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Using Handheld Global Positioning System Receivers for the June Area Survey

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EXECUTIVE SUMMARY

In 2005, the Washington Field Office (WA FO) and the Research and Development Division (RDD) demonstrated that handheld Global Positioning System (GPS) receivers could be utilized successfully for the Agricultural Resource Management Survey Phase II (ARMS II). Afterwards, the WA FO and RDD explored the use of GPS receivers for the June Area Survey.

Currently, June Area Survey field enumerators use county-highway maps and aerial photos to reach sampled segments outlined on the aerial photos for enumeration. Sometimes there are no road signs and the geography of the land is so similar that determining where a particular segment is located can be time consuming and could lead to collecting information for the wrong land area, which would adversely affect data quality. Hence, this research project's primary goal was to see if handheld GPS receivers could assist enumerators in locating sampled segments.

Thirty-nine Washington field enumerators were provided with handheld GPS receivers previously used for the ARMS II. Additionally, the centroids (center points of the segments) were provided on the back of the aerial photos for each of Washington's 267 segments. Field enumerators could then compare their GPS receiver's reading with the segment's centroid to verify if they were in the general vicinity of the segment or several miles away. The GPS receivers could not display where the boundary lines of the segments were, but rather would only assist the enumerators in reaching the general vicinity of each segment.

For each segment, the enumerators were instructed to complete a feedback form pertaining to whether the GPS receivers were needed and if so, helpful or not. Of the 267 segments enumerated, 198 feedback forms were returned. The GPS receivers were used to locate/verify the locations of 25 segments. Eight times the enumerator found the GPS receiver useful in locating the segment. The remaining 17 times the receivers were used for verification purposes.

This limited use of GPS receivers was due to four reasons. First, the field enumerators had enumerated 241 of these segments last year. Each year only 20 percent of the segments are replaced with new segments and since the field enumerators are typically assigned segments by their geographical location, they will likely return to many of the same segments for several years. Second, the enumerators typically work around the area they reside and thus acquire knowledge of the surrounding agricultural operations and the local area itself. Third, the field enumerators were instructed to use their GPS receivers only if they were unable to locate the sampled segments through conventional means. Finally, the enumerators were simply able to use their county-highway maps and aerial photos to locate the segments. Although these reasons for not using the GPS receivers weren't unexpected, the project did show that the GPS receivers helped the enumerators locate some segments which likely saved time and may have lessened the chance of collecting data for wrong areas.

The next page shows the Cost/Benefit of using GPS receivers for the June Area Survey in Washington.

Cost-Benefit Summary:

Costs	Benefits
• \$50 Batteries and miscellaneous supplies. • 1 hr. Statistician time in preparing and training enumerators. • \$160 Total enumerator training expenses.	• Helped enumerators locate 8 segments (3 percent). • Used for verifying the location of 17 segments (6 percent). • Re-use the GPS receivers over multiple years and for other projects such as for ARMS II.

RECOMMENDATION

1. Recommend field offices already having Global Positioning System (GPS) receivers use them for the June Area Survey since, with minimal expense, there is potential to improve data quality and save enumeration time. However, do not recommend purchasing GPS receivers for additional field offices since the savings were not measurable.

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Michael W. Gerling[1/]

Abstract

The National Agricultural Statistics Service (NASS) surveys United States' and Puerto Rico's agriculture for the purpose of making estimates on crops, livestock, production practices, farm economics, etc.

One of these surveys is the annual June Area Survey. The survey requires field enumerators to physically go to sampled land areas (segments) designated on aerial photos and collect information on agricultural activity within the land area. Sometimes these land areas are difficult to find due to similarity in geography and missing road signs.

In 2005, NASS researched whether handheld Global Positioning System (GPS) receivers would be helpful in locating the sampled segments. All aerial photos contained the latitude and longitude coordinates of the centroid of the segments for the enumerators to compare with their readings on the GPS receivers. Field enumerators could then tell if they were in the general location of a segment or miles away.

