

City of Durango's 2004 Community Forestry Program

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Abstract

The City of Durango, Colorado, utilized ArcView 8.3 and ArcPad Application Builder to design and implement an inventory of all city-owned trees and planting sites within the city limits. Student volunteers were equipped with HP iPAQ handheld computers and field-trained in the use of GPS and the botanical techniques of species identification, measurement criteria, conditional assessment, and maintenance needs. Field data was then uploaded to city park personnel via customized ArcPad forms and stored in a geodatabase.

Background

In 1978 the Durango City Council adopted a resolution to assume ownership of all trees located in city right-of-ways. The city thus assumed maintenance responsibilities including the pruning of trees; the identification and removal of dead, diseased, or dying trees; and the planting of new or replacement trees. The City of Durango's Parks and Recreation Department was assigned to manage urban forestry issues. Park department personnel determined that a formal tree management plan was needed so in 1980 the city joined the National Arbor Day Foundation and submitted an application for recognition under the Tree City USA program. To qualify as a Tree City USA, the City of Durango had to adhere to the four standards set forth by the National Arbor Day Foundation and the National Association of State Foresters.

1. Pass an ordinance for tree protection and maintenance
2. Hold an annual Arbor Day ceremony
3. Establish a Parks & Forestry Board
4. Hire a full-time forestry staff

In 1982 the Durango Parks Department hired a full-time arborist and assistant to maintain city-owned trees. Three years later the current City Arborist, Ron Stoner, assumed responsibility to oversee urban forestry division management.

The need for a tree inventory and comprehensive management plan became apparent to the city forestry staff, so they initiated the city's first tree inventory in 1989 with the assistance of the Colorado State Forest Service. Using maps, the city's interior was subdivided into 14 forestry management units plus parks, schools, and cemetery. Data collection was parsed accordingly. Criteria established in the inventory included tree species, size, placement, location, condition, and management needs. The community forestry program established that the City of Durango owned 3,428 trees within public right-of-ways and on public property valued at several million dollars. Information was provided to the city in the form of a report and appropriate measures were taken to prune, treat and/or remove trees as recommended in the report summary.

Although the tabular tree inventory report was initially very useful to the city arborist and his staff, it became increasingly outdated in the early 90's as it lacked a functional management plan and ways to manage data collection in the field. It was about this same time that the city initiated an interpretative photogrammetry program to develop a planimetric and topographic base map for its recently established geographic information systems (GIS) program. In 1994, Merrick and Company of Denver, Colorado, provided the city multiple base layers including a tree layer created by supervised classification and digital extraction of the aerial imagery. Tree features were attributed by type as deciduous or coniferous but were never fully integrated with the tabular data of the 1989 tree inventory. Nevertheless the data layer provided a useful spatial reference and visualization tool for the City Forestry Division as well as Public Works, Planning and Community Development, and Parks and Recreation Departments.

The late '90s ushered in a construction boom in Durango that continues to the present day. Growth and urban expansion within Durango added several thousand new trees to the City Forestry Division's responsibilities through annexation and development of the surrounding areas. An updated tree inventory was requested by forestry personnel to identify the new city-owned trees and to update and map those of the previous inventory. The inventory was coordinated with the City GIS program to make the data more portable and to facilitate development of a functional forestry

management plan. Advances in GIS technology and the advent of the personal digital assistant (PDA) and mobile GIS application supported this course of action.

In the spring of 2001, the City of Durango embarked on a new and expanded aerial photography/digital mapping program with Bohannon-Huston, Inc. (BHI) of Albuquerque, New Mexico, that flew the entire city boundary and periphery. A mosaic of the 1:7200 color orthographic imagery and high resolution (0.5 ft.) aerial mapping of the city interior and surroundings were released for integration with all GIS applications the following year. Elements of the '89 tree inventory and '94 GIS survey were combined with the aerial data to develop a city tree geodatabase using ESRI ArcMap 8.3 software. The geodatabase model served as the foundation of the new forestry inventory. Much of the same criteria (e.g., size, condition, management needs, etc.) used in the previous tree inventory were incorporated into the new inventory but some revisions in context and indexing were made. Forestry management units were redrawn to account for the urban expansion that occurred since the last community program and changes in demographics. School properties were removed from consideration because they no longer fell under city jurisdiction. The ability to integrate relational tables with the geodatabase allowed for enhancement of identification criteria. Tree species and sub-species could be defined by both their scientific and common names by relating the former to the latter. Subclasses and domains were also incorporated into the geodatabase schema to highlight site details, categorize descriptive tree information, and assure consistency of data.

