector habitat) after the survey for enhanced understanding.

Geographic information includes two components: location and attributes. Location is *where* in space the items of interest are, while the attributes provide information about *what* is occurring there<sup>1</sup>.

## Coordinate Systems

By definition, geographic data must refer to a location. Locations are usually referenced with a coordinate system. Though there are many different coordinate systems, perhaps the most common is latitude and longitude.

- Latitude defines location in a north/south direction and uses the equator as its reference. Positions north of the equator have positive latitudes while positions south of the equator have negative latitudes. The earth's poles represent the maximum values for latitude. The North Pole is 90 degrees north, while the South Pole is 90 degrees south.
- Longitude defines location in an east/west direction and uses a line known as the Prime Meridian as its reference. The Prime Meridian, as established by international convention, is a line that runs through the Greenwich Observatory in Greenwich, England. Positions that are east of this line have positive longitudes while positions west of the line have negative longitudes. On the other side of the earth from the Prime Meridian is the International Date Line. The International Date Line has a longitude of 180 degrees and is the maximum longitude.

## Geographic Information Systems (GIS)

The key tool for maximizing the use of geographic data is a Geographic Information System or GIS. GIS is a combination of computer hardware and software used to store, manipulate, analyze, and display geographic data. Looking at a range of data from this spatial perspective can often add valuable context to human activity. GIS facilitates this type of analysis by integrating common database operations, such as query and statistical analysis, with the unique visualization benefits that maps can provide. The powerful analytical capabilities of the software mean that attributes can be queried and more complex questions explored. For example, a dataset of health facilities containing their location and attributes, such as how many doctors and nurses are on staff, may be useful. But knowing the location of the communities they serve and how easy or difficult it may be to reach the facilities might be more important. Knowing where the catchment population is and routes of travel can answer this kind of question. GIS gives users the opportunity to analyze these layers of information simultaneously.

---

<sup>1</sup> Although GPS is the focus of this manual, it should be noted that GPS is by no means the only source of geographic data. Existing hand-drawn maps, such as those outlining census enumeration areas, are common sources of geographic information. Hand-drawn maps can be digitized, georeferenced and merged with other sources of information. Remotely sensed data such as air photos, satellite and radar images provide land use and land cover data for almost any place on earth. A wealth of remotely sensed data is commercially available but it can be expensive to purchase and process. Public domain digital datasets are increasingly available at little or no cost from the internet but the quality and resolution of these datasets is not always good. Many countries are beginning to establish their own collections of digital geographic data, often supported through international donor agencies. But because of the multidisciplinary nature of geographic data, it is rarely centralized under one ministry or government agency.

## **The Global Positioning System (GPS)**

The Global Positioning System or GPS is a satellite-based navigation system developed by the United States Department of Defense to provide a consistent and accurate method of determining location. While it was originally designed for military applications, GPS also provides commercial and recreational users with worldwide navigation coverage. A GPS receiver determines its position using satellites that orbit the earth. Each satellite's position, as well as the current time, is transmitted via radio signals. The GPS receiver uses these signals to calculate its location.

### **GPS Accuracy**

There are several types of GPS receivers. Survey grade receivers are the most accurate and the most expensive. Typically these receivers have sub-centimeter accuracy and cost in the tens of thousands of USD. Mapping grade receivers typically can produce sub-meter accuracy and cost between 1,000 USD and 5,000 USD and are designed for high-end cartographic activity. Recreational grade GPS receivers are designed for use when hunting, hiking, and boating, etc. Of the three types, recreational receivers are particularly well suited for use in the Demographic and Health Surveys (DHS), Malaria Indicator Survey (MIS), and AIDS Indicator Surveys (AIS). The cost of the receiver is typically less than 200 USD and positional accuracy is 15 meters or less (often around 5 meters).

Understanding and defining the accuracy needs of the project is crucial to ensure successful GPS data collection. For most projects 10-15 meter accuracy is acceptable. This level of accuracy can be achieved with nearly all recreational grade receivers.

### **Benefits of Collecting GPS Data**

The benefits of GPS data are substantial. For example, GPS data recorded at each sample cluster can be linked to all of the household and individual level attributes contained in the full DHS dataset. Locations for health facilities can be linked to the inventory and information on health workers. Rather than constraining a geographic analysis to national or provincial levels, data for the sample clusters can be aggregated to new units of analysis such as climatic zones or ethnic regions. New variables can also be extracted from the GPS data and used in multivariate analysis.

### **Drawbacks to GPS Data**

The accuracy of the GPS receiver's calculated location depends on the strength and number of satellite signals it receives. The receiver will always collect data from as many satellites as it can and will choose the four best according to angle and strength of signal to compute its location (see GPS Accuracy above). But obstacles such as buildings, mountains, and tree canopies can distort the signals and introduce error. Even more serious, user mistakes such as inaccurate or incomplete waypoint identification can be extremely difficult to rectify after the data collection teams and GPS receivers have returned from the field.

### **Altitude Adjustment**

Altitude, also called elevation, is the measurement of height above sea level. Most GPS receivers record the altitude along with the location. Altitude is important in the DHS because it allows for adjusting the hemoglobin level to properly classify anemia status.

## PLANNING AND MANAGING GPS DATA COLLECTION

---

Collecting GPS data during the DHS is simple and requires little additional work. GPS data can be collected within the existing framework of the survey, many GPS receivers are inexpensive, and survey staff can be trained quickly in their use. This section describes the benefits and drawbacks of GPS data collection as well as an overview of the steps required to add a GPS data component to projects.

Before beginning any project that will incorporate GPS data, planning is essential. It is important to coordinate equipment purchases and arrange for training and personnel needs. The specifics of the project will determine how some decisions will be made; however, there are some things that will be common to all projects.

### Required Equipment

Project managers should make equipment purchases as soon as the contract is signed. The following equipment is required:

- **GPS receivers:** One receiver per team, plus two backup receivers for the survey. (100 to 400 USD per receiver)
- **Power supply:** Four times the number of batteries required per GPS receiver or sufficient quantities of chargers should be ordered (most recreational receivers use AA batteries).
- **GPS/PC connector cables:** At least two per survey should be ordered because cables are easily misplaced. Most GPS receivers are sold with their own cable which is usually a USB connection.
- **GPS utility software:** GPS utility software is used to download data from the GPS receivers onto a computer. This software is described in a subsequent section. (FREE to 40 USD)
- **Paper record:** In addition to recording the location in the GPS receivers, field teams must record the data on a paper form. A template is included as an appendix to this report (see Appendix 3: Sample GPS Data Collection Form). These fields can also be incorporated into the main questionnaire.

### Guidelines for Selecting a GPS Receiver

There are many different GPS receivers available for purchase. This is a list of basic requirements that the GPS receiver should have:

- Ability to store at least 500 waypoints
- Records altitude
- Records date and time
- Allows for various coordinate systems and datums
- Uses power supply that is readily available in the survey location (e.g. AA batteries)

GPS receivers that fit these requirements and are often used for the DHS are the Garmin eTrex Legend H and the Garmin eTrex 10. A field guide for both GPS units are included in Appendix 4 and 5, respectively.

