GPS for Historical Mapping

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Introduction

Historic record keeping is greatly enhanced if precise location information can be included. Locations of buildings, roads, railroads, trails, cemeteries, and other details of historic interest are being lost with time. Even the locations of abandoned towns and cities are fading from memory. Tools are available to document these locations and even help find lost sites.

Obtaining accurate Latitude and Longitude values for historic mapping purposes now (2018) is relatively simple and inexpensive. Even what might be considered recreational grade portable GPS units typically provide accuracy of better than 10 feet (3 meters). That is with GPS units in the $200 to $400 range.

While an accuracy of plus or minus 10 feet is not adequate for legal property line surveys and such, it is adequate for documenting the location of a cabin, entrance to a cave, or other point of interest for future reference. Most of these GPS units can also log their movement along a track. Point and track data is easily transferred between GPS units and computer mapping programs for further processing.

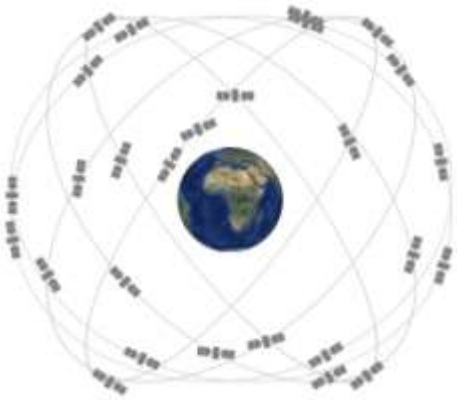
An accuracy of better than plus or minus 10 feet is typically regarded as map grade accuracy. For normal cartographic purposes, greater accuracy is unnecessary. Survey grade GPS units with plus or minus 3

foot (1 meter) accuracy are typically 10 to 100 times as expensive as the map grade units. Survey units are typically used to mark locations within an archeological site.

An added plus in this modern recreational grade GPS equipment is that it is designed to be used by ordinary people. No special technical knowledge or training is necessary. Of course, some initial familiarization and practice is necessary as with any new non-trivial technical item such as a smart phone. However, that familiarization period is short with these GPS units.

Once data has been collected with a GPS unit, it must be preserved and presented in ways useful for research purposes. Inexpensive PC and Mac software is available to satisfy most of those needs. Actually, much of historic research requires little elaborate map data processing. Often site sketches and location descriptions are all that are needed with GPS Latitude and Longitude data supplied in footnotes. Formal mapping is usually a matter of passing a location and track data to professional cartographers.

GPS System Review



US GPS Satellite Constellation

Most people today are aware of GPS and may have some idea of how it operates. That subject is mentioned here as more of a quick review. Some knowledge may help users to achieve the best performance out of their GPS units. A degree in satellite technology is not necessary.

GPS is a satellite based system. A GPS hand held receiver monitors time and position information transmitted by GPS satellites. There are 24 active GPS satellites orbiting the Earth at an altitude of about 12,500 miles. The position and timing of those satellites is arranged so as to provide continuous multi-satellite ground coverage. That non-trivial satellite orbital coordination and satellite systems control is handled by the US Air Force.

The Russian Space Agency has made their GLONASS satellites available for civilian use. The GLONASS system is similar in operation to the US GPS system, with its satellites orbiting at a slightly lower altitude. Newer hand held GPS units often include the ability to use both GPS and GLONASS systems at the same time.

Satellite transmission paths to the ground are typically slightly shifted by the ionosphere and lower atmosphere. That shift is somewhat random and limits direct satellite position accuracy. To overcome this, the GPS system includes a set of ground stations monitoring the signals from the satellites. Those ground stations are able to calculate corrections for atmospheric conditions. Those corrections are transmitted by the GPS system Wide Area Augmentation System (WAAS) satellite and used by GPS receivers to provide +-3 meter (10 ft.) accuracy. In general, accuracy for continental North and South America is better with GPS and WAAS only. Adding GLONASS degrades accuracy in some situations.

To obtain a Latitude/Longitude position fix on the ground, a minimum of three satellites in view is necessary. A fourth is needed if altitude is to be determined. Modern GPS receivers are able to select among the satellites they are receiving to choose those with the best geometric alignment to achieve an accurate fix. Six or more satellites may be used simultaneously to provide further reduced position error.

To obtain the best accuracy for a location, having a clear view of the sky, preferably from horizon to horizon, is helpful. It is best to hold the device up at shoulder height when marking a location or recording a track. The newer GPS units will still work well when carried in a pocket or on a hip belt but holding it high and in the clear will provide the most reliable results.

GPS receivers do not transmit. They are receive only devices. They are safe to use around other sensitive electronic devices. There are walkie-talkie/GPS receiver combinations and satcom/GPS receiver combinations but you pay extra for those devices. Most smart phones include a GPS receiver chip to determine its location but it is not that chip that sends that information out to the world.

Hand Held GPS Devices

Garmin hand held GPS devices (35t and 64st models)

There is several manufacturers of hand held GPS devices. Of them, Garmin is, by far, the leader. They provide the widest range of products and have the widest 3rd party support. Their equipment is reliable and reasonably priced. Garmin is probably the 'safe' choice for a recreational grade GPS device to be used for historical mapping.

Most current Garmin GPS units are compact and touch screen operated. They are convenient for casual use as they may be slipped into a shirt pocket until needed. However, touch screens are subject to smudges and scratches if used in dirty environments. A button operated unit such as the Garmin GPSMAP 64st holds up better in rough or dirty conditions and is much easier to use with gloved hands. Both have the same screen size and resolution. Overall, the GPSMAP 64st is the favored workhorse unit for field GPS work.

However… your specific use may favor the use of a touch screen unit. Field entry of text to label waypoints and to take notes is easier with the touch screen model. Usually though, field mapping work is labeled and annotated back in the office from short notes taken while in the field.

Discussions from this point will center on the GPSMAP 64st. Overall operation is quite similar between hand held GPS though menus and key input sequences vary. Attempting to cover more than one GPS device at a time would likely prove more confusing than helpful.

Operating a new hand held GPS unit for the first time may seem a bit overwhelming. The small display size limits the amount of text that can be displayed so some things might appear rather cryptic. To confuse things more, there are usually many options and features that you will likely never use. Don't be

too frustrated as most of it will become familiar with a few hours of use. These units are designed for use by the general public so are difficult to damage by playing with options and settings. It is easy to set the unit back to factory default settings if necessary.

