Austin Invasive Management (AIM) Project Development Guide
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Angelita Rodriguez, Dan Krenzelok, Robert Clayton, Alex Duncan, Mateo Scoggins, Ana Gonzalez and John Clement

City of Austin
Watershed Protection Department
Environmental Resource Management Division

Abstract

Alien species pose a significant threat to ecosystem function and biodiversity all over the world. Urban areas are hotspots for alien plant invasion due to high levels of disturbance and the introduction of novel landscape plants without regard to their potential invasiveness. An important step in addressing alien plant invasions is to record their presence in combination with ecological parameters, such as native species richness, habitat and soil type, to provide an understanding of their distribution and ecosystem impacts. This document details the coordinated public efforts of the City of Austin, the Lady Bird Wildflower Center and trained citizen scientists to collect baseline invasive plant distribution data on City of Austin public lands and to provide public education and outreach to concerned citizens. Information on study design, data collection methods, data management, and volunteer training and mobilization are provided here. Analysis and interpretation of data collected through this effort will be presented in future short reports.

1.0 Overview

This project development guide describes the objectives and methods for collecting invasive plant distribution data in Austin, Texas. The methodology outlined in this document was developed by the City of Austin Watershed Protection Department (COA WPD) staff as part of the Austin Invasive Management (AIM) program. The AIM program forms the basis for implementation of the COA Invasive Species Management Plan (ISMP) (City of Austin, 2012), which identifies 5-year goals for all City departments that engage in vegetation management. The work described here, the AIM 2013 Summer Sampling Study, focuses on two of the goals identified in the ISMP – 1) the collection of baseline data on invasive species distributions on City-managed properties and 2) public education through the training and mobilization of volunteers in invasive species identification and data collection methods.

In order to help meet these goals, a 2012 grant was applied for and received from Bloomberg Philanthropies Cities of Service Impact Volunteering Fund for $25,000. This grant allowed WPD to team with the Ladybird Johnson Wildflower Center to train 144 volunteers in identification and data collection methods for invasive plants. In addition, five interns were hired for the summer of 2013 to spearhead the sampling effort.

2.0 Study Design

2.1 Overview

A Quality Assurance Project Plan (QAPP) was developed by the City of Austin staff biologists and data analysts to detail the data objectives, collection methods, validation of samples and assessment and reporting of data prior to the implementation of the invasive species field effort. The WPD Water Resource Evaluation (WRE) Quality Management Plan (City of Austin, 2004) requires that QAPPs be developed for all WRE data collection efforts and outlines a structure for QAPPs based on Environmental Protection Agency (EPA) guidelines (Environmental Protection Agency, 2001). The EPA defines a QAPP as a "… written document that describes the quality assurance procedures, quality control specifications, and other technical activities that must be implemented to ensure that the results of the project or task to be performed will meet project specifications."

The Texas Invaders App (Texas Invasive Plant and Pest Council, 2011), a simple point-presence data collection method for smartphones, was initially considered as a data collection tool for this project. However, WPD staff determined that a more robust, repeatable and descriptive data collection effort was needed to make informed management decisions. A data collection protocol was designed based on randomly distributed plots that could be sampled for invasive species characteristics beyond simple point-presence and also potential ecological correlates of invasive species presence and abundance. At the same time a method was developed to identify high-priority City-managed lands for evaluation of invasive species distribution and potential impacts.

Based on staff estimates of the time in which a data plot could be collected and the amount of staff, intern and volunteer time available for the project over the course of three months, a projected number of square kilometers to survey was decided upon as well as the density at which plots should be placed. The projected goals were 583 hectares (1,440 acres) surveyed at a rate of 3.7 points/hectare (1.5 points/acre) or 2,160 plots.

2.2 Parcel Identification, Prioritization and Stratification

City of Austin-owned parcels were identified from 2013 central appraisal district documents for Travis, Hays, Williamson and Bastrop counties in Central Texas. A total of 3,106 parcels covering 202.9 sq km (50,147 acres) were identified (Figure 2.1). As a first step to narrow down parcels to be evaluated, COA-owned parcels falling outside of the municipality's full-purpose jurisdiction were removed from selection. Then COA-owned parcels managed by Austin Water Utility Wildlands Division were also removed from selection as the Wildlands Division already has well-developed invasive species monitoring and management practices in place. This reduced the total number of potential parcels to sample to 2,624 covering 81.9 sq km (20,247 acres, Figure 2.1).