KEY WORDS: Agricultural Survey, Data Collection, GPS, Segment

1. INTRODUCTION

The National Agricultural Statistics Service's (NASS) primary purpose is to provide timely, accurate and useful statistics on United States and Puerto Rico agriculture. NASS conducts hundreds of surveys for the purpose of making estimates on crops, livestock, production practices, farm economics, etc.

The June Area Survey (JAS) is conducted annually and collects

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agricultural information for sampled land areas, referred to as segments. Field enumerators were provided with handheld Global Positioning System (GPS) receivers to see if these devices would help in locating segments for the 2005 June Area Survey.

2. JUNE AREA SURVEY

The June Area Survey provides information about U.S. crops, livestock, grain storage capacity, and type and size of farms. The June Area Survey's sample is comprised of designated land areas (segments) which field enumerators visit to collect data on all agricultural activity occurring within the segments. Each segment is outlined on an aerial photo which is provided to the appropriate field enumerator. A typical segment is about one square mile, which is equivalent to 640 acres.

3. ARMS II TO JAS

In 2005, NASS' Washington Field Office (WA FO) and NASS' Research and Development Division (RDD) successfully showed that handheld Global Positioning System receivers could be used for the Agricultural Resource Management Survey Phase II (ARMS II). See Gerling, 2005. The WA FO and RDD next investigated using GPS receivers for the June Area Survey. This research project's goal was to see if GPS receivers could assist field enumerators in locating the June Area Survey segments.

4. WHAT IS A GPS HANDHELD RECEIVER?

The Global Positioning System is comprised of at least twenty-four satellites orbiting the earth. These satellites transmit signals to GPS receivers on the ground. The majority of GPS receivers are about the size of a standard television remote control.

A GPS receiver only receives signals from the satellites. It does not transmit. To function properly, a GPS receiver requires an unobstructed view of the sky.

First, the GPS receiver acquires signals from these various satellites. Next, the GPS receiver determines the location of the satellites from the information included in the satellites' transmissions. The receiver then determines the distance it is from each satellite. Finally, the receiver is able to determine where it is actually located on the Earth within a certain degree of accuracy.

The receiver will display its location in latitude and longitude coordinates. Latitude measures the distance north or south from the Equator while longitude measures the distance east and west from the Prime Meridian.

A common use of GPS receivers is for hiking. Hikers utilize these receivers to trace their trail or to mark a unique location that they would like to return to at a later date.

The particular GPS receiver used was the Garmin GPS-72. See Figure 1. These GPS receivers were the same receivers purchased and used for the ARMS II research project conducted in the fall of 2004. At that time Garmin was selected because the company was a respected manufacturer of GPS receivers for 15 years. The GPS-72 model was also among the lowest-price GPS receivers ($150) offering Wide Area Augmentation System (WAAS). WAAS provides the potential to obtain a level of accuracy of ten feet. Typically, the GPS-72 receiver will provide a level of accuracy between 10 and 50 feet.

Figure 1: Garmin GPS-72

5. THE RESEARCH PROJECT

Thirty-four of Washington's 39 field enumerators working the June Area Survey were supplied with a Garmin GPS-72 receiver. Not all field enumerators were supplied with a receiver since one field supervisor had miscommunicated the number of enumerators working the survey. These field enumerators, however, were able to share the allocated GPS-72 receivers.

Washington's 2005 JAS sample size was 267 segments. The centroid (center point) was provided on the back of each segment's aerial photo.

The field enumerators were instructed to use their GPS receivers if they were unable to locate the sampled segments using their county-highway maps and aerial photos.

The GPS receiver would display the enumerator's location in latitude and longitude coordinates. The field enumerators would then compare their GPS coordinates with those on the aerial photos. Finally, using their provided handouts on distances, the enumerators would determine if they were in the general vicinity or several miles from the segment. The handout contained a conversion chart showing what the difference in degrees, minutes, and seconds between two points equates to in feet and miles. The GPS receivers could not display where the boundary lines of the segments were, but rather would only assist the enumerators in reaching the general vicinity of each segment.

They were also instructed to complete an enumerator feedback form for each sample asking if the GPS receiver was needed and if so, helpful or not. See Appendix A for a copy of the Enumerator-Feedback Form.