For historic field mapping purposes, the operations needed from a GPS device are:

1. Determine exact current location.
2. Save the current location latitude and longitude for future reference.
3. Save a track of the movement of the unit along a path or road.

But the GPSMAP 64st includes these additional features/functions:

4. Preloaded 100K topographic map of the entire US.
5. 3 Axis compass.
6. Altimeter.
7. Calculator.
8. Alarm clock.
9. Calendar
10. Stopwatch.
11. Sun and Moon rise and set times.
12. Route planning and direction.
13. Waypoint proximity alarm.
14. Geocache listings.
15. Transfer waypoints, tracks, and other info to/from another 64st.
16. Bluetooth operation with smart phone.
17. Etc.

Fortunately the GPSMAP 64st is configurable so that you can easily do the things you would like without having to dig past things that you don't care about. Even more convenient is that you can have more than one operational profile with different configurations and easily switch between them.

Again, while the feature set may vary from model to model and brand to brand, such flexibility is not unusual. Newer generations of GPS gear will likely be even more feature rich. Fortunately, those changes will be incremental so learning your first GPS device will equip you well to adapt to the next one.

One point should be emphasized. Hand held GPS unit CANNOT be used for <u>legal</u> property boundary or landmark marking purposes. Legal surveys may only be performed by licensed surveyors. Their job is much more complex, involving use of legal benchmarks and property descriptions. However, for finding and recording the location of points of historic interest, modern hand held GPS units are generally more than adequate. Future historians can use that information to return to a location with confidence that they are within about 10 feet of where you recorded it.

GPSMAP 64st Main Pages

Once you power up your GPSMAP 64st and its boot sequence completes there are some steps that will help getting your unit ready for field operation. The supplied sequence of display pages is likely a wild guess on the part of Garmin as to what a user might want to see. You can see their initial choices by repeatedly pressing the **PAGE** button while watching the entries on the horizontal ribbon that scrolls through the middle of the page. Stop pressing the **PAGE** button if you want to see what a page looks like.

Page Sequence

What you can do is to change that page selection to something more appropriate for your use. That is done by stopping on the page labeled **Main Menu**. Scroll up or down in that menu to find the entry labeled **Setup** and select it by pressing the **ENTER** button. In that menu, scroll up or down and select **Page Sequence**.

The **Page Sequence** page allows you to add, move, or remove entries from the page select sequence. A reasonable beginning list of pages is:

- **Satellite**
- **Map**
- **Compass**
- **Track Manager**
- **Waypoint Mgr**
- **Main Menu**

To add a missing entry, scroll down to the entry labeled **Add Page** and press **ENTER**. You will be presented with a list of potential pages. Scroll up or down to highlight the entry to be added and press **ENTER**.

To remove an entry from the list, scroll up or down to highlight it and press **ENTER**. Select **Remove** and press **ENTER**. Removed pages will show up in the **Add Page** list so are not actually lost.

You may use the **Move** option to adjust the sequence the pages will be display when the **PAGE** button is pressed.

Once you have finished adjusting your page list, press the **QUIT** button a few times to exit the **Page Sequence** and **Setup** menus.

Individual Page Adjustments

Most main pages have configuration options. There are some that will be helpful.

Satellite: This page shows which satellites the GPSMAP 64st is able to receive and their signal strengths. Press the **MENU** button while viewing that page. There are two entries on that list that are of interest.

One selects **Track Up** or **North Up**. **North Up** is the best choice for most GPS work done on foot. The second selects **One Color** or **Multi-Color**. **Multi-Color** is the prettier choice. In making these choices, remember that the choice shown in the menu is what the change will be to. When **North Up** is selected, **Track Up** will be shown in the menu. Likewise, when **Multi-Color** is selected, **One Color** is shown in the menu. This is a common menu item operation in the GPSMAP 64st.

Map: In the **Map** menu, select **Setup Menu**. In the setup menu select **Orientation North Up**. Next, select **Map Information Select Map**. In the **Select Map** map list, only **TOPO U.S. 100K** need be **Enabled**.

Compass: The **Compass** page is one of the most configurable pages. A number of preconfigured **Dashboards** are provided for specific uses such GeoCashing or driving with Garmin's City Navigator maps loaded. As a starting configuration I would suggest:

Dashboard:

- **Small Data Fields**

Data Fields:

- **Time of Day**
- **GPS Elevation**
- **Battery Level**
- **Distance to Next**

The **Distance to Next** field becomes active if you are using the GPS to return to a previous location. A large arrow will show up inside the compass pointing the direction to that location.
*(Hint: Navigation can be cancelled by pressing the **FIND** button and selecting **Stop Navigation**.)*

(For additional compass configuration info see the **Heading** entry in **Configuration Settings** below.)

Track Manager: (No change needed.)

Waypoint Manager: (No change needed.)

Configuration Settings

There are several settings in the GPSMAP 64st that should be adjusted before it is used in the field. These adjustments are made in the **Setup** menu found on the **Main Page**:

System:

Satellite System: **GPS** (Using **GPS+GONLASS** may improve satellite reception in areas with poor sky coverage)

WAAS/EGNOS: **On**

Language: (**English** or other as appropriate)

Interface: **Garmin Serial**

AA Battery Type: (Set as appropriate for the battery type you are using. The GPSMAP 64st monitors the battery voltage and uses the battery type info to determine its discharge level. An incorrect battery level indication and warning will be given if the wrong type is selected.)

Display:

Backlight Timeout: **2 Minutes** (Can be set as short as 15 seconds)

Battery Save: **Off** (**On** shuts display off when backlight is off. This is useful to save battery life if the GPSMAP 64st will be on to record a track but will be viewed only infrequently. To view the display, the **power button** on the side of the unit is pressed momentarily.)

Main, Setup, Find Style: **List (7 Items)**

Screen Capture: **Off**

Map:

Orientation: **North Up**.

Guidance Text: **When Navigating**

Data Fields: **0** (You may experiment with this to add information to the Map page display.)

Advanced Map Setup: (This provides another menu to adjust how things are displayed on the map. Set **Detail** to **Most**. Set **Shaded Relief** to **OFF** for clearer topo map display.)