## **Personnel Needs**

GPS data collection can almost always be done without hiring additional personnel. The details and number of people will vary according to the projects. There should be a field team which will collect GPS data and a GPS coordinator. The project manager must identify a local staff person to serve as the GPS coordinator and must decide which field staff will be charged with the responsibility of actually collecting the GPS data. The main responsibilities of the GPS coordinator are to ensure that:

- Field staff are well-trained in the use of GPS receivers
- GPS data are collected for all locations in the survey
- Technical and protocol questions raised by the GPS data collection team are resolved
- Team members are following the established GPS data collection protocols
- GPS data are regularly downloaded from the GPS receivers and verified
- GPS data from the paper forms are entered into a computer and verified
- All necessary GPS data are collected
- Copies of the GPS data are provided to the managing institutions

## **Training of GPS Coordinator and Field Team**

Adequate training of personnel is crucial to promote an understanding of and proper use of the GPS receivers and to troubleshoot problems that may occur in the field. The GPS coordinator should be identified early so that s/he can fill the role for the duration of the training, data collection and data processing. This person should be someone who has existing knowledge and/or experience with GPS data or the willingness and ability to learn quickly. Because of the advanced tasks the GPS coordinator must perform, s/he will need additional training beyond what is provided to the collection teams. This training will include how to transfer locations from the GPS receiver to a computer as well as some more advanced training with the GPS receivers. At a minimum the GPS coordinator should understand the basic operation of the GPS receiver and how to reset and modify the system settings (e.g. coordinate system, datum, measurement units).

The GPS coordinator should be trained by the project manager or designee. The training of GPS data collectors can then be conducted by the GPS coordinator in collaboration with the project manager.

The field team must be trained in the basics of the GPS receiver, the data collection protocols, and simple troubleshooting techniques. In order to prevent a “black-box” syndrome where the team does not understand how the GPS receivers work, it is helpful to cover the basics of how GPS works. Lastly, the team should be given time to practice collecting GPS data. This training can last from a half to a full-day depending on the number of people and the specifics of the project. The GPS training site should have access to a field or park where there is a clear view of the sky. It is essential to incorporate GPS training, including a hands-on session, in the regular project training regime.

## **Suggested Training Components**

The training should include the following:

### **1. Overview of GPS**

Everyone using the GPS receivers should have a basic understanding of the GPS and the underlying theory behind the technology. This allows users to understand how the system works and the importance of following proper protocols. Users who have an understanding of GPS will be more likely to recognize problems that may arise in the field and know the necessity of resolving the problem. Typically this section of training lasts 30 minutes and should cover the following topics:

- History of GPS
- Description of the components of GPS: satellites, ground stations, receivers
- How the GPS receiver calculates a location
- Errors that are present in GPS data and how to minimize them

### **2. Introduction to the GPS Receiver**

Everyone on the data collection teams should be introduced to the GPS receiver in the training session. The basics of using the GPS receiver should be covered: on/off, initializing the receiver and adjusting settings (datum, coordinate system, measurement units), acquiring a location, checking satellite coverage, changing the waypoint name, renaming and deleting waypoints, adjusting contrast, light, and time/day.

### **3. GPS Data Collection Protocols**

Well-defined data collection protocols are essential to obtain accurate data. These protocols should explicitly describe how identifiers are assigned and where GPS data should be collected. This section of training should describe the protocols in detail.

### **4. Troubleshooting**

Guidance should be given on solving problems that might be faced in the field. This includes replacing batteries, checking the GPS receiver's settings, and finding adequate satellite coverage in the sky. Typically this section of training should last 30 minutes.

### **5. Hands-on Practice Session**

GPS technology is relatively simple to use, however it does require some practice for people to become proficient in its use. Therefore, it is vital that time be set aside in each training session for the users to practice collecting GPS data and filling out the GPS data collection forms. This hands-on training *must* be conducted outside and should last at least 60 minutes.

## GPS DATA COLLECTION IN THE FIELD

---

The following section presents general information and suggestions for collecting GPS data in the field, including when to collect data during the survey process and how to name and store the data.

### Determining the Appropriate Collection Approach

GPS data collection can take place during the listing process or during the administration of the survey itself. DHS fieldwork is often divided into two phases: the listing and the main fieldwork. After the survey population has been stratified and enumeration areas identified, teams go out to the field to carry out the listing. In each enumeration area or cluster that has been selected, all of the households must be identified on a sketch map. The final sample selection is drawn from the listed households. A DHS generally always has a listing component.

If a listing phase is part of the survey, the recommendation is for the teams to collect the GPS data during this time when they are not occupied with the survey itself. Because there are typically fewer listing teams than interviewing teams, fewer GPS receivers are required. Also, field supervisors are not preoccupied with the main survey so GPS data collection is easier to incorporate during this stage of the survey. Additionally, if any data needs to be re-collected this can be done during the survey.

If GPS data is collected during survey fieldwork, one GPS receiver per interviewing team is required. Since field supervisors are very busy with other responsibilities, GPS data collection is more likely to be forgotten or lower on the priority list. The GPS coordinator must pay careful attention in surveys where GPS data is collected during main survey fieldwork.

### Collecting GPS Data

One GPS location must be recorded for each site in the survey. For a DHS, the reading is collected at the center of the cluster. The location should be relatively open, away from tall buildings, and out from under tree canopy in order to receive adequate satellite signal strength.

DHS clusters are usually census enumeration areas, sometimes villages in rural areas or city blocks in urban areas. Collecting only one GPS location for the cluster greatly reduces the chance of compromising confidentiality of the respondents but it is enough to allow the integration of multiple datasets for further analysis.

A DHS typically conducts household interviews in 250 to 500 clusters. Each team usually visits 10 to 25 clusters depending on the topography of the area and total number of clusters to be surveyed. Many affordable GPS receivers have a maximum capacity of 500 stored points. It is unlikely that any one team would need to collect more than 500 points. If a team needs to collect more than that, special arrangements must be made. The GPS data can be downloaded to a laptop in the field (as long as each team has access to a laptop and PC cable) or the GPS receivers can be returned to the central office for downloading. The GPS receiver's memory can be cleared and sent back out for additional data collection.

## Establishing Naming Conventions

Each cluster's data must be saved in the GPS receiver's memory. The saved GPS data is called a waypoint and each waypoint has a unique name. When a waypoint is saved, the GPS receiver assigns it a default name. Normally the waypoint ID should be the same as the cluster ID. For example, some GPS receivers have a maximum number of characters for the waypoint ID. If the cluster ID is longer than 6 characters, an alternative naming convention must be established.

**FIGURE 1: NAMING CONVENTIONS FOR MULTIPLE TYPES OF LOCATIONS**

ID	Latitude	Longitude
104	+27.647116	+085.277370
105	+27.717165	+085.333155
108	+27.710256	+085.291103
129	+27.647104	+085.277059
130	+27.717111	+085.333042
141	+27.710240	+085.291169

When the waypoint is saved in the GPS receiver, the default name must be changed to the cluster ID. In some cases, it is necessary to include an alpha character or additional number to differentiate a particular location. For example, multiple readings may be recorded for one cluster. These scenarios should be determined prior to data collection so that all teams follow the same format.

### **Naming conventions must be strictly followed!**

## Collecting and Storing GPS Data

The GPS data for a cluster is stored in two places: in the GPS receiver and on a paper form. GPS receivers can be broken or lost and experience has shown that a hardcopy backup is essential. In addition, the paper form provides a backup should the data in the GPS receiver be changed, deleted, or misidentified (e.g. the operator names the cluster incorrectly in the GPS receiver). The paper form is where notes should be made in cases where multiple readings are recorded for one cluster. The GPS coordinator must be in charge of making sure the data management protocols are strictly followed.

