ANALYSIS OF ACCURACY ASSESSMENT PROCEDURES AT TUZIGOOT NATIONAL MONUMENT

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Introduction

Tuzigoot National Monument was chosen as one of the first pilot locations in the NPS - USGS/BRD Vegetation Mapping Program. Field sampling and photointerpretation were conducted during fall and winter of 1995, and a draft vegetation map was produced by summer, 1996.

Evaluation of spatial accuracy

In the fall of 1996 Karl Brown and Ralph Root collected GPS field data at several sites on the monument (road system, ruins boundaries, and several clearly visible vegetation boundaries). These data were entered into the TUZI GIS and overlayed on the vegetation map to test its spatial accuracy. In all instances data collected from the GPS (with a locational accuracy of 5 to 10 m.) fell within 10 to 12 m. of the corresponding features on the vegetation map.

Evaluation of accuracy of vegetation types

Determination of sampling scheme

Because of the small size of this area a 100% sample was taken for the accuracy assessment. The vegetation map contains a total of 240 polygons for the monument and its environs. The label point for each polygon was viewed in Arc/Info, and moved closer to the center of the polygon if it fell within 10 to 15 m. of the polygon boundary. Where polygons were very small or long and thin, it was not always possible to place the label point more than 10 m. away from the edge. Selecting multiple points within single polygons was considered, but with only one week of field time available it was not thought that more than 240 sites could be visited. Therefore, this accuracy assessment was limited to 240 points.

Procedural objective

The objective was to visit and document vegetation types at 240 sites representing label points of mapped vegetation polygons at Tuzigoot NM. Expected real-time GPS accuracy was 10 meters or less Circular Error Probable (CEP). The Precise Lightweight GPS Receiver (PLGR) with PLGR+96 Federal Version software was utilized, with Estimated Horizontal Accuracy (EHE) $\pm$ meters 2D as the accuracy statistic.

Estimating the field effort that would be required

Our initial estimate for navigating to and identifying the vegetation at each polygon was 20 minutes per site. We envisioned a two-person field team visiting 24 polygons (3 per hour)in one full 8-hour working day. With 3 teams working simultaneously we estimated that it would take between 3 and 4 days to complete the field work. With an initial day of training and familiarity we estimated that a full 5-day week in the field would be required to sample a single point in each of the 240 polygons.

Preparation for field work

One of the more difficult aspects of conducting this accuracy assessment was mobilizing the people needed for the work. Our assumption that 3 teams would be required necessitated that we locate 3 persons who are able to identify the vegetation, and three additional persons capable of (and authorized) to use PLGR GPS receivers. It took several months to bring these people together in combination with selecting a suitable time frame for identifying the vegetation. Bill Rosenberg, who did the initial plot sampling and descriptions was the lead vegetation person. Karl Brown was the lead GPS person. Ralph Root served as overall coordinator for the field work.

Coordinates representing the label point of each polygon were output from Arc/Info to an ASCII file using "ungenerate". The coordinates for each label point were then converted to the required comma delimited format for waypoints in the PLGR GPS by using both the "vi" text editor and Excel. The PLGR mission planning software was used to read the waypoints and download them into the PLGR GPS receivers. All 240 points were loaded into each PLGR to be used in the field for maximum flexibility. Before going to the field, waypoint numbers as loaded in the PLGR were checked directly against the GIS and hardcopy field maps to verify that point numbers and locational coordinates were consistent.

Two 1:2400 scale maps were prepared for field crews to use while navigating to points. One contained the polygon boundaries, label points, and corresponding label number. The second map, also 2400 scale, was an orthophoto with the polygons and labels superimposed. Two maps were needed because the label numbers were not always readable over the orthophoto. Field crews were also equipped with aerial photographs from the mission used for the vegetation mapping and a photocopy of the 1:24,000 USGS topo map covering the area.

Copies of the vegetation key and vegetation descriptions prepared during the vegetation mapping were made as reference documents for each field team.

A field recording form was also prepared with columns for point number, local time, estimated locational error as shown on the PLGR, the observed vegetation type, a Y/N for whether or not the crew was able to navigate all the way to the point, and comments for estimating an offset if necessary. We later saw that putting the names of field teams on the sheets was important in case questions arose about specific sites after the field work was completed.

The superintendent was contacted before the field work, and he arranged to have the resources management specialist at the visitor center for the first part of our field orientation.