The city tree geodatabase was designed and implemented in the fall of 2003, but had many null records. It utilized the geospatial data collected in 1994 to create the tree point feature class but attributed data was largely outdated and incomplete. Linking the tree features to the tabular 1989 data was not practical because size and condition criteria were no longer accurate. Furthermore, the earlier inventory did not formally index trees so assignment of an id to each of the 3000+ records would be necessary in order to link the tabular data to the attributes of the tree feature class. A method to facilitate mobile data collection to update the tree count and classification criteria was therefore needed. City forestry and GIS staff agreed to deploy Hewlett-Packard (HP) 5550 iPAQ pocket PCs running ESRI ArcPad 6.0.2 software to execute the tree inventory system and update the tree database. ESRI Application Builder 6.0.1 was used to customize the ArcPad configuration file and tree inventory form. In addition, one of the two iPAQs used in the survey was equipped with a Navman 3450 GPS receiver. The City Forestry Division created four intern positions in early

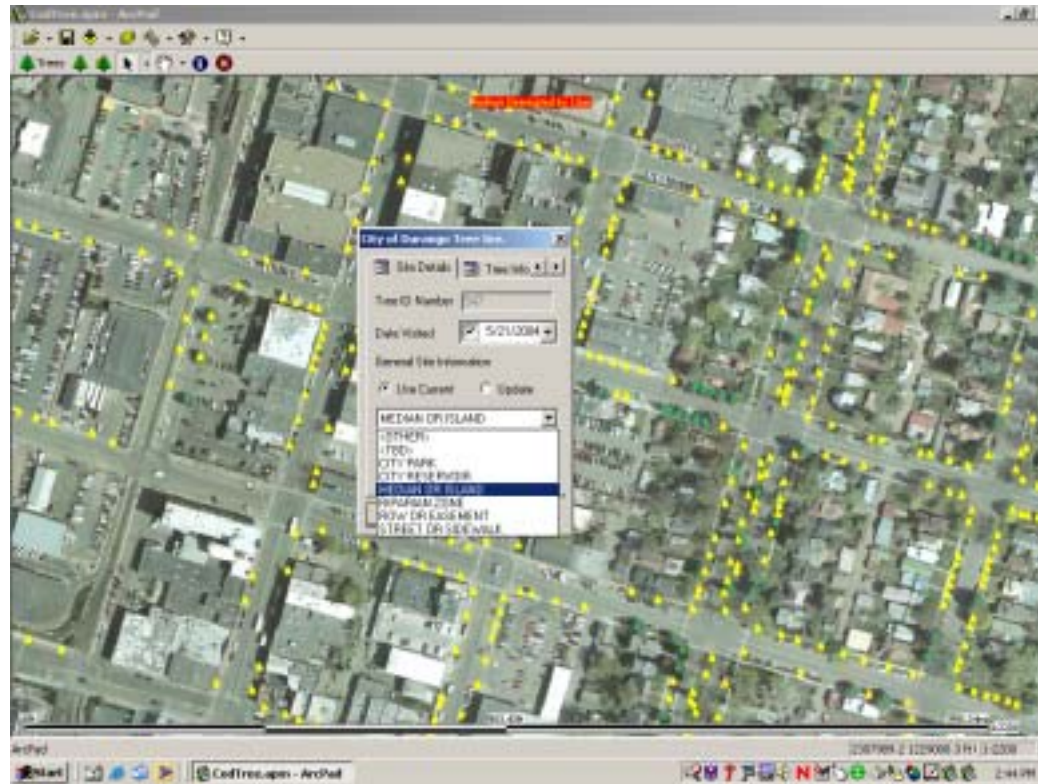
2004 and enlisted students from Fort Lewis College upon recommendation by Dr. Scott White, GIS Coordinator for the Department of Geosciences. The student interns were trained by the city arborist to identify tree species, measure tree diameters (i.e., diameter-breast-height (DBH), caliper), qualify tree conditions, recommend management needs, and evaluate potential planting sites. The GIS Analyst trained the students in the use of ArcPad and the GPS extension.

Mobile Tree Inventory System

An integral component of the City of Durango Tree Inventory system design is the customization tools in ArcPad Application Builder Studio. By utilizing a custom configuration file (.apx) and layer definition file (.apl) to design custom forms in ArcPad, the City of Durango was able to port relevant elements of the city trees database directly to the PDA for data entry and updating of the city trees shapefile (.shp). The default configuration file in ArcPad was modified to better serve forestry personnel in the field. Two toolbars were incorporated into the design. The first was the default 'Main' toolbar. It contained the built-in tools: openmap, newmap, layers, addlayer, GPSPositionWindow, etc., and various related tools in submenus. The second was a custom 'Trees' toolbar that merged several built-in tools (e.g., modeselect, delete, fixedzoomin, modeidentify, exit, etc.) in menus and submenus with a custom Addtree and GPSTree tool. The submenus allow more editing and selection options to be embedded into the program while the custom tools allow the data entry/edit form to be launched at the same time a new tree point is added to the dataset.