Map Information Select Map: In the **Select Map** map list, only **TOPO U.S. 100K** need be **Enabled**. Enabling others may slow startup.

Tracks:

Track Log: **Record, Show On Map**

Record Method: **Auto**

Recording Interval: **Normal**

Auto Archive: **When Full**

Color: (Whatever you like for this)

(Note: A later section of this document covers the use of these parameters in more detail.)

Position Format:

Position Format: **hddd.ddddd** (When working with USGS topo maps, **hddd.mm.ss.s** or **UTM UPS** may be more convenient.)

Map Datum: **WGS 84**

Map Spheroid: **WGS 84**

(Note, the GPSMAP 64st does not change its internal location information format when any of the three items above are changed. Position information calculated from the GPS satellites will continue to be collected in that same consistent internal format. Displayed formats will reflect the above choices. Manual Lat/Lon input will be interpreted as in those formats also.)

Heading:

Display: **Directional Letters**

North Reference: **True**

Go To Line (Pointer): **Bearing (Large)**

Compass: **Auto**

Calibrate Compass: This option invokes a procedure to calibrate the GPSMAP 64st internal three-dimension electronic compass. You should move to a large open area that is free of metal before beginning this procedure. The GPSMAP 64st displays the instructions for this procedure.)

Routing:

Activity: Direct Routing (Direct routing provides a compass bearing to a selected waypoint. Other selections enable routing on routable maps such as street maps.)

Calculation Method: Prompted (Allows selection such as shortest or fastest routes on routable maps.)

Lock On Road: No (Only enable for road travel using routable maps.)

GPSMAP 64st Use for Beginners

Startup

When you turn your GPS unit on for the first time, three things must happen before it becomes usable.

1. As it is a computer, it must complete its boot sequence. That can take 30 seconds or more.
2. Next it must search and synch its internal receiver with at least one satellite and download a current satellite constellation ephemeris. This can take several minutes.
3. With that ephemeris available, it can begin synching its receiver with other satellites to calculate its own position. This usually takes only a few seconds.

Restarting the GPSMAP 64st within a few days at the location where it was powered down allows it to skip step number 2 above. That makes for a much quicker startup.

Selecting the Satellite page will provide a view of which satellites the unit is able to receive, their positions in the sky, and their signal strengths. This page also shows an indication of the accuracy expected with the configuration of satellites currently being received.

Walking Around

With the GPSMAP 64st powered on and successfully receiving satellites, it is ready for use. Select the **Map** page to show your location on the internal map. The **IN** and **OUT** buttons zoom the map in and out. The map may be zoomed in until the distance show from side to side on the display is only about 60 feet. Maximum zoom out is about 1500 miles from side to side. Display updates become quite slow when zoomed out more than 100 miles or so.

Before using any GPS unit for any serious field work, some familiarization with it is a good idea. Fortunately, that consists of little more than taking the unit outside and walking around the neighborhood. As you walk along, the position indicator in the middle of the Map page remains fixed while the map displayed moves under it. You will also see your track marked on the map.

The receivers in newer GPS hand held units are very sensitive. The GPSMAP 64st will normally work well even inside an automobile, provided that automobile has an open sky above it. To record your driving route, simply stand the GPSMAP 64st in a cup holder or similar location.

Recorded tracks may be managed on the Track Manager page. Tracks may be saved, deleted, and archived (moved out of working memory). Those operations are covered in a later section of this document.

While you are moving about, save a Waypoint for practice. This is done by pressing the **MARK** button. A page will pop up on the display allowing you to change the symbol to used to show the location on the display, change the Waypoint name, and add notes if you wish. Highlight **Done** and press the **ENTER** button to finish saving the Waypoint. Waypoint operations will also be covered in more detail in a later section of this document.

GPSMAP 64st Waypoints

Waypoints are locations you record and store in the device. **Waypoints** can mark where you are, where you are going, or where you have been. You can add details about the location, such as name, elevation, and depth. Though simple in concept, they are a very powerful GPS tool.

The dictionary definition of a **Waypoint** is 'an intermediate point on a route or line of travel.' The term came into common use near the end of the 19th century. It is used to indicate a location you must pass through before turning onto the next leg of your journey. When navigating an automobile travel route, **waypoints** are typically placed at important highway or street intersections.

Waypoints have many more uses than indicating locations to head toward on a travel route. Marking a location with a **Waypoint** is much like planting a GPS flag on that spot. Though nothing is physically left on the ground, that location information will not be lost for future generations. The quality of historic information degrades rapidly. People simply don't bother recording what they consider every-day activities. Knowing the date of a battle, the name of a hero, or the location of a monument tells us very little about the world of their times. GPS **Waypoints** can help slow that loss by supplying the where to history stories.

The GPSMAP 64st can store 5000 **Waypoints**. That is probably far too many **Waypoints** to manage on a hand held unit intended for field use. It will be comforting to know that you will not have to be concerned about hitting a limit when saving **Waypoints** during field work.

Creating a Waypoint

You can save your current location as a **Waypoint**.

1. Press the **MARK** button.
2. If necessary, select and change a field to change the **Waypoint** information.
3. Select **Done** and press the **ENTER** button.

Projecting a Waypoint

You can create a new location by projecting the distance and bearing from a marked location to a new location.

1. Go to the **Waypoint Manager** page.
2. Select a **Waypoint** and press the **ENTER** button.
3. Press the **MENU** button
4. Select **Project Waypoint** and press the **ENTER** button.
5. Enter the bearing, select **Done**, and press the **ENTER** button.
6. Select a unit of measure and press the **ENTER** button.
7. Enter the distance, select **Done**, and press the **ENTER** button.
8. Select **Save** and press the **ENTER** button.

Navigating to a Waypoint

1. Press the **FIND** button.
2. Select **Waypoints** and press the **ENTER** button.
3. Select a **Waypoint** and press the **ENTER** button.
4. Select **Go** and press the **ENTER** button.

Ending Navigation to a Waypoint

1. Press the **FIND** button.
2. Select **Stop Navigation** and press the **ENTER** button.

Editing a Waypoint

1. Go to the **Waypoint Manager** page.
2. Select a waypoint and press the **ENTER** button.
3. Select an item to edit, such as the name, and press the **ENTER** button.
4. Enter the new information, and select **Done**, and press the **ENTER** button.