6. ENUMERATOR TRAINING

Each year a June Area Survey Workshop is conducted to review details of the survey and data collection procedures. Educating all 39 field enumerators on how to use the GPS receiver was incorporated into the workshop.

The GPS receiver training took approximately 20 minutes. Fourteen of the 39 field enumerators were new to using a GPS receiver. The other 25 field enumerators had used GPS receivers for ARMS II. An instructional handout was provided, explaining the use of the GPS receivers and how to convert the difference between the GPS receiver's coordinates with that of the aerial photo's coordinates in order to determine how far he/she is from the center point of the segment. See Appendix B for a copy of the instructional handout.

7. FINDINGS

Despite being a requirement, only 198 enumerator feedback forms out of a possible 267 forms, were returned. The following numbers are based on these 198 feedback forms, unless otherwise noted.

Eleven (28%) of the 39 enumerators used the GPS receivers to find or verify the location of 25 segments. This equates to nine percent of the 267 segments. This limited GPS receiver usage was primarily due to four reasons. First, the field enumerators were instructed to use their GPS receivers only if they were unable to locate the sampled segments through conventional means. Second, the field enumerators had enumerated 241 of the 267 segments last year. Each year approximately 20 percent of the segments are replaced with new segments and since the field enumerators are typically assigned segments by their geographical location, enumerators likely return to many of the same segments each year. Third, the enumerators typically work around the area they reside and thus acquire knowledge of the surrounding agricultural operations and the local area itself. Finally, the enumerators were simply able to use their county-highway maps and aerial photos to locate the segments.

For eight of these 25 segments, the enumerators stated that the GPS receivers helped them locate the segment. For the other 17, the GPS receivers were used to verify that the enumerator was in the general vicinity of the segment. However, one enumerator accounted for eight of these verifications.

There were 41 new segments rotated in Washington's JAS. As stated earlier, approximately 20 percent of the segments are replaced by new segments each year. The receivers were used in finding seven (17%) of these 41 new segments. Table 1 displays some of these findings.

Table 1: GPS Receiver Usage

Description	Segments		Number of Enumerators 3/
	Count	Percent	
GPS receivers used to locate segment.	8 1/	3	6
GPS receivers used to verify segment location.	17	6	6
GPS receivers not used to locate/verify segment.	242 2/	91	28 4/
Total	267	100	39 5/

1/ Seven of the eight segments were new segments.
2/ Assumes those segments without returned feedback forms didn't require a GPS receiver.
3/ Enumerators may be counted more than once.
4/ Number of enumerators not using GPS receivers at all.
5/ Total number of enumerators (not double counted).

All of the enumerators stated that for the next JAS, they would like to be provided with one of the coordinates of a segment's side, particularly the side that overlays a road. The enumerators felt that finding the road that coincided with a side of the segment would help in locating the segment.

The enumerators also wanted instructions on how to enter and locate waypoints. A waypoint is a stored point (latitude and longitude) in the GPS receiver. The receiver will display the direction and distance to this stored point. This would provide enumerators with the ability to enter the coordinates of a segment's centroid and then have the receiver calculate the distance and direction to the centroid. The WA FO and RDD staff decided to instruct the field enumerators only on the basic functionality of the GPS receivers first and perhaps next year introduce more advanced topics like waypoints.

Finally, if GPS receivers were to be adopted for the June Area Survey, perhaps requiring the enumerators to use their GPS receivers for at least verification of their location to that of the segments' might be worthwhile.

8. COST - BENEFIT ANALYSIS

A cost/benefit analysis was conducted to determine if using GPS receivers for the June Area Survey is practical and cost efficient.

The WA FO already had 34 GPS receivers from an earlier research project involving ARMS II. Miscellaneous supplies (batteries, paper, printing costs, etc) totaled $50. Enumerator training cost $160. Also, one hour of a statistician's time was needed to prepare and conduct the training at the JAS Enumerator Workshop.

Hence, the total additional "out of pocket" cost of using GPS receivers was $210 and one hour of a statistician's time. Table 2, located on the following page, displays the total costs of using GPS receivers for the JAS.

