

Major Activity I (Groups 1, 2, and 3): Methods Assessment Projects

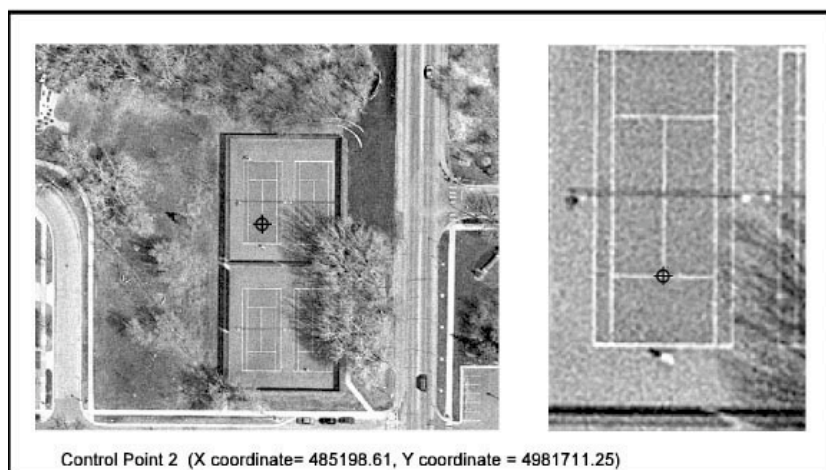
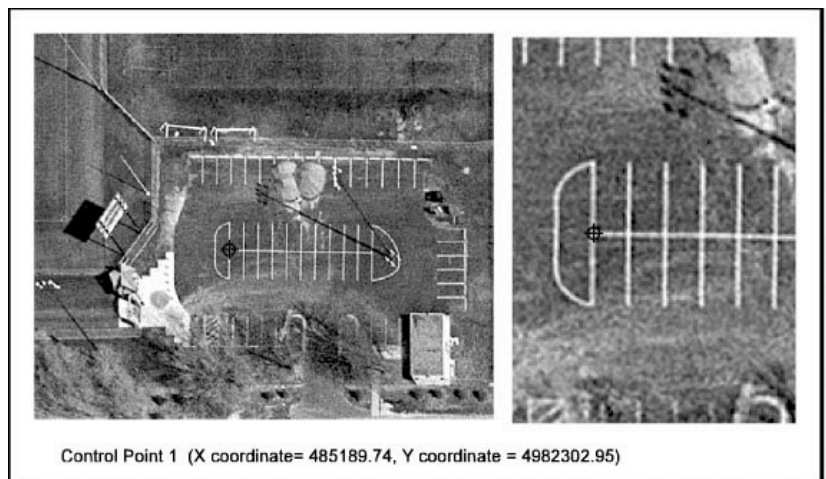
You will spend the first part of the semester in one of three groups, either

- 1) developing a control network using high-accuracy GPS,
- 2) evaluating the accuracy of aerial photographs from various sources, image mosaicing if needed, building, infrastructure, and impervious surface mapping, or
- 3) evaluating the accuracy of code-phase GPS data collection at open and sub-canopy points, and then developing the trails data layer from a combination of on-screen and field digitizing.

Each group will write a short report, approximately 4-6 double-spaced pages of narrative, plus any pages required for figures, on their methods and results tables and figures. Detailed instructions are found below.

Note that these group projects will take place across all study areas. Some will concentrate more on certain portions of the study area, but for the most part each group should strive to distribute their methods assessment project across study areas A, B, C, and D.

Group 1: Control Points. This group will develop precise control points on campus via carrier phase GPS surveying. They will use a high-accuracy GPS receiver (Trimble ProXH) and a local base station. At least 15 well-distributed control points. Six of these will be in support of Group 3, described below, paired sets of points from which that group may triangulate to sub-canopy locations. Group 3 may establish and mark these "baseline" points, from which to triangulate the sub-canopy points, with ground-flush wooden stakes. The remaining 9 control points (not used to support Group 3) should be photo-identifiable, e.g., as shown to the right. The output will be a document describing the methods used to develop the control points, the x, y, and z locations of the control points, an annotated photo of the study area showing control point location, and a large-scale image "chip" of each control point, with the location identified (see the graphic later, in the detailed description of the group 1 requirements). All coordinates and errors will be reported in NAD83 UTM Zone 15N meters.