Deleting a Waypoint

1. Go to the **Waypoint Manager** page.
2. Select a waypoint and press the **ENTER** button.
3. Press the **MENU** button.
4. Select **Delete** and press the **ENTER** button.

GPSMAP 64st Tracks

A **Track** is a recording of your path. A **Track** contains information about points along the recorded path, including time, location, and elevation for each point. You can think of it as something like a bread crumb trail, but very accurate.

Tracks are handy for marking trails or routes you are travelling. **Tracks** are easily read from the GPSMAP 64st by Garmin's **BaseCamp** program and other software. Recorded **Tracks** may then be display in those programs. **Track** data may also be exported by **BaseCamp** directly to **Google Earth** or to disk files for transfer.

The GPSMAP 64st does have some specified limits:

- 10,000 points per **Track**
- 200 saved **Tracks**
- 2,000 archive **Tracks**

10,000 points allowed per **Track** is unlikely to be a problem. Historic mapping **Tracks** will likely need no more than a few hundred per **Track**. The track that is being recorded is the **Current Track**. The **Current Track** can be saved to memory while recording continues. For practical software reasons, there is a limit of 200 of those 10,000 point **Tracks** in working memory. To overcome that limitation (!?), saved **Tracks** can be archived (moved) to main internal storage. Current, saved, and archived tracks can be displayed. **BaseCamp** can read them for display and export.

Though out of order for this presentation, it is probably a hint worth keeping in mind while reading the remainder of this section: To create a clean mapping trace, as when walking a trail, clear "CURRENT TRACK" at your chosen track start point. Save the CURRENT TRACK immediately as you complete that track.

Don't be intimidated by the GPSMAP 64st track system. It will make sense when you start using it. The initial step in creating track logs is to set up the GPSMAP 64st track settings.

Tracks Settings

Select **Setup** > **Tracks**.

Track Log

Turns Track recording on or off.
Choices are:

- **Do Not Record**
- **Record, Do Not Show**
- **Record, Show on Map**

*"**Record, show on Map**" is probably the best choice while mapping in the field. However, that can quickly clutter your display. "**Do Not Record**" will minimize clutter and remind you turn tracking back on when you intend to use it. "**Record, Do Not Show**" would be used when traveling in an unfamiliar area and might wish to have some means to trace your way back to your starting location or later see where you have been without cluttering the display. **Track Manager** options (below) allow you to view or to navigate back on a saved track.*

Record Method

Sets a **Track** recording method.
Choices are:

- **Distance**
- **Time**
- **Auto**

Auto records the tracks at a variable rate to create an optimum representation of your tracks.

Recording Interval

Sets a **Track** log recording rate.
Intervals appropriate for each "**Record Method**" are selectable.
Recording points more frequently creates a more-detailed **Track**, but fills the **Track** faster.

Auto Archive

Sets an automatic archive method to organize your **Tracks**. **Tracks** are saved to archive and cleared from working memory automatically on the following schedules.

Choices are:

- **When Full** *(more than 200 saved **Tracks** or 10000 points in **Current Track**)*
- **Daily**
- **Weekly**

Color

Changes the color of the track line on the map.

Track Manager

The **Track Manager** selection in the **Main Menu** provides operational functions for working with tracks.

Track Manager top level selections are:

- **Current Track**
- **Archived Tracks**
- [a list of saved tracks]

When one of the above is selected, the following options are provided:

Current Track

- **Save Track** *(allows giving the track a text name when saving)*
- **Save Portion** *(allows first and last point to be selected)*
- **View Map**
- **Elevation Plot**
- **Set Color**
- **Clear Current Track**

Archived Tracks

- **View Map**
- **Elevation Plot**
- **Change Name**
- **Delete**
- **Make Favorite** *(changes track back to saved status)*

[Saved Tracks]

- **View Map**
- **Elevation Plot**
- **Show / Hide On Map** *(toggles between Show and Hide – Show keeps track visible on map)*
- **Set Color**
- **Change Name**
- **Copy Reversed** *(reverses order of points in track)*
- **Delete**
- **Archive** *(Move out of working memory to static storage)*

Most of these options are reasonably self explanatory. **View Map** has an interesting feature. Pressing **Menu** while on that display brings up a menu with the option: **Review Track**. That review includes distance traveled and number of points in the trace, along with other info.

Garmin provided a short list of track operations for quick reference:

Viewing the Current Track

1. Select **Track Manager** > **Current Track** .
2. Select an option:
   - To show the current track on the map, select **View Map**.
   - To show the elevation plot for the current track, select **Elevation Plot**.

Saving the Current Track

1. Select **Track Manager** > **Current Track**.
2. Select an option:
   - Select **Save Track** to save the entire track.
   - Select **Save Portion**, and select a portion.

   *Note: When a track is saved, an option to clear **Current Track** is presented to provide a clean start for another track.*

Clearing the Current Track

Select **Track Manager** > **Current Track** > **Clear Current Track**.

Deleting a Track

1. Select **Track Manager**.
2. Select a track.
3. Select **Delete**.

Navigating a Saved Track

1. Select **FIND** > **Tracks**.
2. Select a saved track.
3. Select **Go**.

Using Tracks

Over the years, Garmin has gradually upgraded its GPS product **Track** capabilities until it is a comprehensive system. These units now provide for naming and saving multiple **Tracks**. However, as with most things, more features means an increase in operational complexity. Fortunately, once the newer system is understood, it is easy to use.

The first concept to understand is the **Current Track**. Whenever **Record, Show on Map** or **Record, Do Not Show** is selected, the location of the GPSMAP 64st will be recorded in the **Current Track**. When the GPSMAP 64st powered off, recording stops. When it is powered back on, it will continue recording into **Current Track**. If powering off and powering on are not at the same location, the **Current Track** will contain that position difference as just one long track segment and continue recording normally from there.

While that Current Track operation may be a little confusing at first for historical mapping, it does make sense when the GPSMAP 64st is used for extended hiking or camping activities. Powering the unit off to save batteries while remaining at a single location for hours or days without losing the past travels could be handy.