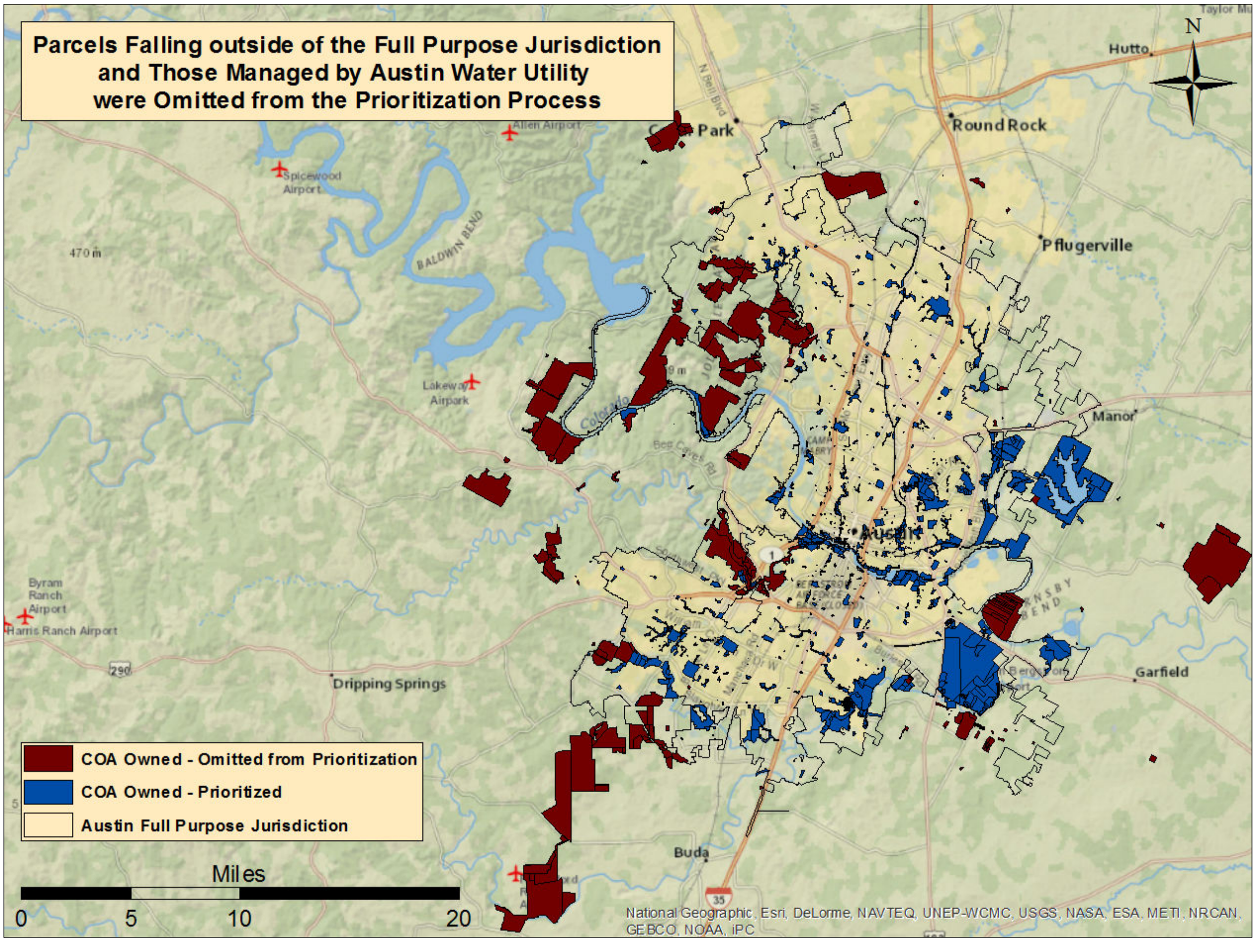

Fig 2.1 COA-owned properties evaluated for inclusion in this study.

Prioritization of the remaining parcels was performed using metrics pertaining to land management that were readily available in GIS format. Six metrics were decided upon and overlaid on COA-owned parcels:

- **Endangered Species Habitat**: Parcels were scored based on presence of habitat for Black-capped Vireo, Golden-cheeked Warbler, Barton Springs Salamander and Jollyville Salamander, as well as for karst features associated with endangered cave invertebrates.
- **Critical Environmental Features:** Parcels were scored based on mapped wetlands, springs and rimrock as defined by City of Austin code.
- **Natural/Unmanaged Areas:** Parcels were scored based on whether they were classified by the City of Austin Parks and Recreation Department as "unmanaged areas".
- **Creek Density:** Parcels were scored on calculated linear feet of creek per parcel acre.
- **Wildfire Risk:** Parcels were scored based on their wildfire risk as identified in the Texas A&M Forest Services TxWrap (Texas Wildfire Risk Assessment Portal) coverage.
- **Use/Aesthetics:** Parcels were scored based on their association with trails, Capitol View Corridors and Hill Country Scenic Roadways.

All of these datasets, other than TxWrap, are internal City of Austin coverages.

The six metrics were weighted equally. In cases where a metric represented more than one feature, such as multiple endangered species or critical environmental features, methods were developed to distribute the score among features within a metric. Raw values were reclassified to allow equal weighting between metrics and to reduce the difference between high and low scores while increasing the difference between positive values and a score of 0 (presence/absence).

Additional information on how scores were developed for these metrics is presented in Appendix A.

Once COA-owned parcels were prioritized there was a significant geographic skew of parcels to the southwest. To obtain a more balanced spatial distribution throughout the city, parcels were stratified using COA watershed regulation areas (WRAs) as defined in the City of Austin Land Development Code (§25-8-2 – Descriptions of Regulated Areas). An appropriate proportion of areal coverage for each WRA was calculated by taking the ratio of COA-owned parcels in each WRA to total COA-owned parcels and weighting it by the percentage of area the entire WRA occupies within the City as a whole (Table 2.1). Scores for the 37 highest priority samples following stratification are presented in Appendix B.

Table 2.1 Sample stratification based on Watershed Regulation Area

Watershed Regulation Area	Sq Km of COA-Owned Land	% of Total COA-Owned Land	Sq Km of Land Within Full-Purpose Jurisdiction	% of Total Full-Purpose Jurisdiction Land	Weighting Values
Suburban	55.2	67	316.0	46	0.56
Barton Springs Zone	9.1	11	99.5	14	0.13
Urban	14.2	17	154.7	22	0.20
Water Supply Rural	0.0	0	35.0	5	0.03
Water Supply Suburban	3.4	4	883.6	13	0.08
Total	81.9	-	693.5	-	-

Following the prioritization process, the locations of sampling plots within each of the 37 highest priority plots were distributed using ArcGIS Random Point tool. Figure 2.2 shows the distribution of sampling points in an example parcel (East Boggy Greenbelt).