Table 2: Research Project Expenses

Item	Details	Total Costs
34 GPS Receivers[1/]	Re-used receivers from ARMS Phase II Study.	0
Miscellaneous Supplies	Batteries, paper, etc.	$50
Enumerator Time & Mileage	No additional time or mileage recorded.	0
Enumerator Training (salary & benefits) [2/]	39 enumerators, each receiving 20 minutes of GPS training.	$160
WA FO Staff	One hour for preparation and training of enumerators.	N/A [3/]
Research Project's Total Cost		$210

1/ If GPS receivers needed to be purchased, the cost for this item ($150 per unit) would have totaled $5,100.
2/ All enumerator costs were based on each enumerator's actual time and salaries. The average salary of the enumerators was $10.14 per hour. The average salary and benefits of the enumerators (using NASS' formula of (salary*1.0763)*1.11) calculates to $12.11 per hour.
3/ Staff salaries and associated benefits expenses were absorbed by the field office.

The benefits of using GPS receivers for the June Area Survey are difficult to equate to an actual dollar value. The eight instances that the enumerators stated they used the receivers to locate segments are a definite benefit. However, the improvement in data quality or reduction in enumeration time in trying to locate the segment was not able to be measured. Also, the seventeen times the receivers were used to verify that the enumerators were in the general vicinity of their segments basically made the enumerators feel more confident. This benefit also could not be tied to a dollar value.

The GPS receivers can also be used for other surveys (ARMS II and Wheat Objective Yield).

Hence for the WA FO, which already had GPS receivers, this was an economical opportunity to possibly improve data quality and save on enumeration time. For states that do not have GPS receivers, it would have to be decided whether the $150 cost per receiver is practical.

9. CONCLUSION

Using handheld GPS receivers for the June Area Survey is practical for field offices already having GPS receivers since the additional cost is minimal. As the enumerators' GPS skill level increases, they will be able to enter and locate waypoints which should make the receivers more useful for the June Area Survey.

The WA FO and RDD will continue to explore new ways to utilize the GPS receivers to improve data quality and/or improve the efficiency of data collection.

10. REFERENCES

Gerling, Michael. 2005. "Using Global Positioning Receivers for Phase II of the Agricultural Resource Management Survey." RDD-05-04, United States Department of Agriculture, National Agricultural Statistics Service.

APPENDIX A – Enumerator Feedback Form

June Area Survey - Global Positioning System Research Project

Enumerator - Feedback Form

Enumerator ID	

Segment Number	

1. Was the GPS receiver used in locating the segment or in verifying that you had found the segment?

☐ Yes	Was the receiver helpful? Save any time? Please elaborate:
☐ No	Please elaborate:

OVERALL COMMENTS on the GPS Receiver

APPENDIX B – Instructional Handout

Overview and Field Enumerator Instructions on Using Garmin Global Positioning System Receivers for the June Area Survey

United States Department of Agriculture
National Agricultural Statistics Service

Table of Contents

Introduction

The Research and Development Division and the Washington Field Office (WA FO) are conducting a research project on using handheld Global Positioning System (GPS) receivers for the June Area Survey.

Currently, field enumerators use a combination of county-highway maps and aerial photos to reach the designated land areas (segments) outlined on the aerial photos for enumeration.

In some cases, there are no road signs and the geography of the land is so similar that determining, where a particular segment is, can be very difficult for the enumerator, and sometimes an enumerator may collect information for the wrong land area. This costs NASS in field enumeration time and data quality.

Hence, the research project's primary goal is to see if GPS receivers can assist enumerators in locating the segment.

The Research Project

Thirty three Washington FO field enumerators have been be provided with a handheld GPS receiver. This should provide most enumerators working the June Area Survey with a receiver.

For all 267 segments, the centroid or (center point of the segment) will be provided. The field enumerators will use their GPS receivers to verify that they have reached the land area to be enumerated.

The receiver will not help the enumerator determine where the boundaries of the segment are but rather will provide the enumerator with another way to verify that they are in the general vicinity of the segment. Naturally, if the receiver's coordinates matches those of the segment's centroid then the enumerator is inside the segment.