There are three options for saving tracks for research purposes:

1. Standing at the start location of a **Track** you wish to record, delete the existing **Current Track**. (*See **Clearing the Current Track** above.)* Begin walking or driving your **Track**. Immediately upon reaching the end of your **Track**, save the **Current Track**. *(See **Saving the Current Track** above.)*
2. Simply save the **Current Track** using the **Save Portion** option. This option allows you to specify beginning and ending points of the **Track** you wish to save. This should be practiced before it is attempted in the field. It may be difficult to identify those desired beginning and ending points.
3. Clear or save and clear the **Current Track** at the beginning of a mapping session. Travel the intended track or tracks. Save the **Current Track** at the end of the mapping session. Edit the saved **Current Track** in **Base Camp** or other mapping software. This also requires practice but it has the advantage that it can be done sitting at a desk, indoors.

When working with **Tracks** in programs such as **Base Camp**, it is possible to make safety copies of **Tracks** before modifying them. Copy the **Track** to a separate **Base Camp** folder and rename it. If you damage the **Track** beyond repair while editing it, you may delete that working copy and start over with a fresh copy.

Even when Track recording is not planned for a day's mapping work, having a record of the days travels may be useful. While the GPS unit will provide precise location information in the field, viewing those travels as a trace on a map can provide context. A set of recorded Waypoints can be difficult to interpret, even for the person who recorded them, without a reminder of the day's travels.

As mentioned above, mapping programs typically allow for creating a Track. Individual **Waypoints** and recorded Track segments may not be adequate to convey the entire path of a trail or road. An artificially drawn **Track** can show a complete path unambiguously. This allows that information to be saved in a format that can be transferred between programs in GPS data format.

Garmin Software

Using a hand held GPS unit to collect waypoint and track information is only half the historic mapping job. Actually it may be significantly less than half. History is about documentation for further study and review. Fortunately Garmin and other companies supply software for reading data in a GPS unit and saving it a PC for further work. Garmin's program is named **BaseCamp** and is available free on Garmin's web site.

Once you have **BaseCamp** installed and running, you may connect the GPSMAP 64st to your computer via the supplied USB cable. Base Camp will automatically detect the GPS unit and display its internal storage. **BaseCamp** will also begin copying the **TOPO U.S. 100K** map to your PC for display. That map will be available in **BaseCamp** whenever you connect the GPS unit.

The folder listing will show a **Devices** section. Your GPSMAP 64st will show up in the **Devices** list. When you click on its **Internal Storage** folder, a list of saved waypoint, tracks, and routes will show up below. You may click on any of the **Internal Storage** items to have it displayed on the **BaseCamp** map.

A word of warning though, though **Internal Storage** is displayed by **BaseCamp**, that data is not automatically saved in the PC. That must be handled manually. Create a folder in **My Collections** in the **Library** area. Name the folder something appropriate for your project. Click on **Internal Storage** again to open that folder. Click-slide-and-drop **Internal Storage** entries into your new folder. Those entries will remain available in the GPS unit until explicitly deleted from there. See the "**Retrieving and Saving GPSMAP 64st Data**" chapter for a more detailed description of this process.

Note: You may also use that Click-slide-and-drop process to move things into your GPS unit.

Once you have your data saved into your PC you may begin the cartographic part of the work. **Waypoints** and **Tracks** may be renamed to provide more explicit or mnemonic explanation of their purpose. Redundant and mistaken **Waypoints** may be deleted. Unnecessary parts of **Tracks** may be trimmed off. **Waypoints** may be added along recorded tracks to provide a more complete **Waypoint** list for a trail or road.

A feature worth considering in mapping programs is **Track** creation. Individual **Waypoints** and Track segments may not be adequate to convey the path of a trail or road. An artificially drawn **Track** can show a complete path unambiguously.

When a clean set of data is available, it may be presented on computer screens or printed to hard copy. **Waypoint** and **Track** symbols, sizes, colors, and opacities will likely need adjusting – on a point by point basis – for desired image clarity and impact.

That data may also be exported to disk files for use or processing by other programs. **BaseCamp** has limited export flexibility but other free or low cost software can translate those files in a number of different formats.

Enhancements:

The functionality of **BaseCamp** can be improved with some simple add-ins:

BirdsEye:

One add-in of interest is the Garmin **BirdsEye** aerial photograph add in feature. **BirdsEye** allows users to download aerial photographs directly into **BaseCamp**. Though Garmin's server limits image size, images blocks several miles on a side may be downloaded.

BirdsEye aerial photographic images may be turned on and off while work with GPS data. This feature will allow ground image verification of data editing work. Occasionally, the topographic map presentation in BaseCamp may not provide sufficient clarity in map location versus true physical location. **BirdsEye** image downloads are free for the first year of GPSMAP 64st ownership.

OpenStreetMap:

An option worth considering is adding street and road maps to **BaseCamp.** Garmin provides its **Garmin City Navigator** products. **City Navigator North America** is priced at $80. This product is map data that is loaded into Garmin's street map products but does not include the highway intersection graphics. For Historical Mapping functions however, the Garmin product may be overkill.

The **OpenStreetMap** project provides free, high quality, road maps. The **OpenStreetMap** project is user supported for both mapping updates and funding. Both wide area and individual state maps are available for download. Maps are available in both **BaseCamp** add in and GPSMAP 64st loading formats. These maps are routable. That is, given as starting and ending location, both **BaseCamp** and GPSMAP 64st can calculate a route between them and supply turn by turn travel information. These maps are available at: http://garmin.openstreetmap.nl/

Both downloaded BirdsEye images and OpenStreetMap maps are operable without the GPSMAP 64st connected to the PC.

Retrieving and Saving GPSMAP 64st Data

Concept:

Data collected with a Garmin GPSMAP 64st as part of a historical mapping effort should be preserved for analysis and processing. First, and foremost, the raw collected data must be retrieved and placed in secure storage. Next, a working copy of that data should be created. The raw data storage will be available for correcting any errors that might occur while removing redundant or erroneous waypoints or tracks.

Retrieving data from a GPSMAP 64st is both simple and safe. Reading the GPS data is accomplished by connecting the unit with a USB cable to a PC running Garmin BaseCamp. Reading the GPS data with Garmin BaseCamp and other similar programs does not delete the data on the GPS unit. Deletion is done with BaseCamp using an explicit delete command.