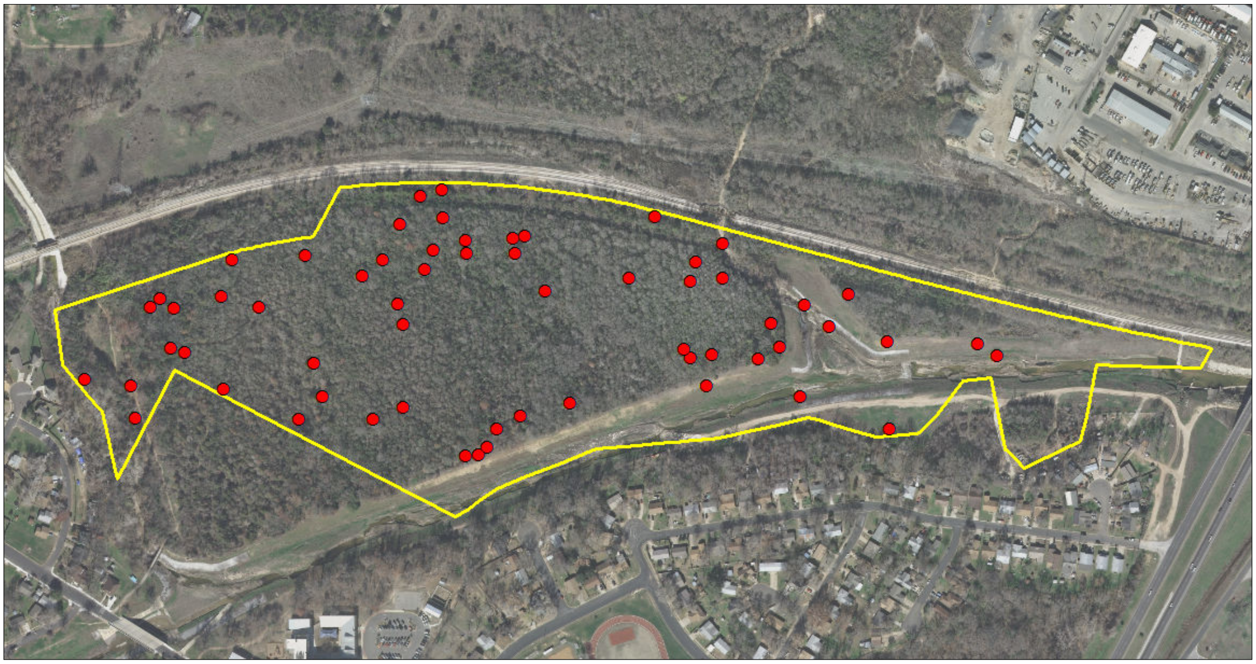

Fig 2.1 Randomly distributed sampling points in East Boggy Greenbelt.

2.3 Field Sampling

At each sample point, two 10-meter ropes were positioned perpendicular to each other with the ropes crossing on the center point to delineate the sampling area for each plot. Each point represented the center of a 5-meter radius cylinder with a height extending from ground level up to the tallest vegetation in the plot. This effectively divided the plot area for sampling into quadrants. Generally, data was collected by quadrant and then averaged (percent data) or summed (count data) across the plot. Within the sampling area cylinder data was collected for three different strata. The area from substrate level up to 1.5 feet (0.46 m) was considered groundcover, the area above 15 feet (4.57 m) was treated as canopy and the intervening area was considered understory.

For each sample cylinder, habitat type (wooded, open, edge) and dominant soil condition (clay, compacted, organic, rocky, sandy) was recorded. For each stratum within the sampling cylinder, the following information was collected:

- Percent cover of each invasive plant species present,
- A tally of native plant species present
- Presence of select native canopy tree species
- Percent open space.

Invasive and native species tracked in this study are provided in Table 2.1. Only live vegetation was included in the invasive percent cover and native plant tallies. Since both invasive and native species age and recruitment were to be analyzed, each plant was only counted in the highest stratum that it reached – e.g. percent cover of a Chinaberry tree reaching 30 feet in height would count only as canopy cover, even if some branches hung down into the understory.

Open space in the canopy and understory strata was interpreted as how much sky could be seen from under the vegetation in each layer, as though the vegetation were condensed into a two-dimensional plane. In the groundcover stratum, open space was interpreted as how much bare ground could be seen – that is, ground without living vegetation, rocks, leaf litter, or logs. Unlike percent cover of individual species, the open space category for each stratum takes into account any living plant material, even if an individual plant reached into a higher stratum – e.g. a Chinaberry tree reaching 30 feet may take up open space in each of the three strata with its trunk, hanging branches, etc.