The enumerators will also be supplied with a form to record their use of the GPS receivers and if the GPS receiver was helpful or not.

What is GPS?

GPS stands for Global Positioning System. This system is comprised of at least 24 satellites that orbit the earth. These satellites transmit signals to global positioning system equipment on the ground, like the GPS receiver that each of you have been provided.

The GPS receiver acquires signals from these satellites. Thus, the receiver requires an unobstructed view of the sky. The GPS receiver is able to determine the location of the satellites since this information is included in the satellites' transmissions. Next, the receiver determines the distance it is from each satellite. Finally, (without getting too technical), the receiver is able to determine where it is actually located on the Earth within a certain amount of accuracy.

The receiver will display its location in latitude and longitude coordinates. Latitude measures the distance North or South from the Equator while longitude measures the distance East and West from the Prime Meridian.

A common use of these devices is for hiking. Hikers utilize these receivers to trace their trail or to mark a unique location that they would like to return to.

Hence, a GPS receiver is not a remote control for the television but rather a sophisticated electronic device that can tell the user where he/she is (within 50 feet), speed of movement, which way North is, and even the distance to a particular point of interest. However, for this research project, the receivers are to be used as another tool to help the determine the location of the segment. The next few pages will discuss the GPS receiver and what you will need to do to successfully use the device. Welcome to the World of Global Positioning.

Overview
of the
Garmin GPS (Model No. 72)

Below is a general overview of the receiver that you have been provided.

Interface Keys

POWER Used to turn the unit on and off. To turn the unit off, press the POWER key and hold it. The POWER key is also used to display the adjustment window for the back light and contrast. To activate the back light/contrast adjustment window, press and release the POWER key.

PAGE Cycles through the five main display pages in sequence.

MENU Used to display the page option menus. If pressed twice, the Main Menu will be displayed.

ENTER Used to confirm a selection.

QUIT To cycle through the five main pages in reverse sequence. The QUIT key will also end an operation in progress and display the previous page.

ROCKER Located in the center of the keypad, is used to control the Up/Down and Left/Right movement of the cursor on the display pages and during data entry.

GOTO, **IN**, and **OUT** keys will not be needed for this study. If additional information is needed on these keys please see the provided Owner's Manual.

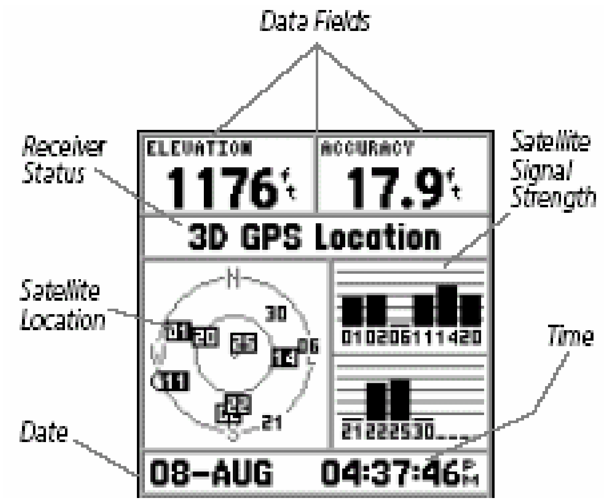
GPS Receiver Instructions

Use these instructions to verify that you have found the selected segment.

Step 1: Press the **POWER** key to turn on the GPS receiver.

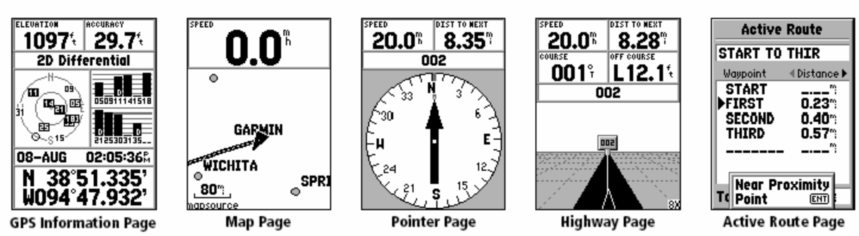
Step 2: A Warning screen will appear. Press the **PAGE** key and wait for the unit to acquire the satellites (up to five minutes). For best results, the receiver's internal antenna (Page 4) should be facing up at the sky.