The design of Durango's tree inventory data entry/edit form built upon the standard tree inventory form already embedded in ArcPad but expanded it to several pages. The first of these pages records site details including the tree ID number at a location, the date visited, and general site information (GSI). The GSI info is selected from a combo box using the domains: street or sidewalk, city park/property, city reservoir, median or island, riparian zone, row or easement, other, and the default to-be-determined (<TBD>). Two radio buttons were added to page one to set the current GSI as default or to update the GSI selection, respectively (see Image 1). These commands were added to accommodate batch entry of trees at a uniform location (e.g., city park).

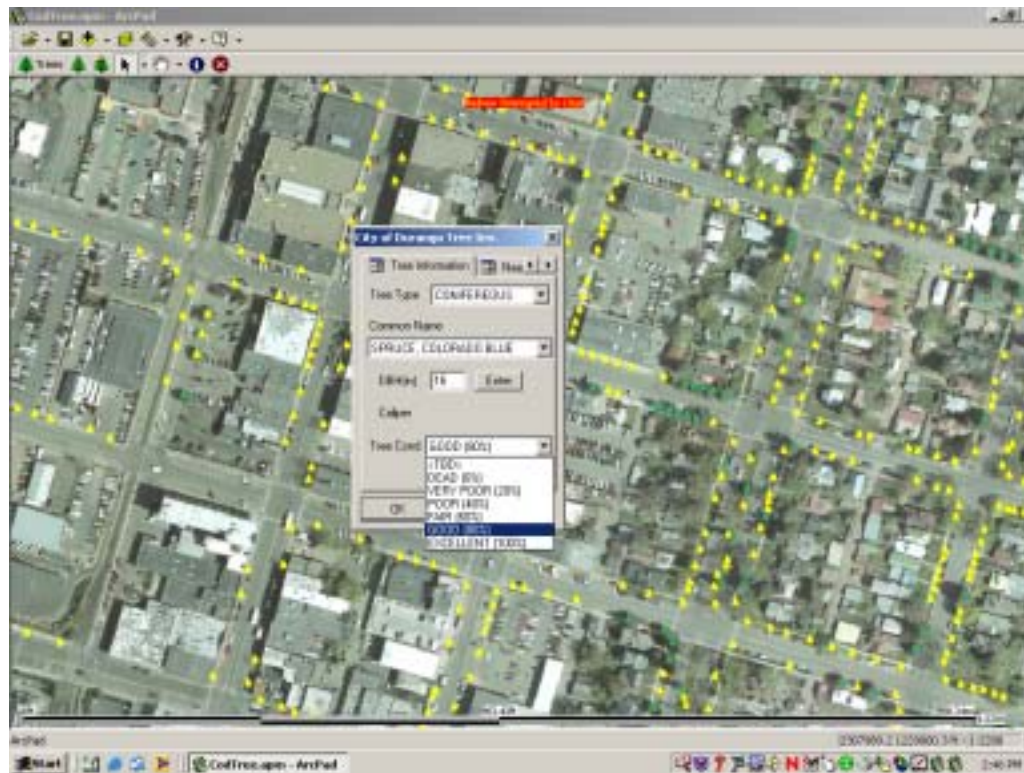
Image 1:



The second page in the form records tree information including tree type (coniferous or deciduous), common name (i.e., species and subspecies), DBH (in) or caliper range (in), and tree condition (see Image 2). Combo boxes with associated domains are used for the tree type, name, caliper, and condition fields. The DBH is a text field and has an associated 'enter' button to validate the data entered. The tree type field defines the symbology used to display the tree features in the ArcPad map document (.apm). It was the only populated field imported from the Merrick shapefiles. The common name field consists of a pull down menu listing 82 tree names (38 species) known to exist on city property. The caliper domain lists four diameter ranges for immature trees: 0-1 inch, 1-2 inch, 2-3 inch, and 3-4 inch. The DBH text field allows entry of tree diameters