Table 2.1 Priority Invasive and Native Species

Invasive Species List	**Native Canopy Tree Species List**	
Broadleaf Ligustrum, *Ligustrum lucidum*	American Elm, *Ulmus americana*	Live Oak, *Quercus virginiana*
Catclaw Vine, *Macfadyena unguis-cati*	Ash, *Fraxinus sp.*	Mesquite, *Prosopis glandulosa*
Chinaberry, *Melia azedarach*	Ashe Juniper, *Juniperus ashei*	Osage Orange, *Maclura pomifera*
Chinese Parasol Tree, *Firmiana simplex*	Black Cherry, *Prunus serotina*	Pecan, *Carya illinoinensis*
Chinese Privet, *Ligustrum quihoui or Ligustrum sinense*	Bald Cypress, *Taxodium distichum*	Persimmion, *Diospyros texana*
Chinese Tallow, *Triadica sebifera*	Black Walnut, *Juglans nigra*	Possumhaw Holly, *Ilex decidua*
Giant Cane, *Arundo donax*	Black Willow, *Salix nigra*	Post Oak, *Quercus stellata*
Golden Bamboo, *Phyllostachys aurea*	Boxelder, *Acer negundo*	Soapberry, *Sapindus drummondii*
Heavenly Bamboo, *Nandina domestica*	Bur Oak, *Quercus macrocarpa*	Sycamore, *Platanus occidentalis*
Japanese Honeysuckle, *Lonicera japonica*	Cedar Elm, *Ulmus crassifolia*	Texas Red Oak, *Quercus texana*
Johnson Grass, *Sorghum halepense*	Cottonwood, *Populus deltoides*	Wafer Ash, *Ptelea trifoliata L.*
Paper Mulberry, *Broussonetia papyrifera*	Roughleaf Dogwood, *Cornus drummondii*	White Shin Oak, *Quercus sinuata*
Tree of Heaven, *Ailanthus altissima*	Gum Bumelia, *Sideroxylon lanuginosum*	Yaupon Holly, *Ilex vomitoria*
Other Invasives: Photinia, *Photinia serratifolia;* Silk Tree, *Albizia julibrissin*	Hackberry, *Celtis laevigata*	

3.0 Field Coordination

3.1 Team Organization and Responsibilities

The Implementation of the sampling design required volunteer training, volunteer and vehicle coordination, digital data collection via iPad, data interpretation, and data quality control (QC). Specific staff assignments are outlined in Table 3.1:

Table 3.1 Team Roles and Responsibilities

Role	Responsibility
Field intern(s)	Collect data using established method Coordinate volunteers Coordinate vehicles and sampling gear
Field technician/ QC coordinator/ Volunteer trainer	Collect data using established method Coordinate QC data collection Demonstrate data collection method for volunteers and participating staff
GIS specialist/ Data analyst	Assist in developing prioritization parameters and distribute sample points in GIS Produce sampling maps/access points/topographic maps Organize data, summarize data for QC analysis
Data coordinator	Develop data collection software based on the Fulcrum platform for iPad Review and QC data Perform database queries to generate tabular data for analysis
Volunteer manager	Recruit citizen volunteers Organize volunteer registration and training Manage public outreach for data collection effort Interact with media outlets
Project manager	Develop sampling methodology Oversee sampling effort and make adjustments to methods as necessary Interpret and summarize data for use in management prioritization strategy

Communication flow for the data collection effort was as follows:

- Several weeks prior to the collection effort, the volunteer manager scheduled volunteer training days for interested participants and coordinated registration procedures. Volunteer trainers coordinated with the volunteer manager on the training schedule and the best training methods. Volunteer trainers demonstrated the data collection method to volunteer groups on scheduled training days and answered questions about the collection effort. The volunteer manager and volunteer trainers communicated registration and scheduling procedures to the volunteers.

- The data analyst was responsible for establishing individual sample point locations in GIS.

- The data coordinator developed data collection software that allowed real-time geolocation of both the sampling points and field staff to provide wayfinding to each point.

- Field interns and technicians coordinated sampling areas/vehicles/gear distribution with each other prior to each work day. In addition, volunteer coordinators contacted registered volunteers two days prior to their scheduled sampling dates as a reminder. Volunteer coordinators also organized meeting places and times for volunteers, and remind them of safety protocols.

After each workday, field technicians reported the number of sites visited/rejected/temporarily rejected to the data coordinator and to each other. Each day the data coordinator ensured that the number of sites staff thought they had collected matched the number of sites with data stored in Fulcrum. Weekly, field technicians and the data coordinator reported back to the project manager and volunteer manager to discuss progress, methods, issues, and questions. Any proposed changes to sampling protocol were authorized by the project manager.

Quality control sample points were selected by the data coordinator and project manager and flagged by field technicians. The QC coordinator set up staff pairs, coordinated vehicles and gear, and set up sampling dates and times to re-visit designated QC points within a two-week timeframe at the end of the sampling period.

3.2 Schedule

Invasive plant field data collection took place over the course of the summer of 2013. Each week, sampling occurred Wednesday through Sunday, to accommodate weekend hours for volunteers. Sampling hours each day were from 8am-12pm to avoid prolonged exposure to heat. On average, a pair of field technicians/volunteers completed 5-12 points in one four-hour sampling session. Field sampling continued in this pattern until a target number of points was reached (determined by data coordinator and project manager based on total area to be sampled) or personnel resources (interns/field technicians) and allotted time ran out.

3.3 Health and Safety

Per department policy, all field technicians, staff, and volunteers are required to do field work with at least one other person at all times.

Field technicians and assisting staff were all equipped with sunscreen, bug spray, and poison ivy block in each one of the gear packs provided for sampling teams. Each city vehicle was equipped with a first aid kit. Field technicians brought extra water coolers in each city vehicle, and advised volunteers to bring adequate water. Field technicians and volunteers were instructed on appropriate field and sun protective attire – pants, light-colored, long-sleeved shirts, hiking boots, long socks, and hats. Gloves were provided when requested.

If at any point during sampling, safety was a concern for field technicians or volunteers, sampling procedures were discontinued until the issue was resolved. If a sample location presented a safety risk, such as dangerous terrain, suspicious human activity, wildlife or insect (e.g., wasps, bees) concerns or weather concerns, the sample was marked as either "cleanup" or "rejected" based on whether the issue was temporary (e.g., transient encampments) or an inherent part of the location (e.g., steep cliff face). If the area was known to have active transient camps, park rangers were requested to walk the area ahead of the sampling crew to assess whether they presented a safety risk. If other health concerns arose (e.g., heat exhaustion, injury), the sampling was delayed until the appropriate medical attention was provided or all participants felt confident in continuing. Sampling was terminated until the next sampling day in some instances, when the health concern or weather was too severe to continue in a safe manner.