Step 3: The **GPS Information** page showing the location coordinates should appear. The screen should look similar to the one shown below.



N 37° 45' 27.3"
W110° 41' 31.4"

Note: If the GPS Information page does not appear, press the **PAGE** key to cycle through the five main pages of the device.



Step 4: **Verify that the Location box is showing degrees, minutes and seconds**. An easy way to check this is to look at the latitude coordinate and make sure that it has a **"** after the last number.

The **Location** box displays the latitude (N for North) and the longitude (W for West) of where the receiver actually is.

In Step 3, the GPS Information Page displayed the following location:

N 37° 45' 27.3"
W110° 41' 31.4"

N 37° 45' 27.3" is read as:
37 degrees, 45 minutes and 27.3 seconds North.

W 110° 41' 31.4" is read as:
110 degrees, 41 minutes and 31.4 seconds West.

If the Location box does not display the coordinates in this format, please go to **Appendix B** to re-format your GPS receiver.

Step 5: Look on the back of the aerial photo for the label containing the coordinates of the segment's centroid.

Example is shown below:

Segment 101

	LATITUDE		**LONGITUDE**
N	42 . 17 . 25	**W**	110 . 39 . 12
	dd mm ss		*ddd mm ss*

Step 6: The goal is to have the latitude and longitude coordinates of your GPS receiver get close enough to those of the segment so that you can use the aerial photo and county-highway map to determine where the segment is. Walk around with the GPS receiver and see how the seconds change first, next minutes, and finally the degrees. Walking North and South affects latitude, while walking West and East affects longitude.

Compare the latitude and longitude coordinates provided on the GPS receiver with those of segment's centroid.

The coordinates will more than likely be different so you will first need to determine how far away you are by looking at degrees, minutes and then seconds.

The following distance conversions will help you determine how many feet or miles away you are from the segment's centroid.

Latitude

1 degree = 69 miles
1 minute = 1 mile = 5,280 feet
1 second = 100 feet

Longitude

1 degree = 47 miles
1 minute = 3/4 mile or 4150 feet
1 second = 70 feet

Hence, one degree of latitude is about 69 miles while one second is about 100 feet. Depending on the distance, you must determine whether to walk or drive in the direction that brings you to the segment. An example is provided on page 10.

Step 7: Locate the segment and proceed with your normal enumeration procedures.

Step 8: Complete the "June Area Survey - GPS Receiver Usage: Feedback Form".

Important: Please carry an extra set of AA batteries with you. When the batteries are running low, a low battery warning will appear that will not disappear unless new batteries are installed. See **Appendix C** for instructions on how to install a new set of batteries.

Example of Using the GPS Receiver for the June Area Survey

An enumerator wants to verify that he/she is in the general vicinity of the segment and therefore powers on his/her GPS receiver. The receiver displays the following coordinates:

GPS Receiver

N 42° 17' 26.1"
W 110° 39' 41.4"

Next, the enumerator looks at the coordinates displayed on the back of the segment's aerial photo.

Aerial Photo Label for Segment 140

	LATITUDE		LONGITUDE
N	42 . 25 . 24	**W**	110 . 39 . 12
	dd mm ss		*ddd mm ss*

The enumerator first focuses on latitude and notices that the first set of numbers is identical at 42 . However, the second set (minutes) is different. Comparing the minutes of the GPS receiver to those for the segment's centroid, the enumerator calculates 17 minus 25 = 8 minutes. Hence, the enumerator is approximately 8 miles south of the segment's center.

Next, the enumerator looks at longitude, the first two sets of numbers are identical. However, the third set is different. 41 - 12 = 29 seconds. (Ignore the tenths of a second displayed on the GPS receiver.) This means that the enumerator is about 2,000 feet (1/3 of a mile) west from the center of the segment.

Therefore, the enumerator is southwest of the segment's centroid and should drive about 7 miles north and using the map, photo, and GPS receiver determine if he/she has reached the segment.