These data should be captured in the GPS receiver and recorded on the GPS data collection form (for a sample collection form see Appendix 3: Sample GPS Data Collection Form):

- GPS receiver number
- GPS waypoint name (e.g. cluster ID, facility number, etc.)
- Latitude (in decimal degrees to at least 6 decimals)
- Longitude (in decimal degrees to at least 6 decimals)
- Altitude (in meters)



## **A Good GPS Location**

A “good” GPS location is outside in an open area far away from tall buildings and tree canopy. GPS data should not be collected indoors. If the GPS data represents multiple households or buildings, a “good” GPS point is located near the center of the structures.

It is sometimes difficult to get an open view of the sky in urban areas due to tall buildings. If you are unable to make sufficient contact with satellites from the center of the survey site, identify the closest large intersection or park. You are more likely able to connect with satellites from that location. Similarly, survey sites surrounded by many tall trees may not gain sufficient contact with satellites to record a GPS location. Move to the closest road, clearing, or other area with an open view of the sky.

Heavy clouds can also obstruct the ability of GPS receivers to obtain satellite signals. While not impossible, it will be more difficult to collect GPS data under heavy cloud cover or while it is raining. You may have to wait for the cloud cover to dissipate if it is preventing your GPS receiver from obtaining satellite signals.

## **Preventing Common Human Errors**

### *Duplicate or paired locations*

Duplicate and paired locations mean two or more waypoints were given the same latitude/longitude coordinate, or coordinates that are located only meters from each other. Duplicate and paired waypoints are considered an error unless otherwise documented and must be re-collected.

Pairing and duplication usually occurs when the GPS receiver has not made contact with enough satellites to calculate a new position and the receiver uses its last known location (the GPS coordinate of the previous cluster). Therefore, when pairing occurs, one waypoint - the first of the two - is often correct. To avoid duplicate and paired waypoints, wait until the GPS receiver indicates that it is ready before collecting a new waypoint.

GPS data collectors can check for duplicate and paired points while they are in the field using their GPS receivers. The GPS coordinator can also spot this type of error in a GPS utility software once the GPS receivers have been returned from the field.

### *Missing data*

Missing GPS data is easy to avoid but occurs often. This happens when the GPS data collectors either forgot to collect the data, or gave the wrong waypoint name in the GPS receiver. The GPS coordinator can easily identify missing waypoints in a GPS utility software by comparing the number of waypoints collected in the GPS receiver with the list of survey sites that should have been visited. If there are too few GPS points, the GPS coordinator identifies which clusters have no GPS data and ensures they are re-collected.

### *Hand-entry typos*

GPS data should be recorded in two places: 1) the GPS receiver and 2) a paper form. The GPS data collector hand-records the GPS data on a form provided. It is common for data entry errors to occur. The paper copy serves as a back-up if the data in the GPS receiver is lost or corrupted so it is very important to double check all hand-recorded data to ensure that it is accurate.

## PROCESSING GPS DATA

---

Common errors in GPS data can be identified when GPS data are simply displayed in a GPS utility software such as GPS Track Maker (specific instructions on how to use GPS TrackMaker are included in Appendix 6) or another geographic information system (GIS).

### Materials and Equipment Needed:

- GPS receivers (being used by the GPS data collectors)
- The USB cable specific to the GPS receivers
- The USB drivers for the GPS receivers
- A computer with a USB port
- GPS TrackMaker program (also free at [www.gpstm.com](http://www.gpstm.com)) or other GIS software

### Processing GPS Data

After the GPS data has been downloaded into a GIS, the data verification and validation process can begin. There are a few key things to verify when processing the data:

- Duplicate or paired point: This is the most common error and will usually appear as the same latitude and longitude but different waypoint IDs. Checking the date and time of the GPS reading can assist in verifying which point was taken first and thus is likely to be the correct waypoint number.
- Verify that the waypoints are located in the proper country, province/region, and where possible district or other lower administrative unit. This will require supplemental data that displays the administrative boundaries.
- Verify that all clusters have a latitude and longitude. If a point is missing information check the back-up paper collection form. If this is also missing, you may have to consider leaving that specific waypoint as missing or finding a proxy GPS location to use instead. A proxy might include the center of the village, a nearby health facility, or using a gazetting tool or Google Earth to find the location on a map.

## **LIST OF APPENDICES**

---

Appendix 1: Checklist for Project Manager

Appendix 2: Checklist for GPS Coordinator

Appendix 3: Sample GPS Data Collection Form

Appendix 4: Field Guide for GPS Waypoint Collection Using eTrex Legend H

Appendix 5: Field Guide for GPS Waypoint Collection Using eTrex 10

Appendix 6: Processing GPS Data Using GPS TrackMaker

## **APPENDIX 1:**

### **CHECKLIST FOR PROJECT MANAGER**

---

#### **Six months prior to any fieldwork...**

- ✓ Schedule GPS data collection, preferably during listing process
- ✓ Identify number of teams to calculate hardware needs
- ✓ Order equipment:
  - ✓ One GPS receiver per team plus 2 backups
  - ✓ Four times the number of batteries required per GPS receiver or sufficient quantities of chargers
  - ✓ At least two PC cables
  - ✓ One copy of a GPS utility software

#### **Three months prior to fieldwork...**

- ✓ Identify and train GPS coordinator
- ✓ Coordinate general GPS training

## **APPENDIX 2:**

### **CHECKLIST FOR GPS COORDINATOR**

---

#### **At the beginning of GPS data collection...**

- ✓ Clear out any existing waypoints in all receivers and set receivers to correct data display formats (Datum: WGS84; Position format: decimal degrees, i.e., hdd.ddddd; Units: metric)
- ✓ Set the time and date on the GPS receivers
- ✓ Log out all GPS receivers and other supplies by recording serial and team numbers

#### **During data collection...**

- ✓ Spot check field teams throughout GPS data collection to make sure data are saved in GPS receivers and on paper forms
- ✓ Verify data in GPS receivers against the paper form
- ✓ Monitor waypoint naming convention

#### **After data collection...**

- ✓ Log in GPS receivers and return supplies to central office
- ✓ Ensure that GPS data were collected for each survey cluster
- ✓ Download data from all GPS receivers
- ✓ Enter data collected on paper forms in Excel or a similar program
- ✓ Verify that GPS receiver data and data collected on paper match
- ✓ Ensure that any missing data are re-collected
- ✓ Send copies of both datasets back to the managing institution

## Incorporating Geographic Information into Demographic and Health Surveys

13

**PAGE INTENTIONALLY LEFT BLANK**

## APPENDIX 4: FIELD GUIDE FOR GPS WAYPOINT COLLECTION USING ETREX LEGEND H

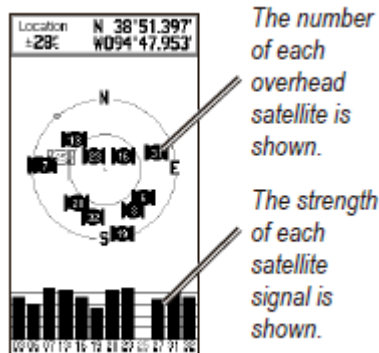
---

### *How to Set-up the GPS Receiver:*

*Insert two AA batteries...*

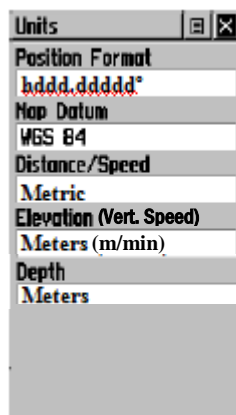
1. Remove the battery panel on the rear of the receiver.
2. Flip the small metal handle and rotate counter-clockwise to open the battery compartment.
3. Insert two AA batteries
4. Replace the battery panel.