Equipment used in the field that was potentially contaminated with poison ivy, chiggers, and other irritants was washed regularly using Tecnu cleanser. This included ropes, clothes, gloves, and bags. The screens and surfaces of the iPads were regularly cleaned with alcohol. Field technicians were recommended to shower thoroughly with Tecnu after each workday. Careful removal of plant debris by hand or using duct tape was occasionally necessary if exposed to adherent seeds.

3.4 Navigation

The Spyglass™ GPS and navigation app for the iPad was used to locate predetermined points for data collection. Coordinates for each point were copied from the Fulcrum data collection app (discussed below) and entered into Spyglass, which gave a real-time cardinal direction and distance to the entered point (Figure 3.1). Once the field technician was within three meters of the entered point, the aerial map on the Fulcrum app was used to confirm that the field technician was at the appropriate location (Figure 3.2). Either app could be used individually to find the point based on user preference, but the location was always verified using the other app once the sample point was reached. Data entered for each point was uploaded to cloud storage for access by the database manager using Fulcrum's "sync" function.

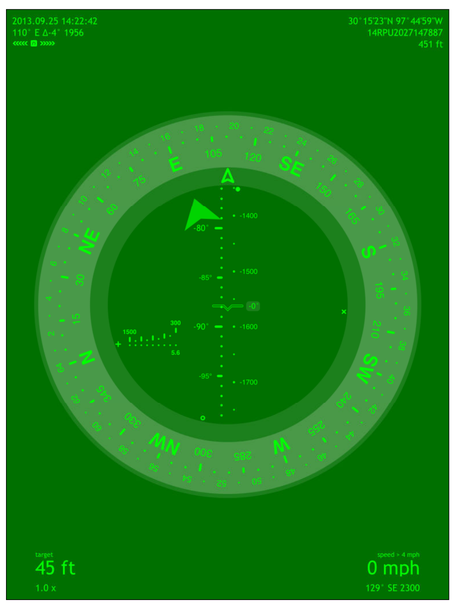

Fig 3.1 Screenshot of Spyglass app compass function.

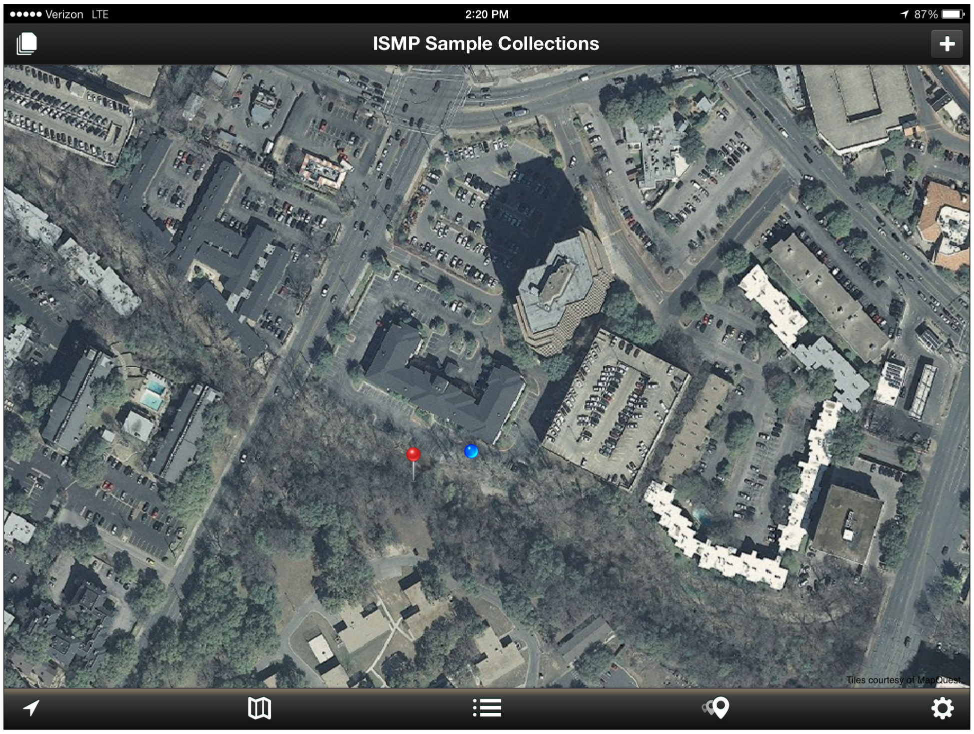

Fig 3.2 Screenshot of Fulcrum aerial map function. The red pin indicates an un-sampled point of interest and the blue dot indicates the location of the field technician.

4.0 Sample Collection and Processing

4.1 Field Data Processing

Development of electronic data collection methods for environmental monitoring and assessment has been a COA WPD priority for many years. The strict data model of the AIM study combined with the large number of points to be sampled made a clear case for the time savings to be gained through use of an electronic data collection process. The "off-the-shelf" web service Fulcrum (http://www.fulcrumapp.com) was chosen as a platform for development of the data collection software.

The Fulcrum platform allows data managers to develop electronic forms through their App Builder web interface. Data collected using these forms can then be uploaded to the Fulcrum site and retrieved by the data manager as needed. The "Fulcrum app" used for AIM data collection was developed as a form to allow capture of the data described in Section 2.3 above. Sample point identification and georeferencing data were uploaded to the Fulcrum app so as to have several pre-populated fields that would allow the field technicians to identify the sites uniquely and locate them using the navigation tools described above. The Fulcrum forms developed for this project can be made available upon request (contact Robert Clayton, robert.clayton@austintexs.gov).

Figure 4.1 provides an example of the main page of the data collection form. Figure 4.2 shows a page for entry of specific vegetation data associated with a site.