Reading GPS Data:

Reading the current data stored in a GPSMAP 64st is easy. Start Garmin BaseCamp and connect the GPSMAP 64st supplied USB cable. BaseCamp will discover that the unit is connected. It will show up in the folder listing at the left side of the map in a category labeled “Devices.”

Though waypoints, tracks, and even maps show in BaseCamp, the GPSMAP 64st data is not yet in the PC. It is being read from the 64st internal memory. That data may be examined and displayed on the BaseCamp map. Disconnecting the 64st will cause its data folders to no longer be available in BaseCamp. The GPSMAP 64st data will remain on the unit.

Saving the Raw GPS Data:

Saving GPS data in the PC requires that be copied from the GPSMAP 64st to a PC folder. If not already done, a folder should be created to contain the PC copy of the data.

To create your project folder in BaseCamp:

1. Right click on “My Collection” in the folder box to the left of the map in BaseCamp.
2. Select “New List Folder” and enter your project name.
3. Right click on your new project folder.
4. Select “New List” and name it “RAW.”

To copy GPSMAP 64st data to the RAW folder:

1. Connect the GPSMAP 64st to the PC via the USB cable (with BaseCamp running).
2. When the GPSMAP 64st shows up in the folder list at the left of the map, select its “Internal Storage” folder.
3. Highlight the Waypoints shown in the item listing below the folder list box and copy those them to your “RAW” folder.

4. Do as with step 3 above with tracks (indicated with footprints).

To Back Up Your RAW data:

1. Highlight your project "RAW" folder.
2. At the top of the BaseCamp window, select "File" -> "Export" -> "Export 'RAW'".
3. Save "RAW.gpx" to a safe location on the PC or to a thumb drive for future reference.

At this point you have two copies of your raw GPS data, plus what is on the GPSMAP 64st. You may delete individual waypoints and/or tracks from the GPS unit to unclutter it. You may do this using BaseCamp if you wish. That is often easier than manually deleting waypoints and tracks using the units buttons.

The GPSMAP 64st may now be disconnected from the PC.

Future additional waypoints and tracks can be added to your RAW folder from the GPS unit as described above. The new combined list can also be exported to a ".gpx" file as described above.

Note: The ".gpx" file suffix indicates it is a standard GPS data exchange format file. This type of file is recognized by most GPS mapping software.

Working With GPS Data from RAW folder:

GPS data should never be modified or deleted from your RAW folder. Create a working folder in your project folder. Copy desired **Waypoints** and/or **Tracks** from your RAW folder to your working folder. Once in your working folder, waypoint names may be changed to be more descriptive. Tracks may be renamed, corrected, or simplified. Once those data items are set, they may be adjusted for appropriate display characteristics such as size, color, and shape.

Your working folder may also be exported as a ".kml" for safety or version control. This cleaned up ".kml" version of the GPS data may be imported into **Google Earth** for additional adjustment and display. Export to ".gpx" is a common format for other programs such as **ExpertGPS**.

As a side note, programs such as Google Earth and ExpertGPS can also directly read data from the GPSMAP 64st. Garmin GPS products are well supported by mapping software.

Transferring GPS Data to Other Software:

BaseCamp is able to export GPS data in a variety of formats if necessary. This allows flexibility in accommodating data transfers to agencies with preferences other than ".kml" format.

Those choices are:

GPS eXchange Format (*.gpx)
KML 2.2 Document, v2 (*.kml)
Comma-delimited text (*.csv)
Tab-delimited text (*.txt)

KML format is often used by map creation software. Software is available to converting these formats to yet others. As an example, the **ExpertGPS** program can export GPS data in the above formats as well as the following:

Topo! File (*.tpg)
Maptech Mark File (*.mxf)
Point Shapefile (*.shp)
CAD DXF (*.dxf)
GeoJSON File (*.geojson, *.json)

Should the need arise to provide GPS data in a format not shown above, a number of GPS data file format converters may be found on the web, often free. For example, the program "**DNRGPS**" is available free for converting Garmin data and KML files to **ESRI Shapefile** vector GIS data format.

Summary:

The key point to remember is that reading data from a GPSMAP 64st does not cause it to be deleted. Proper research procedure requires that raw data be preserved for future reference. A separate copy of that data should be used as working data. It is common that some waypoints are redundant and some simply invalid. Tracks are especially likely to need deletion or editing. They often show how a search for a location or path involved moving about to find it. Some tracks may simply need to be redrawn. Most mapping tools allow for that.

Once GPS data is collected, it must be preserved. That data often must be cleaned and polished for further use but that work must be performed on a copy of original collected data. Even then, how it is packaged will vary depending upon its final use. Fortunately, Garmin GPS hardware is so common that many tools are available for assistance meeting your ultimate mapping goals.

Editing GPS Data with BaseCamp

Why Editing is generally necessary:

Raw field collected GPS data will normally contain erroneously created **Waypoints** and **Tracks** with unnecessary or incomplete segments. This is simply a reflection of the effort involved in mapping field work. It is often best to mark a location of questionable importance in case further research proves it otherwise. Deleting or correcting data later is easy.

Another purpose for editing GPS data is to insert information not available from a field mapping effort. This information may have been obtained using aerial photographs or other maps. Inserting data that was not directly collected with a GPS unit is a valid approach historical mapping. It must, of course, be used with caution. In all cases, editing of GPS data should be done to increase its accuracy and clarity.

BaseCamp does have one disadvantage over more sophisticated mapping software. It cannot convert **Tracks** into **Shapes** as used in some cartographic software. However, **BaseCamp** may be a preferred way to edit GPS data. Exporting BaseCamp edited data to third party a mapping program such as **ExpertGPS** can provide that conversion. (See *Editing With ExpertPGS* below.)

Why Edit With BaseCamp?

BaseCamp's cartographic capabilities are optimized for showing how to get to a location. In other words, its design is optimized for inserting location and routing information into a GPS unit, not mapping data collected by the GPS unit. As a result, **BaseCamp's** ability to edit GPS data, both created in **BaseCamp** and collected from a GPS unit, is extensive. **BaseCamp** may be used as the data editing and management tool for use in other mapping software for display or printing.

Editing GPS data in BaseCamp:

The first thing to keep in mind while editing **Waypoints** and **Tracks** in **BaseCamp** for display is that there is limited ability to change Icon colors, line widths, and other similar display features. **BaseCamp** is designed as a multipurpose tool with greatest emphasis on routing between locations on roads and trails. High quality cartographic formatting was not part of its original design.