*Turn GPS Receiver On...*

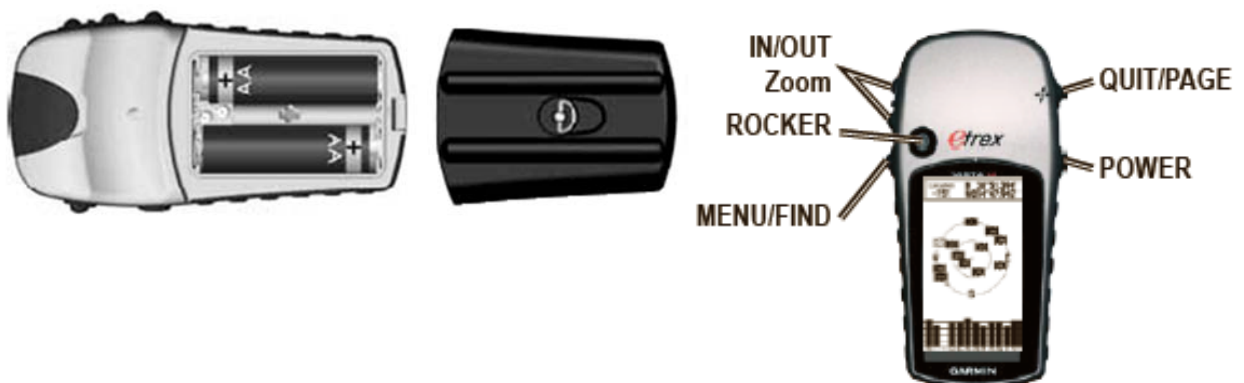


1. Press the POWER button.
2. The first screen says "Wait... Tracking Satellites."
3. After 1-3 minutes, the GPS receiver should acquire a number of satellite signals and display the message "Ready to Navigate Accuracy: XX m."

*Set position format, datum, and distance unit...*



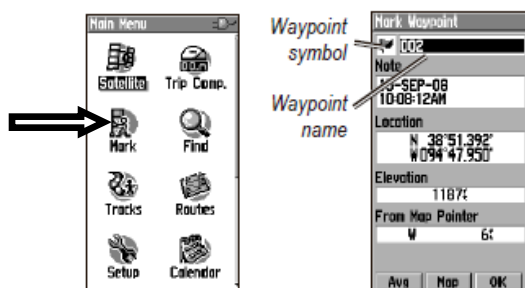
1. Press QUIT/PAGE until you arrive at the MENU screen.
2. Using the ROCKER, scroll to SETUP and press the ROCKER.
3. In the SETUP sub-menu, scroll to UNITS. Press the ROCKER.
4. A screen appears called UNITS. Set these units:  
Position Format: hddd.ddddd°  
Map Datum: WGS 84  
Distance/Speed: Metric  
Elevation (Vert. Speed): Meters (m/min)  
Depth: Meters
  - a. Using the ROCKER, highlight the unit (ex. Position Format) you wish to change. Press the ROCKER.
  - b. Scroll to the correct unit using the ROCKER. Press the ROCKER. for each receiver.





## How to Collect and Edit GPS Waypoints:

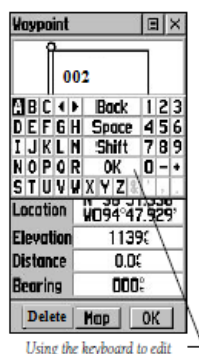
Collect a GPS waypoint....



1. Turn the GPS receiver on by holding the POWER button.
2. The first screen says "Wait... Locating Satellites."
3. After 1-3 minutes, the GPS receiver should say "Ready to Navigate Accuracy: X meters."
4. Press PAGE until you reach the MENU screen. Press the ROCKER.
5. Highlight MARK on the MENU screen. Press the ROCKER.
6. Using the ROCKER, highlight the GPS point number then press the ROCKER.
7. A screen appears with a keypad. Using the ROCKER, change the waypoint name to the Cluster Number. Press the OK.
8. Again using the ROCKER, scroll to OK and press the ROCKER.
9. Record the waypoint name, latitude, longitude, and altitude on a GPS Data Collection Form.

## If You Need to:

Edit a GPS waypoint name...



\*\*\*\*\*

1. From the MENU page, use the ROCKER to highlight FIND. Then press the ROCKER.
2. Using the ROCKER, highlight Waypoints and press the ROCKER.
3. Navigate to the point you would like to edit using the ROCKER, and press the ROCKER.
4. A screen appears called Waypoint. To edit a previously stored GPS point, use the ROCKER to highlight the waypoint name and press the ROCKER.
5. A screen appears with a keypad. Using the ROCKER, change the waypoint name to a Cluster Number. Press QUIT/PAGE.

Review the location of a GPS waypoint...

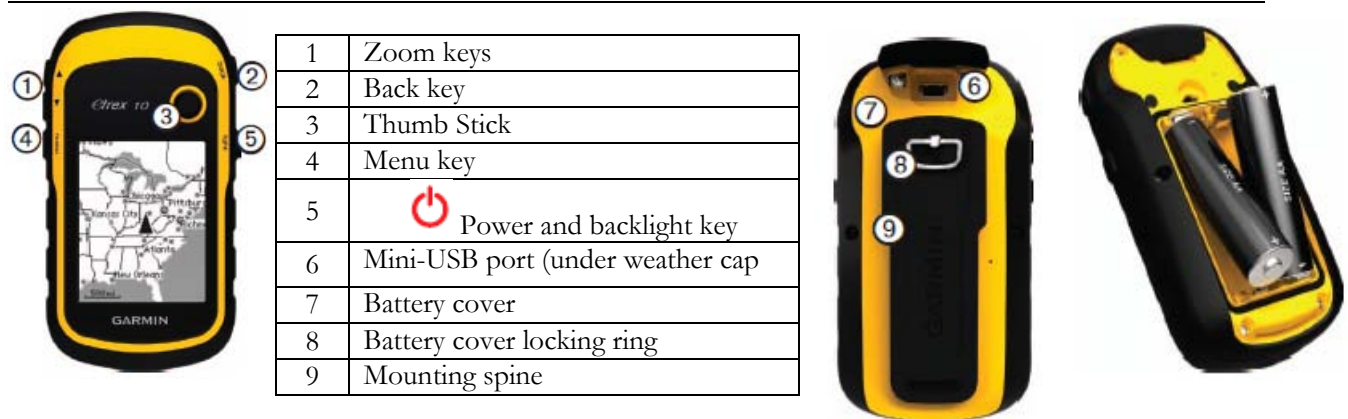
1. From the MENU page, use the ROCKER to highlight FIND. Then press the ROCKER.
2. Using the ROCKER, highlight Waypoints and press the ROCKER.
3. Navigate to the point you would like to edit using the ROCKER, and press the ROCKER.
4. A screen appears called Waypoint. Using the ROCKER, highlight the waypoint name and press the ROCKER.
5. To view the location of a stored GPS point, use the ROCKER to highlight the MAP button and press the ROCKER.
6. This will display a rough map of the points collected.

Delete a GPS waypoint...

If the GPS data collector realizes that waypoints are incorrectly paired, (s)he should delete, then re-collect the incorrect waypoints.