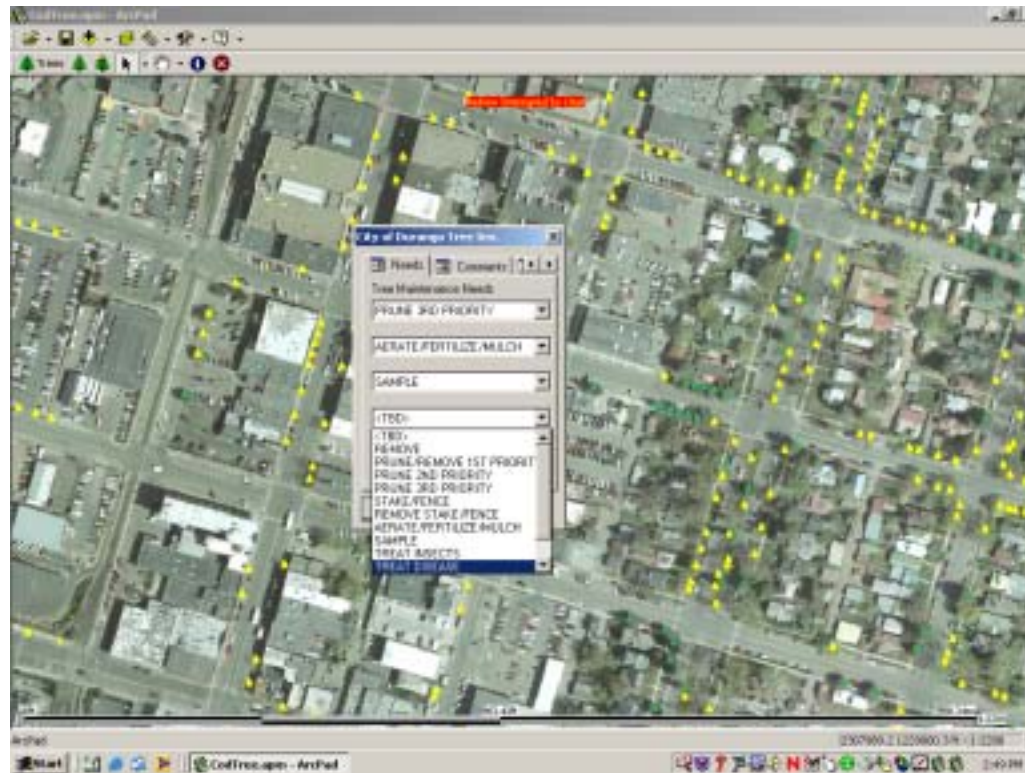
between 4 and 80 inches. If an X value between 0 and 4 inches is entered, the DBH will automatically revert to 0 and the message " X is less the minimum DBH diameter, use caliper range." will appear. If an X value greater than 80 inches is entered, the warning " X inches is high for the DBH of a city tree." "Sure you want to enter this value?" will appear on the screen and the user will be prompted to answer 'yes or no' to accept the value. A valid DBH entry will inactivate the caliper range combo box so that a second diameter will not be entered inadvertently. The final field on page two defines the tree condition based on approximate percentage living or healthy biomass: excellent (100%), good (80%), fair (60%), poor (40%), very poor (20%), and dead (0%).

Image 2:



The third page of the custom form records tree maintenance needs. It contains a stacked array of combo boxes (4-high) that list identical management domains: remove (non-hazard), prune/remove 1st priority (hazard), prune 2nd priority (non-hazard), prune 3rd priority (shape), stake/fence, aerate/fertilize/mulch, sample, treat insects, treat disease, plant, and ok (do nothing). This allows up to four maintenance options to be entered for an individual tree (see Image 3). The fourth and final page of the form contains two text boxes that allow entry of site comments and tree comments, respectively. It serves as a method to add supplemental and/or descriptive information to the data record where appropriate. Because the form was designed using tabular domains (.dbf), values saved into the city trees shapefile and checked back into the trees database are primarily double numbers or integers. Only the comment fields accept text values.

Image 3:



Project Status

The City of Durango Trees Inventory Program began in February 2004 and will continue throughout the course of the year. To date, over 4000 city trees have been recorded with perhaps that many yet to be counted. The initial survey concentrated on older and more established areas of the city where many tree types were already indexed in the trees shapefile. Current counts are taking place in the city's newer annexations and subdivisions. These areas require the deployment of the GPS unit while data gathering to assure more accurate spatial referencing. The four student interns employed to conduct the counts have made remarkable progress in completing the inventory. They have recently been trained to review their field data in ArcMap and to conduct database edits in the office. Once the intensive data collection phase of the tree inventory is completed, statistical analysis and summary will be applied to the data.

Conclusion

Application of the mobile GIS system to the city tree inventory is providing Durango with the functional forestry management plan that it long sought. In the next phase of the project a comprehensive work flow form will be created in Arc Pad Studio as an applet (.apa) file. The new form will be integrated with the city-owned tree inventory to dispatch park crews to a site for maintenance and tree protection. The continued cooperation between the city's forestry and GIS divisions in implementing and sustaining the GIS-based community forestry initiative is a testimonial to the City of Durango's dedication to preserving its natural aesthetics. In 2004, the City was awarded 24 continuous years as a Tree City USA by the National Arbor Day Foundation for its strong commitment to the urban forest.

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