Remember: The goal is NOT to reach the segment's centroid but to use the GPS receiver as another tool to assist in finding the segment.

Appendix A

Initializing the GPS Receiver

The Washington SSO should have initialized your receiver. However, if it is unable to locate the satellites, please do the following steps.

Step 1: Take the unit outside where it will have an unobstructed view of the sky and turn it on by pressing the **POWER** key.

Step 2: Press the **PAGE** key to bypass the Warning Screen.

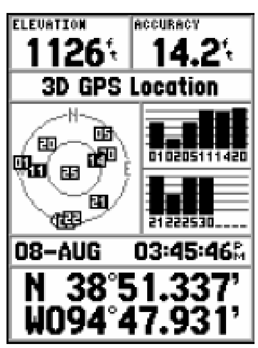
Step 3: If the receiver is unable to acquire enough satellites an options page will appear.

Step 4: Using the **ROCKER** key, select 'New location' then press then **ENTER** key.

Step 5: Next, select 'Automatic' and press the **ENTER** key.

This will allow the unit to continue initializing. This selection will force the unit to search for all satellites. It may take a little longer for the unit to become operational using this method.

A screen that looks similar to the one displayed below should appear. If not, please repeat the above process and if this doesn't work, call the office for additional instructions.

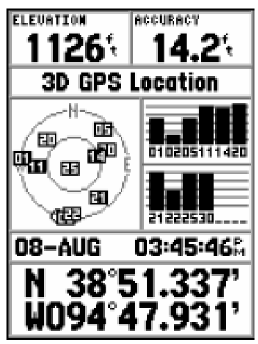


Appendix B

Format Adjustment of the Location Box

The office should have pre-set the format of the Location box for your GPS device. However, if you notice that the format is no longer in degrees, minutes, seconds, then you need will to re-set the location field from hddd° mm.mmm’ to hddd°mm’ss.s”. Having the device display in the latitude and longitude coordinates correctly is critical to having a successful research project. The following steps will guide you on how to re-set the Location box’s format.

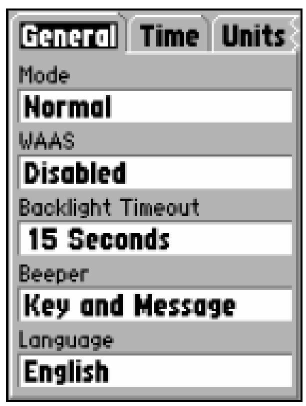
Step 1: Press the **POWER** key to turn the unit on and then press the **PAGE** key. You should be at the screen shown below.



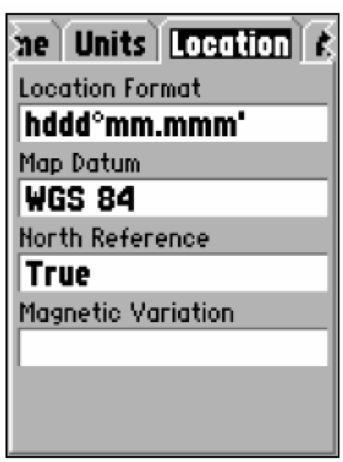
Step 2: Press the **MENU** key. The following screen should appear.

Step 3: Press the **MENU** key again and the Main Menu should appear.

Step 4: Using the **ROCKER** key, rocker down to the Setup option and press the **ENTER** key. The screen shown below should now appear.



Step 5: Using the **ROCKER** key, rocker over to the right to the Location tab.



Step 6: Using the **ROCKER** key, rocker down once to the Location format and press the **ENTER** key.

Step 7: Using the **ROCKER** key select hddd°mm'ss.s" and press the **ENTER** key.

Step 8: Press the **MENU** key three times to return you to your original screen. You should see your new location format.

Appendix C

Installing the Batteries

Step 1: Remove the Battery Cover by turning the D-ring 1/4 turn counter clockwise and pulling the cover loose.

Step 2: Check the battery polarity with the molded diagram in the battery compartment and install the two **AA** batteries inserting the end toward the spring first.

Step 3: Re-install the Battery Cover by reversing Step 1.