1. From the MENU page, use the ROCKER to highlight FIND. Then press the ROCKER.
2. Using the ROCKER, highlight Waypoints and press the ROCKER.
3. Navigate to the point you would like to edit using the ROCKER, and press the ROCKER.
4. Use the ROCKER, highlight DELETE and press the ROCKER.
5. The message "Do you really want to delete waypoint XXX?" appears. Press the ROCKER to select Yes.
6. Follow the steps above to "Collect a GPS Waypoint."

## APPENDIX 5: FIELD GUIDE FOR GPS WAYPOINT COLLECTION USING ETREX 10



### How to Set-up the GPS Unit:

Insert two AA batteries...

1. Remove the battery panel on the rear of the unit.
2. Flip the small metal handle and rotate counter-clockwise to open the battery compartment.
3. Insert two AA batteries and replace the battery panel.

Turn GPS receiver on...



4. Press the POWER button.
5. The first screen is the MENU screen. Using the THUMB STICK, scroll down to SATELLITE and press the THUMB STICK.
6. After 1-3 minutes, the GPS receiver should acquire a number of satellite signals. The "Acquiring Satellites" message will disappear from the screen, and the solid GPS bars will appear on the screen.

Set position format, datum, and distance units...




5. Press the BACK button until you arrive at the MENU screen.
6. Using the THUMB STICK, scroll to and press the THUMB STICK.
7. In the SETUP sub-menu, scroll to SYSTEM. Press the THUMB STICK.
8. Scroll to SATELLITE SYSTEM and press the THUMB STICK.
9. In the SATELLITE SYSTEM sub-menu use the THUMB STICK to scroll to GPS + GLONASS and press the THUMB STICK.
10. Press the BACK button once to return to the SETUP sub-menu and scroll down to UNITS. Press the THUMB STICK.
11. A screen appears called UNITS. Set these units:
  - Distance and Speed: Metric
  - Elevation (Vertical Speed): Meters (m/min)
    - a. Using the THUMB STICK, highlight the unit (ex. Position Format) you wish to change. Press the THUMB STICK.
    - b. Scroll to the correct unit using the THUMB STICK. Press the THUMB STICK.
12. Press BACK to the SETUP sub-menu. Scroll down to POSITION FORMAT. Press the THUMB STICK. Set these units:
  - Position Format: hddd.ddddd°
  - Map Datum: WGS 84
  - Note:* When the Map Datum is set to WGS 84 the Map Spheroid should automatically update to WGS 84.
13. Repeat for each GPS unit.


## How to Collect and Edit GPS Waypoints:

### Collect a GPS waypoint...





1. Turn the GPS receiver on by holding the POWER button.
2. The first screen is the MENU screen. Using the THUMB STICK, scroll down to SATELLITE and press the THUMB STICK.
3. After 1-3 minutes, the GPS receiver should acquire a number of satellite signals. The “Acquiring Satellites” message will disappear from the screen and solid GPS bars will appear on the screen.
4. Press BACK until you reach the MENU screen.
5. Use the THUMB STICK to highlight  on the MENU screen. Press the THUMB STICK.

*Note:* Be careful when selecting the MARK WAYPOINT button, as there are two other waypoint buttons in the MENU.

6. Using the THUMB STICK, highlight the waypoint name at the top of the screen next to the , then press the THUMB STICK.
7. A screen appears with a keyboard. Using the THUMB STICK, change the waypoint name.
8. Using the THUMB STICK, scroll to DONE and press the THUMB STICK.
9. On the next screen, scroll to DONE and press the THUMB STICK.
10. Record the waypoint name, latitude, longitude, and altitude on a GPS Data Collection Form.

### Rename a GPS waypoint...



1. From the MENU page, use the THUMB STICK to highlight . Then press the THUMB STICK.
2. Navigate to the waypoint you would like to edit using the THUMB STICK, and press the THUMB STICK.
3. Using the THUMB STICK, highlight the waypoint name at the top of the screen next to the , then press the THUMB STICK.
4. A screen appears with a keyboard. Using the THUMB STICK, change the waypoint name.
5. Press the DONE button on the keyboard.
6. Press the BACK button twice to return to the main MENU page.

### Review the location of a GPS waypoint...

1. From the MENU page, use the THUMB STICK to highlight WAYPOINT MANAGER. Then press the THUMB STICK.
2. Navigate to the waypoint you would like to edit using the THUMB STICK, and press the THUMB STICK.
3. A screen appears with the waypoint information. Using the THUMB STICK, highlight the MAP button and press the THUMB STICK.
4. This will display a map of the waypoint. If the GPS data collector realizes that a waypoint was incorrectly saved, (s)he should delete, then recollect the incorrect waypoints.

### Delete a GPS waypoint...



1. From the MENU page, use the THUMB STICK to highlight WAYPOINT MANAGER. Then press the THUMB STICK.
2. Navigate to the waypoint you would like to edit using the THUMB STICK, and press the THUMB STICK.
4. Press the MENU button. Then use the THUMB STICK to highlight the Delete button and press the THUMB STICK.
5. The message “Do you really want to delete waypoint XXXXXX?” appears. Press the THUMB STICK to select Yes.
6. Follow the steps above to “Collect a GPS waypoint.”

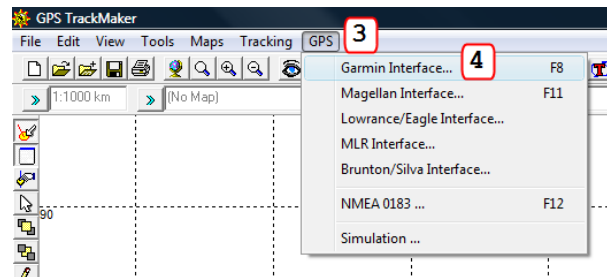
## APPENDIX 6: PROCESSING GPS DATA USING GPS TRACKMAKER

### Install GPS TrackMaker

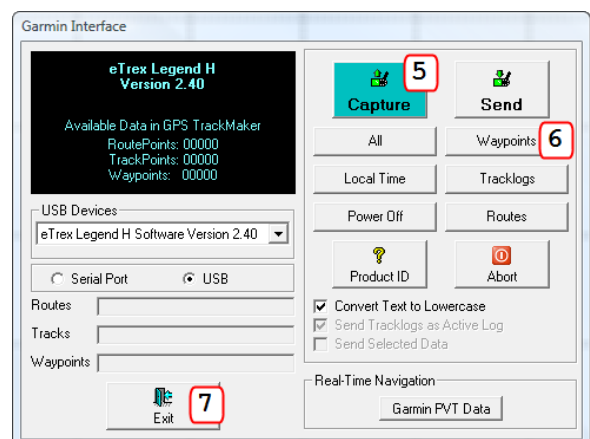
1. Download the current version of GPS TrackMaker (gtm138.exe) from their website <http://www.gpstm.com/dwlpag.php>.
2. Follow the prompts to complete the installation.

### Download Waypoints from the GPS Receiver

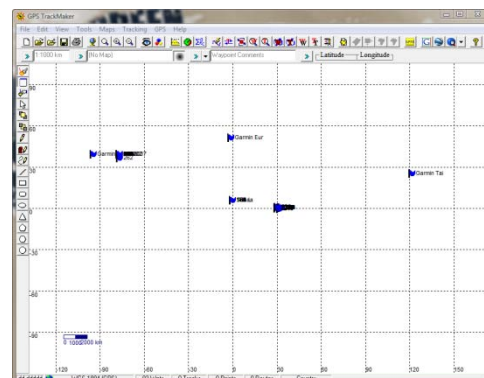
1. Plug the GPS receiver into the computer using the USB cable.
2. Turn the GPS receiver on.
3. Open GPS TrackMaker and click on the GPS tab.
4. Select Garmin Interface. A box will pop up on the screen.