There is a feature in **BaseCamp** editing that can help with fine detail work while editing **Waypoint** locations and **Track** paths. This is easier when aerial photographs of map areas may be used for comparison. Consider adding Garmin **BirdsEye** aerial photo images as described in the *Enhancements* part of the *Garmin Software* section above. Those photographic images may be toggled on and off as needed.

One handy feature of for using the **BirdsEye** images is that the action menu that is provided when right clicking on a **Waypoint** or **Track** contains and entry labeled "**Create BirdsEye Image…**" This selection allows you to size a rectangle over the area and download it from the Garmin server. (Remember that the GPSMAP 64st must be connected to the PC to use the one year free **BirdsEye** service.)

Waypoints

Waypoints may be deleted, moved, or created in **BaseCamp**. Deleting erroneous or redundant **Waypoints** is probably the most common edit operation. **Waypoint** creation from examination of aerial photographs or latitude/longitude obtained from other sources is possible.

A **Waypoint** is edited by right clicking on either its map icon or its entry in its folder listing. A menu will pop up with a series options. The options of most interest are: **Open**, **Move Waypoint**, **Delete**, and **Create BirdsEye Imaging**.

The **Open** selection pops up a properties dialog allowing the icon and text label to be changed. Changes to icons will typically not be carried through to other software. Text labels and notes generally are passed along.

Tracks

Track editing is one of the more useful features of **BaseCamp**. Individual **Track Points** may be deleted or moved to remove casual or unimportant side trips from a **Track**. Editing individual **Track Points** can be a bit tedious but it will provide fine adjustment of a **Track's** path.

Tracks may be split into two or more separate smaller **Tracks**. This is particularly handy for dealing with all-day **Tracks**. That is when **tracking** is turned on when first reaching the field and left on until time to return to the office. That long **Track** can be broken into smaller parts can be saved or deleted as needed.

Editing a **Track** is similar to editing a **Waypoint** in that a right click on a **Track** or **Track Point** will provide an action menu. The action menu for a **Track** includes **Open**, **Delete**, and **Create BirdsEye Imagery**. The action menu for a **Track Point** includes the additional items **Split Track Here**, **Split Track at Segment**, **Insert into Track**, **Move Track Point**, and **Delete Track Point**.

A word of caution: The action menu items labeled Delete and Delete From- with the leading X icon deletes the entire Track even in the Track Point action menu.

Selecting **Open** allows editing of a **Track's** name. Some mapping programs show the name along a **Track** on displayed or printed maps.

To split a **Track**, bring the **Track** into view on the screen. Zoom the **Track** until individual **Track** points are visible. Right click on a trackpoint where you want a split. Select **Split Track Here** or **Split Track at Segment**. **Split Track** breaks the **Track** at the specific point but both resultant **Tracks** contain an identical point. **Split Track at Segment** leaves a gap with the next point along the original **Track** as the beginning point of the new **Track** segment.

Individual trackpoints may be moved within a **Track** while the **Track** is selected. Hold the **Alt** key down. Move the trackpoint by clicking and holding the right mouse button. Release the mouse button. Then finally release the **Alt** key.

Adjusting Waypoint and Track Display

BaseCamp's limited adjustments of **Waypoint** and **Track** display is accessed by editing **Display Options**. This is accessed via **Edit** -> **Options** -> **Display Options**. **Waypoint** size is adjusted with the **Symbol Size** slider. **Track** line thickness is adjusted with the **Track Width** slider.

Display parameters, however, are not reliably transferred to other programs such as **Google Earth** or **ExpertGPS**. These other programs have their own specific display parameters that do not always match up with **BaseCamp's**.

Mismatch in display parameters when transferring data from **BaseCamp** does not mean **BaseCamp** is not useful as an editing tool. Overall, its **Waypoint** and **Track** editing capabilities are significantly more flexible than many other mapping programs. **BaseCamp** is a good choice for cleaning and adjusting GPS data. Once imported into other programs, work then is properly displaying the data.

Editing GPS Data in Google Earth

Concept:

One potential option for providing graphic display of data gathered with the GPSMAP 64st is with the use of **Google Earth**. The obvious advantage of **Google Earth** is that it is free and available on essentially every PC. Additionally it provides a mechanism to view GPS data as aerial photographs at variable scale and detail.

As with Garmin's **BaseCamp**, **Google Earth** can read GPS data from a **GPSMAP 64st**. **Google Earth** could be used as a standalone GPS data editor and display system. However, **Google Earth** is targeted more for displaying GPS data on its aerial photo images than editing it. Moving, deleting, and adding **Waypoints** is straightforward. The steps used to split or modify **Tracks** are somewhat obscure.

It should be emphasized that transforming raw GPS data into attractive graphic presentations is a skill that requires practice and patience to acquire. Fortunately, what is needed for GPS data display is straightforward. The goal is simply to present GPS data in a form appropriate for the intended venue. In historical circles, it is typically the information content of the data, not its form that matters.

Waypoints

Waypoints may be deleted, moved, or created as in **BaseCamp**. **Google Earth** provides extensive editing capability of **Waypoint** parameters such as icon type, color, size, transparency, and name font and size.

An individual **Waypoint** can be edited by right clicking on it and selecting the **Properties** option. The top line of the **Properties** dialog provides for editing the name and icon. The **Style, Color** tab provides for adjusting the color, size, and opacity of both the name and the icon.

To group modify all **Waypoint** properties, edit the first **Waypoint** in a list. You may select it by right clicking on it in the list. Set its icon, and the color, size, and opacity for names and icons. That provides the prototype for the group modification. Right click on the **'Waypoints'** folder line. Select the **Properties** entry. In the **Properties** dialog, click on the **Style, Color** tab. **Google Earth** will notice that not all waypoints have the same properties and provide a button to make them the same as that first **Waypoint** entry.

Tracks

Operations such as splitting or modifying a **Track** in **Google Earth** are not as easy as with Garmin's **BaseCamp**. Spitting a **Track** requires that the project be saved by **Google Earth** as a ".kml" file that must then be manually edited with a text editor such as Microsoft's Notepad.