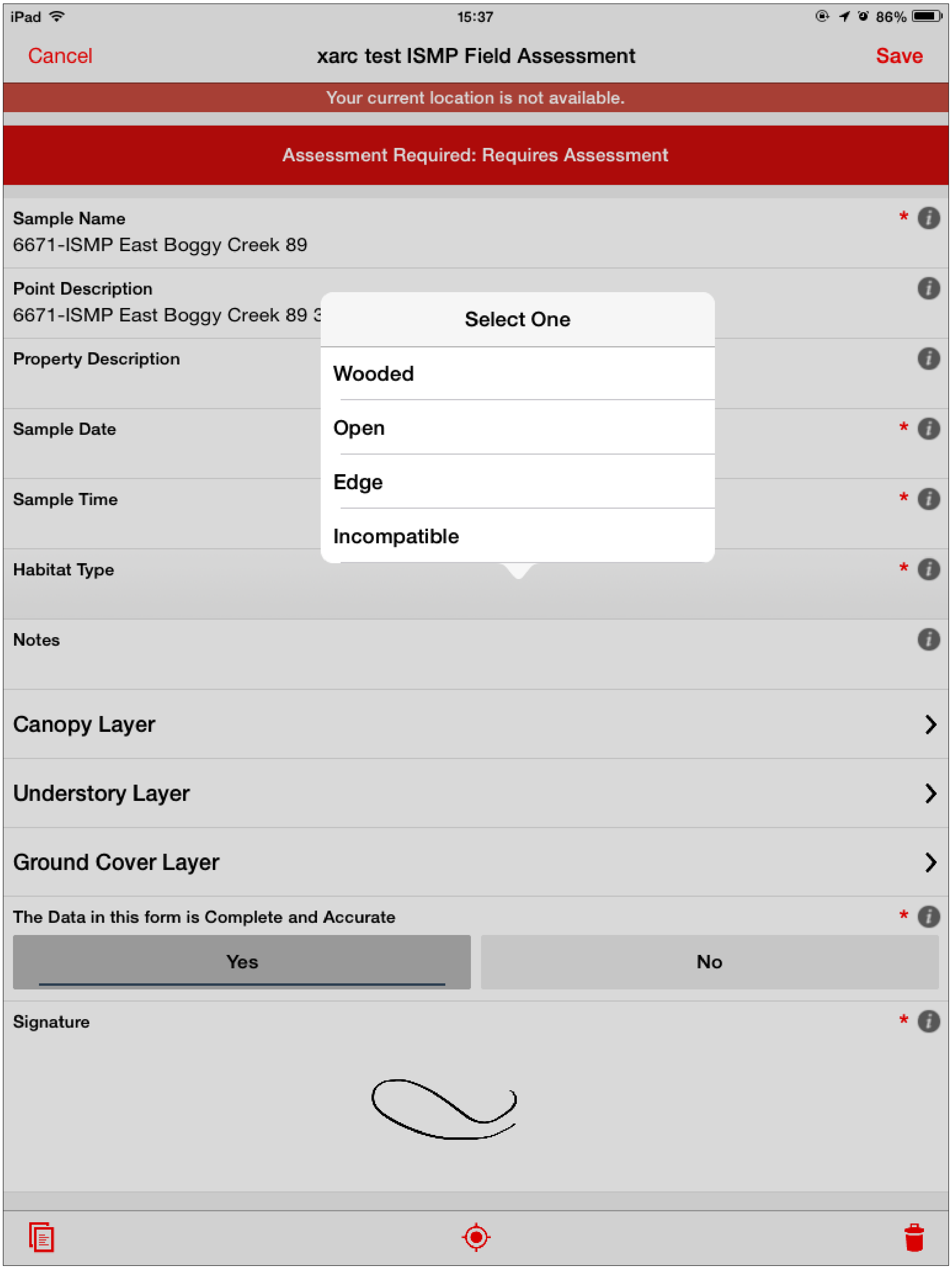

Fig 4.1 An example of the Fulcrum data collection form. *"Habitat Type" has been selected to show the prompts provided for data entry.*