5. Click the Capture button. If you receive a no data message make sure your GPS receiver is turned on.
6. Click the Waypoints button. The waypoints will be downloaded to your computer.
7. Click the Exit button.



8. The waypoints should appear on your screen. If they do not appear click on the view tab and check the waypoints selection.

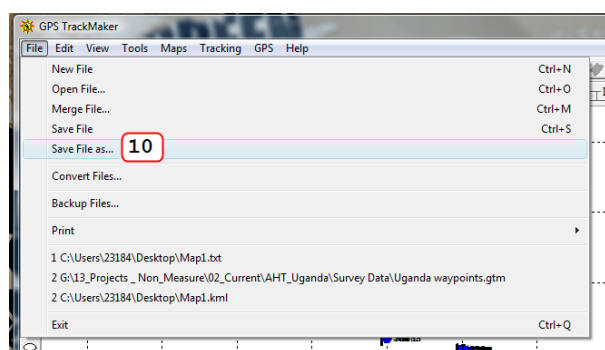


9. Repeat for each GPS receiver that contains data.

## Export GPS Waypoints from GPS TrackMaker and Email to MEASURE DHS

The GPS Coordinator should email GPS waypoints to the Country Manager at MEASURE DHS. The waypoints should be exported in one of the following formats: GPS TrackMaker (\*.gtm) or text (\*.txt). It is easiest to send one file for each GPS receiver.

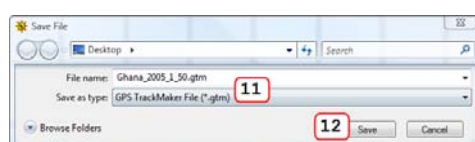
10. Go to File in the menu bar, and select Save File As.



11. Navigate to where you would like to save the file.

- a. Include the survey country, year, and starting and ending waypoint numbers in the file name (e.g. Ghana\_2005\_1\_50.gtm)
- b. Select the file type - either: GPS TrackMaker File (\*.gtm) or GPS TrackMaker Text Format (\*.txt).

12. Click Save.



13. Email all files to the Country Manager.

## **APPENDIX 7: TRANSFERRING GPS COORDINATES FROM CSPro TO THE GPS UNITS**

---

### **Introduction**

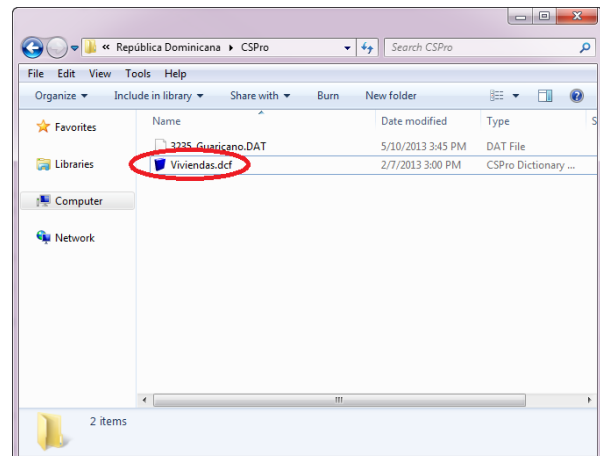
This section describes how to transfer the GPS coordinates for the sampled households from CSPro to the GPS units where they will be stored as “Waypoints”. The Waypoints will be used by the field team to navigate from one selected structure to another during the interviews and by the quality control team. This guide should be used by the GPS Coordinator.

### **Materials and equipment needed**

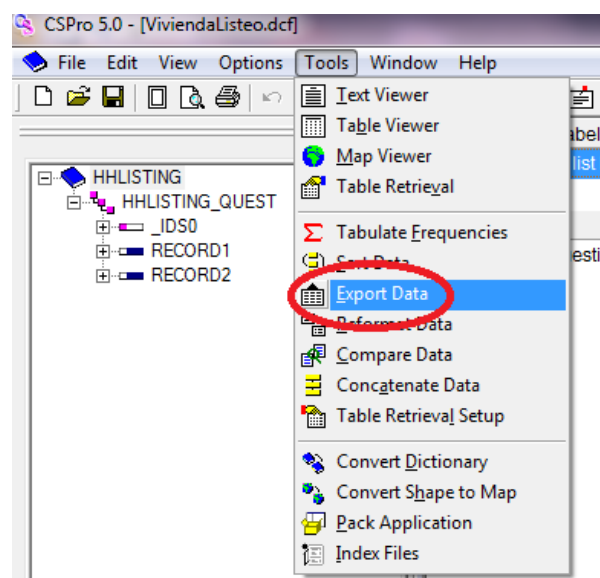
- GPS units (being used by the GPS data collectors)
- The serial cable or USB cable specific to the GPS unit
- A computer with a serial or USB port and the following programs installed:
  - CSPro
  - Microsoft Excel
  - Notepad
  - The GPS TrackMaker program (for installation of TrackMaker see Appendix 6)
- The listing data for the sampled households including the latitude/longitude coordinates. One CSPro .DAT file for each EA.

## Export list of sampled households from CSPro to Excel

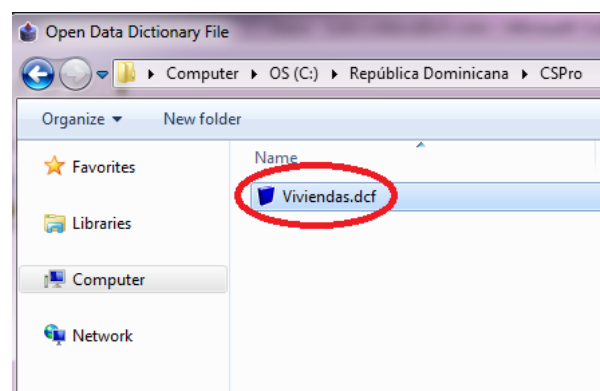
1. Open the CSPro dictionary file (with a .dcf suffix)