A first step for this group will be to assess and document the accuracy of their methods using known control points. You will do this by testing the ProXH in carrier-phase mode, correcting against CORS, to measure the locations of NGS control points on Larpentuer Ave. There is a high-accuracy control point near the capital, known as "Minnesota 1," and five high-order control points along the north edge of campus, coordinates identifiable via the NOAA/NGS websites, you should do at least five tests using this set of known control points.

Points may be sidewalk intersections, curbs, the base of visible lightpoles or other structures, or lines painted in parking lots, sidewalks, tennis courts, or other permanent surfaces. Note that some roads have been repaved, so points may have shifted. Many points will be on the edge of roads. Be extremely careful when selecting points to use, and collecting data. **Use offsets to make sure you do not set up collecting stations and stand in the roads or road shoulders!**

This group will write a report documenting their methods, accuracy test against the Larpentuer points, and point locations. This group must turn in their uncorrected and corrected data as part of this report, in a clearly documented, well-organized condition. A summary page for each control point (or perhaps two points per page), should be produced that looks something like the figure on the preceding page

Group 2: Photo accuracy assessment. This group will evaluate positional accuracy of various photo sources. You will use the Trimble ProXH GPS receiver, with an exterior antenna, to establish the coordinates for photo-visible points. Group 2 will evaluate the positional accuracy of the following images:

- A 2006 USGS aerial photograph of St Anthony Park
- A 2005 Citypics image of St. Anthony Park

Both of these are found in the ESPM4295 website, www.paulbolstad.net/courses/4295/4295_home.html, then follow the links to the image files

You will generate new “true” coordinates via GPS, and perhaps control points developed by this year’s control group.

You will collect image coordinates and “true” coordinates for a set of test points, and determine the difference between the true and image coordinates.

You should first establish the accuracy of the receiver. You should station it over known NGS point indicated on campus, or the "Minnesota" point near the capital, and one of the A-D points along Larpenteur Ave. and collect at least 300 fixes. You should collect control from at least three different NGS points, at least three times at each point, for nine tests of the GPS receiver while collecting 300 fixes. You should differentially correct these data, and compare the GPS-estimated locations to the NGS locations. You may find the mean accuracy, and other statistics for accuracy of your “truth”. You must include the National Standard for Spatial Data Accuracy (NSSDA) statistics in your report.

Once your group has tested the receiver and are sure they can collect accurate data, you should collect data for at least 20 well-distributed ground truth points in the images. You first identify candidate points on the photos, visit them in the field to make sure they still exist (with photos in hand), and collect GPS data for each of these new test points. You collect at least 300 position fixes for each test point. You should then differentially correct the data using Trimble H-star processing. You should obtain at least 25 test points to be used against each image.

You then extract the photo-coordinates from each of the photos for the corresponding points. You should then calculate the positional error for each point. You should then summarize all these data into a report. The report should include tables summarizing average and standard deviation for error by equipment type, and accuracy for each of the images. You need to describe your work such that someone reading it will know what you did, understand the accuracy of each image, and the appropriateness of each image for data development. You should make a recommendation on which to use for the current project.

Group 2 will produce a description of the methods including a map, list, and detailed descriptions of control points and coordinates (x,y,z), and accuracy assessment report with individual point errors, mean errors, and standard errors.

Group 3: Sub-canopy GPS accuracy assessment

This group will establish the accuracy and efficiency of the Trimble ProXT handheld, with and without an external antenna, when collecting a) stream digitizing (single points while walking), and b) 150+ fixes, stationary over a point. Both uncorrected and corrected Trimble data will be evaluated.

You will first verify your ability to use the equipment correctly, and get an idea of open-sky accuracy, by collecting data and calculating positions for three NGS points on Larpenteur Avenue. You will then establish test points under partial canopy (near edges of woods), and sub-canopy. You will coordinate with Group 1, above (read their instructions) so that they may measure "baseline" points, from which you will survey the X/Y coordinates of partial- and completely below-canopy points using a laser rangefinder. You need to collect data for a total of 9 points, 3 open-sky NGS points along Larpenteur to test your receiver accuracy, 3 partially-obstructed points, and 3 dense-canopy points.

Sub-canopy points will be determined by first establishing a baseline with two intervisible points near the forest stand, but in the open, using the ProXH or GeoXH receivers, and collecting at least 15 minutes without an interrupted signal for each point. Then use the laser rangefinder/angle encoder and coordinate geometry calculations to determine the sub-canopy locations. The calculations of x and y coordinates will require some familiarity with coordinate geometry, described in brief in Dr. Bolstad's GIS Fundamentals textbook, and in most surveying textbooks. In Bolstad, you will find a description of triangulation on pages 79-80. You will also need to adjust to horizontal measurements using the formulas on page 85. Useful formulas are also found

in Bolstad Appendix C, starting on page 522.