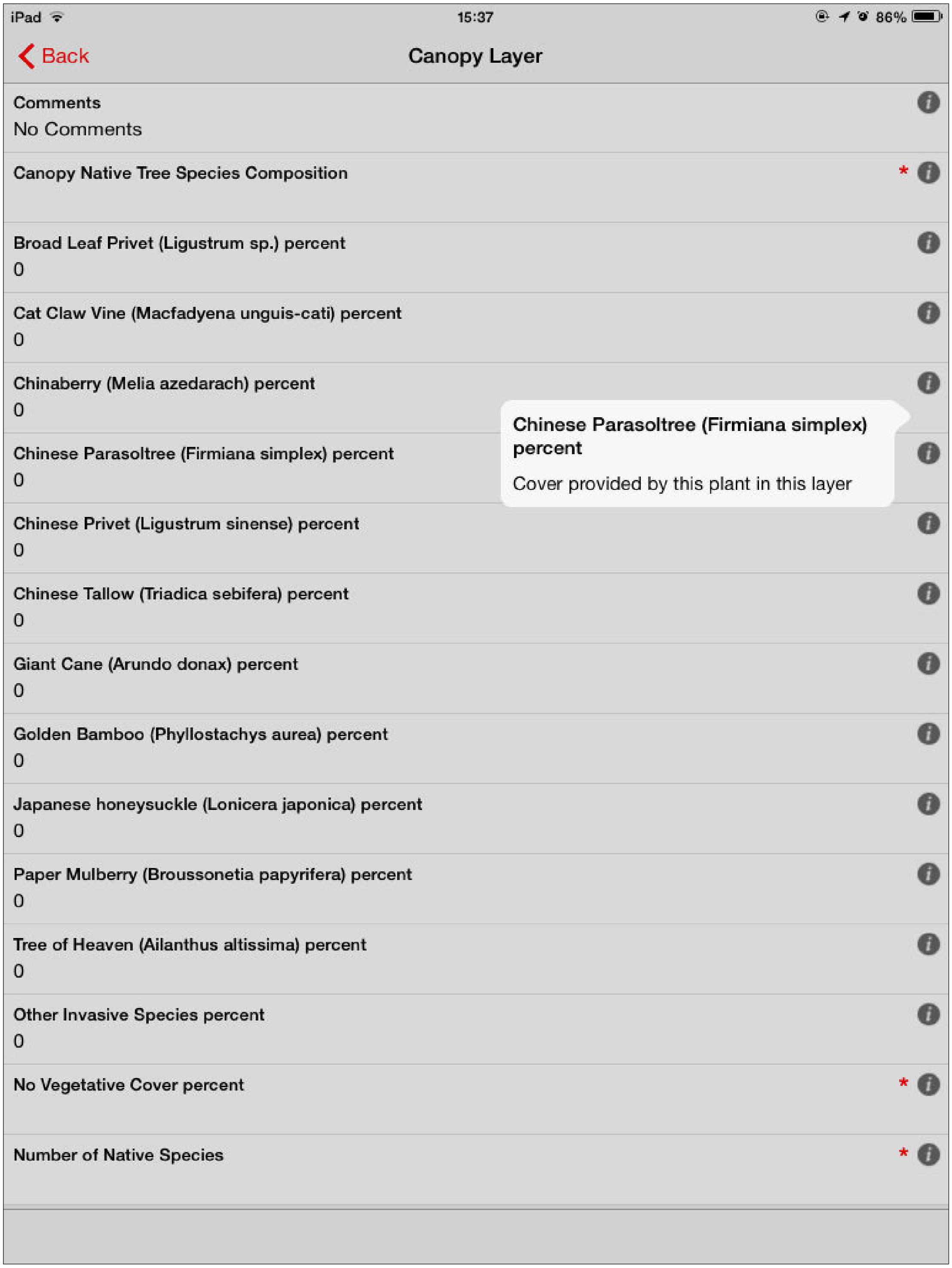

Fig 4.2 An example of a vegetation data collection page. *This page was reached by selecting "Canopy Layer" on the main page (Figure 4.1). Selecting the Information button will prompt the user with explanatory text provided by the programmer.*

Six member accounts were created through the web interface and subsets of the sites to be visited were assigned to each account. Initially, to avoid the potential confusion of having multiple subsets of data points on multiple units, only one account was assigned to each of the six iPad units. As the field technicians grew comfortable with the technology over the course of the summer and the number of sites decreased, permissions were loosened so that all accounts were available on each machine. This allowed staff to redistribute workloads in the field under circumstances where it would be inefficient to require multiple units for data collection, such as when there were only a few remaining points to be sampled at a site.

Once a point was completed, it was designated as "visited" on the Fulcrum app, and its respective pin on the aerial map turned from red to blue. If a point temporarily couldn't be sampled, it was designated as "cleanup" in the database and appeared with a green pin. If it couldn't be sampled at all, it was designated as "rejected" and would then appear with a black pin.

The data that was collected in the field using the Fulcrum app was downloaded from the website and imported into the Field Sampling Database (FSDB) on a weekly basis. The data was transformed from the tabular format of the .csv file to a standard input format using Oracle PL/SQL. Due to the structured nature of the data, the download, translation and loading into the FSDB took about an hour and QC took an additional half hour. Once the data was stored in the database, queries of the data using Excel or ArcMap allowed staff to assess progress, assign future work and see preliminary results.

Over the course of the entire sampling study this process of electronic data management consumed approximately11 hours of time (1.5 person days). It is likely that electronic data collection, while requiring investments in equipment, web service subscriptions, disciplined data management and skilled field technicians, saved approximately 35 person-days of data entry plus roughly 10 person-days of QC time for a total of 360 hours. This is a 97% savings in staff time over standard data entry and quality control methods.

There are some limitations to electronic data collection in general and the use of consumer-grade devices, such as iPads, specifically. It is, for example, challenging for field technicians to apply the same level of error correction to digital data entry that they would apply to hand-written forms. Durability was also a concern. Even though the units were protected with LifeProof™ cases, one unit was destroyed completely and another unit suffered a cracked screen. The latter was replaced for significantly less cost than the purchase of a new unit.

A small fleet of these units can be very useful and easy to maintain and there are technologies available that allow the centralized management of a larger fleet. At six units there were just enough repeated tasks in upkeep of the units tto become a chore.

4.2 Quality Control Procedures

Quality Control (QC) data sets were collected to measure variability in data collection between field technicians. These data sets are replicates of the last 80 points collected during the sampling phase. At each of these points, the center point of plot was flagged during the initial visit with a survey pin in the ground and with survey tape at eye-level. This allowed staff, coordinated by the QC coordinator, to revisit each of the QC points and collect data based on the same collection method. Using surveying flags to mark the center point eliminated the possibility of inaccuracy in sampling location due to GPS variability, technician bias, etc. QC data collection was time-sensitive, as flags could potentially have been removed or displaced. Therefore, all points were revisited for QC within two weeks of flagging.

The replicate QC data sets were used to examine variability in percent cover of invasives, percent bare space, presence/absence of invasives, presence/absence of native plant species, and discrepancies in chosen strata. The points that were used for the QC analysis were chosen by the data coordinator to have an equal number of points originally completed by each field technician. This ensured that the variability measured would be an average, representative of all field technicians that sampled during the summer.