2. In CSPro, select Export Data from the Tools menu

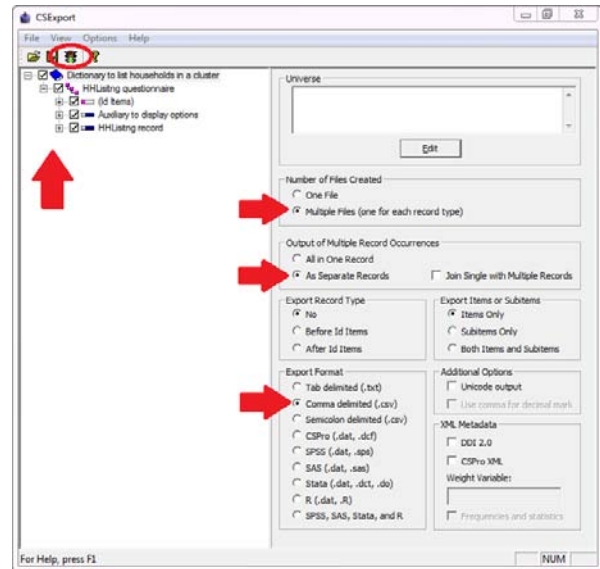


3. In the “Open Data Dictionary File” window, select the same .dcf file and click Open



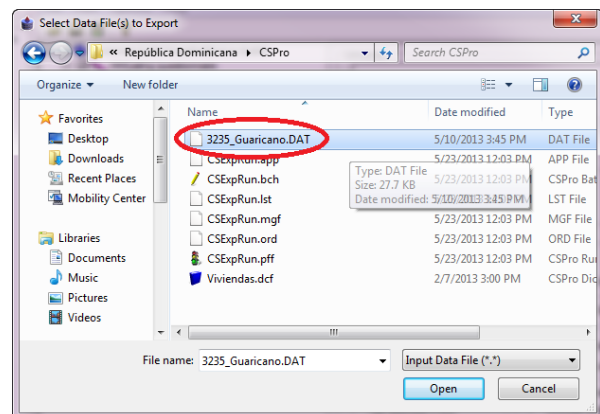


4. In the CSEXPOT window, make the following selections:
  - a. Check all of the boxes in the panel on the left.
  - b. Under “Number of Files Created” select “Multiple Files (one for each record type)”
  - c. Under “Output of Multiple Record Occurrences” select “As Separate Records”
  - d. Under “Export Format” select “Comma delimited (.csv)”



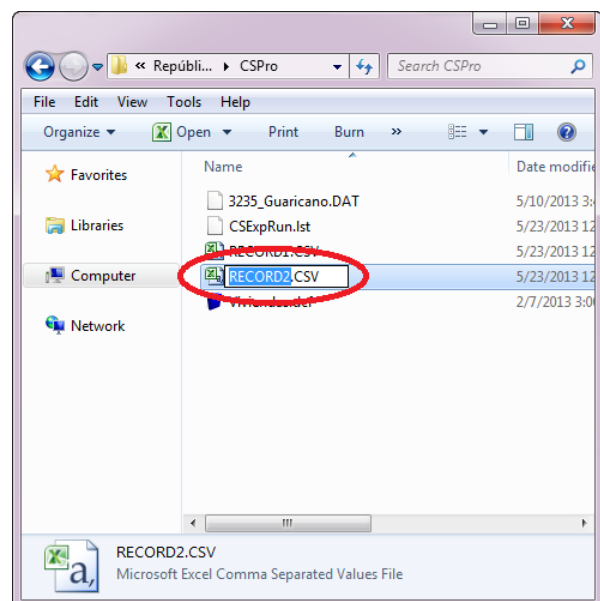
5. Click the export icon

6. In the “Select Data File(s) to Export” window, select the data file (with the .DAT suffix) for the cluster you want and click Open.



7. Close the CSPRO Text Viewer window that will open automatically.

8. Two new Microsoft Excel Comma Separated Values Files will have been saved on your computer in the same folder as the .DAT file. You may wish to rename them with the cluster name or number.



9. Open the file named RECORD2.CSV



## Convert list of sampled households into a comma-separated text file

10. Open the Excel waypoint template file

11. Copy the data from the spreadsheet exported from CSPro to the template file as follows:

- Copy the data in the column named LNUMBER into column C of the template
- Copy the data in the column named LLAT into column D of the template
- Copy the data in the column named LLONG into column E of the template
- Copy the data in the column named LNOTES into column F of the template

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
1	Version	212												
2														
3	WGS 1984	217	6378137	298.2572	0	0	0							
4	USER GRIC	0	0	0	0	0								
5														
6	w	d					00/00/00	0:00:00	0	2	48	0	13	
7	w	d					00/00/00	0:00:00	0	2	48	0	13	
8	w	d					00/00/00	0:00:00	0	2	48	0	13	
9	w	d					00/00/00	0:00:00	0	2	48	0	13	
10	w	d					00/00/00	0:00:00	0	2	48	0	13	
11	w	d					00/00/00	0:00:00	0	2	48	0	13	
12	w	d					00/00/00	0:00:00	0	2	48	0	13	
13	w	d					00/00/00	0:00:00	0	2	48	0	13	
14	w	d					00/00/00	0:00:00	0	2	48	0	13	
15	w	d					00/00/00	0:00:00	0	2	48	0	13	
16	w	d					00/00/00	0:00:00	0	2	48	0	13	
17	w	d					00/00/00	0:00:00	0	2	48	0	13	
18	w	d					00/00/00	0:00:00	0	2	48	0	13	
19	w	d					00/00/00	0:00:00	0	2	48	0	13	
20	w	d					00/00/00	0:00:00	0	2	48	0	13	
21	w	d					00/00/00	0:00:00	0	2	48	0	13	
22	w	d					00/00/00	0:00:00	0	2	48	0	13	
23	w	d					00/00/00	0:00:00	0	2	48	0	13	
24	w	d					00/00/00	0:00:00	0	2	48	0	13	
25	w	d					00/00/00	0:00:00	0	2	48	0	13	
26	w	d					00/00/00	0:00:00	0	2	48	0	13	
27														

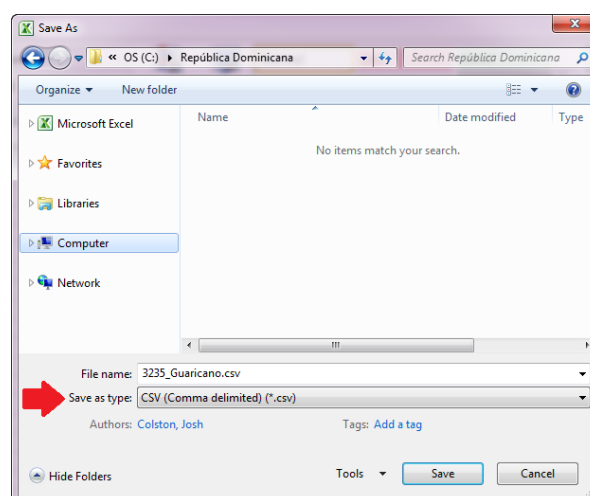
12. Under the File menu, choose Save As

13. Choose the name that you want to save the file under (it should contain the name or number of the cluster)

14. Under the “Save as type” drop-down menu, select “CSV (Comma delimited) (\*.csv)”

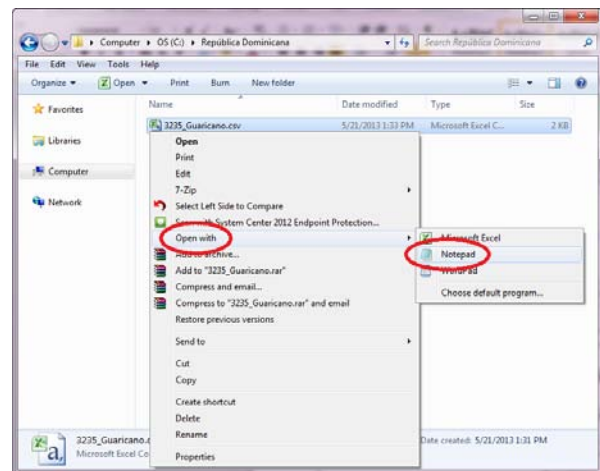
15. Click save. When asked “Do you want to keep the workbook in this format?” click “Yes”

16. Exit Excel. Do not save changes when prompted (you have already saved everything you need).



17. In windows, right-click on the file that you have just saved

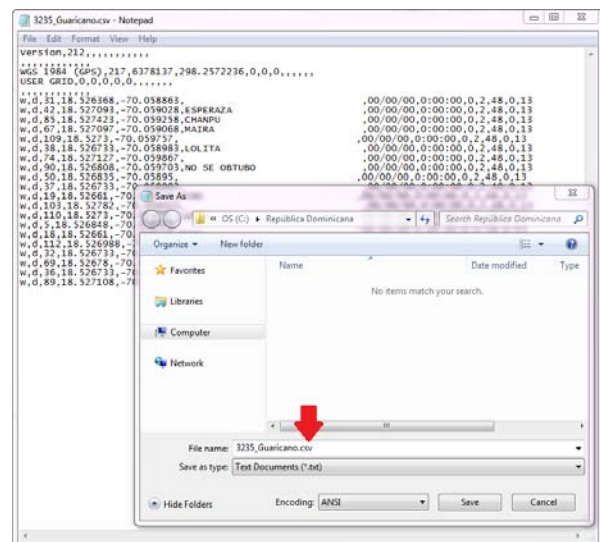
18. Hover the mouse over “Open with...” and choose Notepad from the menu.