On-site procedures

The first day was spent training and orienting field crews. In the morning Bill Rosenberg took the vegetation specialists around the monument to become familiar with using the vegetation key to identify the vegetation types. At the same time Karl Brown taught the GPS team members how to use the PLGR to navigate to the pre-programmed waypoints representing the vegetation polygons. After lunch the entire group formed a single large team and navigated to several points and identified the vegetation. Before mid-afternoon individual teams felt comfortable with going out on their own. The three teams were able to visit close to 50 points during the remaining 2 hours that afternoon.

If for any reason an accuracy assessment point was found to be inaccessible (water, impenetrable mesquite, etc.) the field team navigated as close to the point as possible, determined the direction to the point, and estimated the ground distance using the navigation read-out on the PLGR. When visibility of the point was in question the aerial photographs were used for reference to get a look from "above". Distance and azimuth to the offset point was recorded on the field form.

Three teams worked 8 hours Tuesday and 6 hours Wednesday. All 240 points were visited, nearly two days ahead of our initial estimate. With 3 teams working a total of 54 "team-hours", the time required per point, including transit time between points, averaged 13.5 minutes. Time between points varied from as little as 2 minutes to as long as 40 minutes, depending on terrain, accessibility, and physical stamina of teams.

Improved GPS accuracy over the fall 1996 trip was realized due to increased monitoring of system and signal status, and the consistent use of WAGE (Wide Area GPS Enhancement) settings on PLGRs and field rangepoles for external antennas. Real-time GPS accuracies were consistently below the 10 meter desired minimum, (with 2 exceptions of 12 and 17 m) and went as low as +/- 1.4 m. at one site. The majority of sites had accuracies ranging between +/- 4 and 8 m.)

After completion of the field work, each team went over the notes collected for each polygon with Ralph Root to assure readability of notes. During this process several ambiguities were found and resolved. This brief review process probably saved hours of phone calls and clarifications that would have been needed later as the data were analyzed.

Results and discussion

Since this was one the first accuracy assessment exercises in the NPS / USGS-BRD Vegetation Mapping Program, it was a learning process. The following comments are reflections on the week's experience and things which could be improved upon in future accuracy assessments.

The time required to do this work was significantly less than estimated (13.5 min/site versus 20 min/site). As two person teams were assembled we became aware of the importance of "matching" team members as closely as possible according to field ability, temperament, and physical stamina. Once well-fitted teams are assembled they should be kept together for the duration of the field work, if practicable.

The importance of a well prepared, "tight" vegetation key cannot be underestimated. The key at TUZI was found to have a few ambiguities and inconsistencies which slowed down and confused the field effort. Between the first and second day Bill Rosenberg made some refinements to the key which helped to reduce some of the problems.

The detailed narrative vegetation descriptions resulting from the field sampling work in 1995 were not used by team members to the extent they could have been. More emphasis should have been placed on having these descriptions handy, and referring to them often to help make judgements about types, especially where the type is in doubt.

Distinctions between types which are density dependent were found to be very tricky. Deciding when a type has less or more than 5% cover was sometimes a difficult call to make. This could happen on EITHER side of mapping effort (i.e. PI versus ground verification), causing mismatches in mapped types.

Differences in phenology added complications to identifying types. The field sampling was done in October, 1995, and the accuracy assessment was done in May, 1997. Many of the herbaceous plants observed and described in the October time frame were cured or virtually absent in May, and early season plants provided the converse situation. This required extra time and judgement on the part of the botanists to mentally "cure out" the early season plants, and look carefully for signs of the late season plants. Obviously the answer to this problem is to try to schedule the accuracy assessment for the same approximate season in which the descriptive plant data were collected. In the case of Tuzigoot the accuracy assessment was, in fact, targeted for fall of 1996 but because of scheduling problems could not be implemented until May, 1997.

In the specific case of Tuzigoot, there was some confusion about the precise location of the southern boundary of the mapping area. When plots were positioned for the descriptive field work in the fall of 1995, more emphasis would have been placed on the vegetation characteristics in this area (the river bottomlands). Existing plots did not pick up all the variation found at the accuracy assessment locations in this area. For example, sycamore was found in association with cottonwoods but did not receive adequate emphasis in the original descriptive writeup. The bottom line of this point is the importance of having advance information synchronized with work efforts throughout the sampling and mapping process.

Another comment provided by Bill Rosenberg is that plot locations might have been chosen more effectively if they had had preliminary "tone and texture" polygon delineations as an aid to selection. This procedure has in fact been implemented on subsequent work in other areas.