The calculations should all take place in a planar coordinate system, e.g., UTM. Diagrams in the Bolstad book show examples of such calculations. Note that the angles and distances between the baseline and unknown point depend on their relative positions, e.g., they are different if the point northwest or northeast of the line. Therefore, a drawing made in the field with the approximate north location and point layout is quite useful in setting up the solution equations.

You will measure the accuracy of the test GPS receivers (Trimble ProXT, and if available, ProXH and/or GeoXH) with and without an external antenna. You should test the receivers on 5 separate days/times of day at each of the 6 sub-canopy points.

You will produce a written report describing the purpose, methods, and results, including tables summarizing accuracy using NSSDA. Your report should include a detailed description of control point development methods, annotated images showing general test point locations, and details, large-scale images, showing test point locations.

Major Activity II (Groups A and B): Data Development Projects

You will spend the mid-part of the semester developing and documenting data layers to be used in subsequent analysis, in one of three groups:

- A) trail alignment and attribute collection from existing documents and GPS, for trails both within Marine on St. Croix, and for the surrounding regional trail system, and cadastral data organization and verification,
- B) image data collection/mosaic and building and roads data collection and digitizing (entire study area) and impervious surface and culverts/tunnels on main roads (within Marine on St. Croix), and wetlands from existing digital sources (entire study area), and verification and field updating of large (> 0.3 acre) depressional wetlands in Marine on St. Croix.

Group A: Trail Alignment and cadastral data. Trail data for Marine on St. Croix are contained in diverse sources: Maps, deed records, and memory of long-time residents. One primary purpose of this group is to synthesize these various resources, and create a uniform digital data set and metadata for trails within Marine on St. Croix. This will involve meeting with citizens liaisons from Marine on St. Croix, evaluating current sources, creating an inventory of available data, evaluating these data for quality, and digitizing the trail locations from original source materials, aerial photographs, and field GPS. This work should be conducted within the municipal boundary only of Marine on St. Croix.

Because analyses will be in the context of regional trail connections and land ownership, this group will also collect/organize two other data sets: regional trail alignments, and cadastral data. Cadastral data will be provided for a portion of Washington County. These will be subset and identified as either private or public, and if public, by governmental unit. There is an active project working to extend the Gateway Regional Trail from its terminus, at Pine Point Park, southwest of Marine, to William O'Brien Park, north of Marine. The group will obtain data on lands under consideration, and evaluate various alternative alignments, given constraints on the future trail (maximum allowable slope, a desire to avoid bridges to the extent possible, and other constraints).

Finally, this group will develop/analyze the highest resolution elevation data for the extended study area.

Group B: Road data collection, and impervious surface/main culverts, and wetlands data.

This group should organize existing line road data for the larger study region (Pine Point to William O'Brien parks), verify road existence and update the roads for the study region based on the available aerial photographs, obtain and organize national wetlands inventory data for this larger study area. The group should also develop an impervious surface layer that includes all the paved and building surfaces within Marine on St. Croix, identify the main drainage paths within Marine on St. Croix, including major culverts for road crossings, and update/verify/update depressional wetlands greater than 0.3 ha within Marine on St. Croix that fall on public land, or when permission can be easily obtained on private land.

This work will involve meeting with representatives of Marine on St. Croix to help in identifying streams, drainageways, and major culverts within Marine, and identifying major depressional wetlands that might not be on current maps.

Major Activity 3: Groups X and Y, Analysis

There are two primary groups, corresponding to two main analyses. Group membership in X and Y should correspond roughly to group membership in groups A and B, respectively, although there may be a slight adjustment, due to work load and skills.

Group X will analyze and report on at least two alternative alignments (routes) for extension/connection of a regional trail from Pine Point Park to William O'Brien Park, through Marine on St. Croix, develop a walking tour of historic sites within Marine on St. Croix that connects to one of these regional trail alignments, and produce high-quality digital and hardcopy maps of the historic route.

Group Y will analyze and report on impervious surface threats, and mitigation strategies, for the Marine on St. Croix area, including zones of highest risk of increased runoff if developed, most sensitive near-stream and near-river areas, wetlands vulnerable to siltation with up-watershed development, and locations for runoff mitigation structures. This will involve calculation of contributing area and flow direction surfaces, watershed boundaries, and other hydrologic attributes and analyses.