19. In the open Notepad document, go to the File menu and select Save As

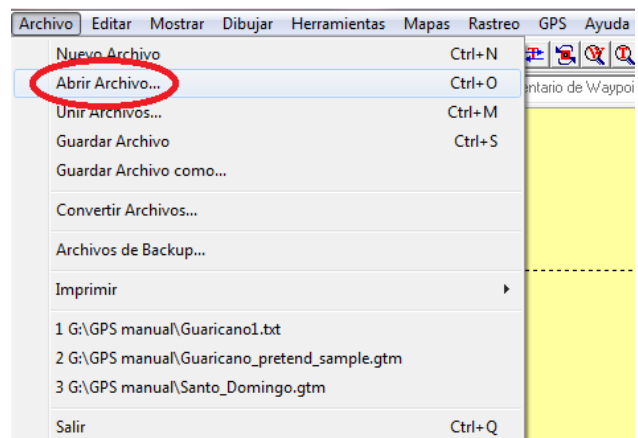
20. In the “File name:” box of the Save As window, change the suffix of the file name from “.csv” to “.txt”

21. Click save

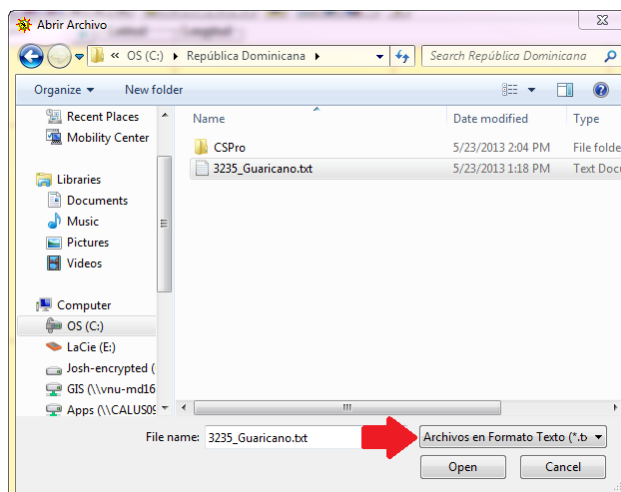


## Upload waypoints on the computer using GPS TrackMaker

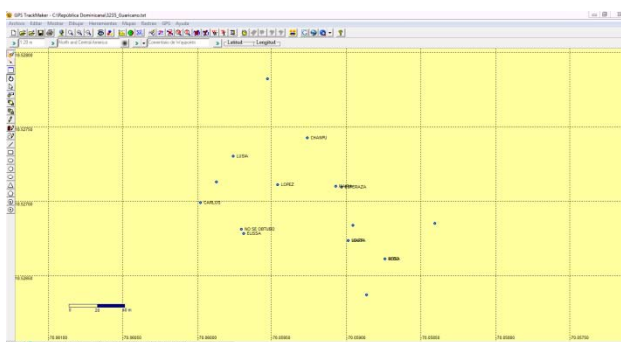
1. Launch GPS Track Maker and go to File/Open file



2. In the Open File window, find the text document that you have just saved. Make sure that “Text Format Files (\*.txt)” is selected from the drop-down menu next to the File Name box.
3. Select the document and click Open.

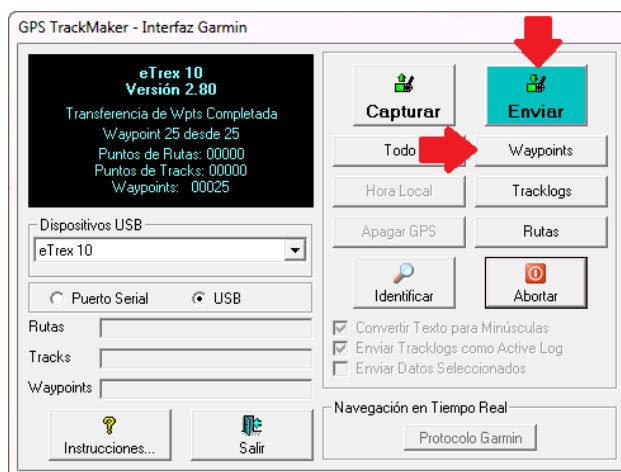
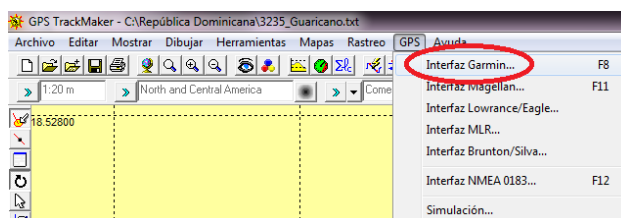


4. The waypoints will be displayed on the screen



## Upload waypoints to the GPS unit

1. Plug the GPS unit into the computer using the serial or USB cable.
2. In GPS TrackMaker, click on the GPS tab.
3. Select Garmin Interface.
4. In the Interface window that will open, click on the Product ID button. The black box will update showing the specifications of the GPS unit being used
5. Click the Send button so that it is highlighted
6. Click the Waypoints button. The waypoints will upload from your computer to the GPS unit.
7. When it says “Waypoint Transfer Completed” in the black box, click the



exit button

The GPS unit is now ready to be used in the field

### *Navigating to a waypoint in the field*

1. From the MENU page, use the THUMB STICK to highlight WHERE TO? Then press the THUMB STICK.
2. Use the THUMB STICK to highlight WAYPOINTS then press the THUMBSTICK.
3. Select the waypoint you would like to navigate to from the list using the THUMB STICK, and press the THUMB STICK.
4. Press the THUMB STICK to select GO on the next screen.
5. The map page opens with your route marked with a thick line. ▲ represents your location on the map. As you travel towards your destination, ▲ moves.

Note that the device only displays the 19 closest waypoints in order of proximity. As you mark earlier ones as found, the hidden ones will appear at the bottom of the list. You can still search for any particular waypoint stored on the device using a spell search as follows:

1. From the MENU page, use the THUMB STICK to highlight WAYPOINT MANAGER then press the thumb stick
2. The screen will show the list of waypoints. Press the MENU button on the left-hand side of the device
3. A small window will appear with three options on it. The Spell Search option will already be highlighted. Press the THUMBSTICK.
4. Use the THUMBSTICK to type the number of the waypoint that you are looking for. Then use the THUMBSTICK to highlight Done and press the THUMBSTICK.
5. Highlight the waypoint you want, then press the THUMBSTICK. On the next screen, highlight Go and press the THUMBSTICK.