Deleting or moving individual GPS points along a **Track** may be done by right clicking a **Track** in its **Track** folder in your project's **Tracks** folder. (That is: [project name] -> **Tracks** -> [track name] -> **Track**) and select **Properties**. Individual **Track** points may be moved, added with a left click, and deleted with a right click. I may take practice to become comfortable with this process.

As with **Waypoints** above, a **Track Properties** dialog allows you to adjust its display characteristics. The **Style, Color** tab allows adjustment of **Track** line color, width, and opacity. **Track Points** are handled separately and are normally left with Zero opacity. Group modification of **Track** display properties may be performed as described for **Waypoints** above.

Finalizing View in Google Earth:

A completed project may be saved as a ".KMZ" file. To create this file, right click on the project folder in the Places listing. Choose "Save Place As....". Save your folder as a ".KMZ" format file. This file can be imported to **Google Earth** on other computers for display.

Editing GPS Data in ExpertGPS

Concept

Garmin's **BaseCamp** and **Google Earth** are both free programs. Both allow extensive GPS data editing and display capabilities. Neither is designed specifically for cartography. Software is available that is oriented toward producing professional quality maps. The majority of this software, however, is expensive, often priced in the $5,000 to $20,000 range. Less expensive but adequately capable software is also available. One example of this less expensive software is **ExpertGPS** for $250.

ExpertGPS is specifically designed for producing maps. It can show GPS **Waypoints** and **Tracks** on topographic, aerial photo, and road maps. It also allows use of scanned maps. It also allows adding, deleting, and editing of both **Waypoints** and **Tracks**. **ExpertGPS** can read **GPSMAP 64st** data and operate as a standalone editing, display, and map printing package.

Waypoints

Waypoint editing is facilitated with two symbols in the tools bar above the map area. The tool used to create **Waypoints** is a small circle with four short lines radiating outward. The "***Move Selected Tool***" (a cross with a small arrow pointing up and to the left) is used to select and move or edit an existing **Waypoint**. To edit the characteristics of a **Waypoint**, right click on it with the selection tool.

Tracks

Track editing is somewhat obscure compared with **Waypoint** editing. **Tracks** may be moved as a unit using "***Move Selected Tool***".

Individual trackpoints may be deleted but not move with respect to other points in the **Track**. To delete a trackpoint, double click on the **Track** containing the point to be deleted. Select "***Trackpoint List***." Locate the point to be deleted by clicking on entries in the **Trackpoint List**. Once the point is located, right click on the point's entry to select "*Delete Point*."

To split a **Track**, follow the same sequence as for deleting a point but select "**Split Track**."

Notes

ExpertGPS includes a data type not available in **BaseCamp**. It an object named **Note**. It is useful for adding descriptive text blocks to maps. **Notes** are similar to **Waypoints** except they do not carry any GPS data collection information. While **Notes** differ from **Waypoints**, the both allow for displayed text and a map symbol. When used as a text block without a symbol, its "***Text Position***" should be set to "***Above Marker***" to provide an easily located handle to move it if necessary.

Note and Waypoint movement is done by selecting its symbol, visible or otherwise.

Shapes

One key additional object type is the **Shape**. **Waypoints** and **Tracks** are most associated with navigation and GPS use. **Notes** and **Shapes** are used in cartography, especially with GIS. **ExpertGPS** allows conversion between the two representation methods.

A **Shape** is a two dimensional object of arbitrary size and shape. When converted by **ExpertGPS**, a **Track** becomes line **Shape**. The difference between a **Track** and a **Shape** is that the **Track** contains GPS collection information while the **Shape** does not.

Waypoint, Track, and Note Display Parameters

ExpertGPS provides a variety of symbols to be used with Waypoints and Notes. Those symbols and colors are not, however, individually set for each object. The same is true for line colors and widths for Tracks and Shapes. These parameters are set by an object's configuration "*Type*." That is the top entry when editing an object. Configuration "Types" are separate for Waypoints, Notes, Tracks, and Shapes even when identical "Type" names are used in each.

Waypoint and Shape configurations include selecting a symbol or none and descriptive text if any. Both allow adjustment of text size but not symbol size. How text is displayed is determined by settings in the "*Map Display Options*" dialog found under "*Options*." Drop shadow and background can be adjusted including *None*, *Transparent*, *Opaque*, and *Framed*. Text and position of that text relative to its symbol (even if invisible) is set separate for individual Waypoints and Shapes. Waypoint text labels may be turned off if desired. Their text size can be set to "Hide."

Track and Shape configurations include color, width, opacity, and whether it has a border. A text label may be added for display alongside the displayed path.

General File Considerations

Waypoint/Track vs Note/Shape: As mentioned above, Waypoints and Tracks are associated with navigation and GPS data. However, commercial mapping systems and GIS primarily use Notes and Shapes. This differentiation is of little concern unless data is to be transferred in disk file form to other agencies. Fortunately ExpertGPS is able to create data files in a number of different formats. If a file format has not been specified when transferring GPS data to other agencies, the likely safest format is Google Earth ".KML" with Waypoints and Tracks converted to Notes and Shapes.

Printable map format: While ExpertGPS can directly print maps, it is often desirable to insert them into other documents. PC systems typically provide a method to print to a file. Microsoft Windows normally provides "Microsoft Print to PDF" printer option. Programs such as Microsoft Word allow the resulting ".pdf" file to be directly inserted into a document. However, the direct ".pdf" insert does not always provide optimal image resolution.

Significantly improved image resolution of inserted ".pdf" maps can be achieved by first converting that ".pdf" to a ".png" (Portable Network Graphics) lossless image file. "PDF to JPG" (Trisun Software) is an inexpensive utility that can do this. "PDF to JPG" is flexible, capable of a variety of conversion formats and resolutions. 300 Pixels/Inch is adequate for typical 8.5 by 11 Word documents. Higher resolution might be preferred for magazine or book imaging.

Finalizing View in ExpertGPS

A completed project may be saved as a ".gpx" file using the familiar File -> Save As method. Be sure to use a descriptive filename. Consider including the file date in the name as file dates and times are often

lost during transfer from one machine to another. Actually, project data should be saved periodically through its development. That past saved data will provide both a record to the project progress but also a backup if the current work is lost. It is easier to recover a project from the previous day's work than from last month's!