4.3 Workflow Analysis

Due to the complexity of the sampling design, field coordination, software development and database management needs of this project, workflow analysis was used to ensure that useable data was collected in an efficient manner. Workflow diagrams for various aspects of the project are provided in Appendix C.

5.0 Conclusion

With alien species recognized as a threat to natural resources in urban areas, it is important to document their presence in city green spaces for future land management decisions and to foster the conservation of native plant species and habitats. As such this guide provides information on a progressive strategy to create collaboration between environmental scientists and trained volunteers to promote sustainable use of public lands and to provide a public education opportunity for invasive species. Additionally, coordination and communication were imperative to the success of the AIM program and were implemented for the study design, field coordination, volunteer training and data collection. AIM also utilized an innovative electronic data collection and processing method that resulted in savings and a reduction in personnel time throughout the duration of the project. Overall, this guide details the process for assessing invasive species impacts within a municipality utilizing trained volunteers working under the guidance of WPD staff biologists that could be beneficial for other cities addressing similar environmental and land management concerns.

References:

City of Austin. (2004) Water Resource Evaluation Quality Management Plan. City of Austin, Watershed Protection Department.

Environmental Protection Agency. (2001) EPA Requirements for Quality Assurance Project Plans (QA/R-5). EPA/240/B-01/003.

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Appendix A
Parcel Prioritization Scoring Methodology

Appendix A. Parcel Prioritization Scoring Methodology

Input	Features	Feature Evaluation	Feature Scoring	Input Score Calculation	Input Score Values	Reclassified Input Score Values
Aesthetics	Trails	Parcel intersects trails	0: Feature doesn't intersect parcel. 1: Feature intersects Parcel	(Trail Value + Capitol View Corridor Value + Scenic Roadway Value) / 3	0	0
	Capitol View Corridors	Parcel intersects CVCs	0: Feature doesn't intersect parcel. 1: Feature intersects Parcel		0.33	0.6
	Scenic Roadways	Parcels within 100 ft of scenic roadways	0: Feature not within 100 ft of parcel. 1: Feature within 100 ft of parcel		0.66	0.8
					1	1
Parks	Natural/Unmanaged Areas	Ratio of natural area to total parcel area	0-1		0	0
					0.01-0.25	0.55
					0.26-0.50	0.7
					0.51-0.75	0.85
					0.76-1.00	1
Wildfire Risk	Wildfire Risk	Parcel given value equivalent to numerically ranked wildfire risk	0-4 (Value assigned by TxWrap)		0	0
					1	0.4
					2	0.6
					3	0.8
					4	1
Creeks	Creeks	Ratio of creek linear feet per acre	0->1,000 (ft/acre)		0	0
					0-150	0.55
					150-500	0.7
					500-1000	0.85
					>1000	1

Input	Features	Feature Evaluation	Feature Scoring	Input Score Calculation	Input Score Values	Reclassified Input Score Values
	Biologic Resource Buffers				0	0
	Wetlands	Select Wetlands not intersecting Biologic Resource Buffers			0.01-0.25	0.55
Critical Environmental Features	Springs	Select Springs not intersecting Biologic Resource Buffers. Apply 75 foot buffer.	0-1 (based on merged features)		0.26-0.50	0.7
	Rock Outcrops	Select Rock Outcrops not intersecting Biologic Resource Buffers. Apply 75 foot buffer.			0.51-0.75	0.85
	Merge Features	4 Inputs merged. Calculate ratio of CEF Area /Parcel Area			0.76-1.00	1
	Jollyville Salamander	Barton Springs and Jollyville Data was combined since Barton Springs Salamander habitat is so limited.	**For Salamander, Vireo, and Warbler Habitat (Each parcel will one value for each of these categories; 3 total):**		0	0
			3: Parcel intersects habitat		0.01-0.25	0.55
			2: Parcel within 1/8 mile of habitat		0.26-0.50	0.7
	Barton Springs Salamander		1: Parcel within 1/4 mile of habitat		0.51-0.75	0.85
			0: Parcel farther than 1/4 mile from habitat		0.76-1.00	1
Endangered Species	Golden-cheeked Warbler	For all endangered species inputs, in addition to identifying parcels intersecting habitat, parcels within a 1/8 mile and within 1/4 mile were also identified.	**For Karst features:**	[(Salamander Value/3)+(Vireo Value/3)+(Warbler Value/3)+(Karst Value/4)]/4		
			4: Parcel intersecting Karst feature with known species of concern			
	Black-capped Vireo		3: Parcel intersecting Karst feature with no known species of concern			
	Karst Features	Parcels were identified over 2 values of Karst features .Those with known species of concern and those without.	2: Parcel within 1/8 mile of karst feature			
			1: Parcel within 1/4 mile of karst feature			
			0: Parcel farther than 1/4 mile from karst feature			

Appendix B
Parcel Prioritization Scoring Results

Appendix B - Parcel Prioritization Scoring Results

Sample Site	TCAD Property ID	Hectares	Property Prioritization Value	Watershed Regulation Area	Aesthetic Prioritization Value	Endangered Species Habitat Prioritization Value	Critical Environmental Features Prioritization Value	PARD Unmanaged Areas Prioritization Value	Wildfire Risk Prioritization Value	Creek Density Prioritization Value
Balcones District Park	504107	20.7	3.7	Suburban	0.8	0.55	0.55	0.85	0.4	0.55
Brushy Creek Greenbelt 1	0	15.1	3.45	Suburban	0.6	0	1	0.7	0.6	0.55
Brushy Creek Greenbelt 2	0	2.9	4.15	Suburban	0.6	0.7	1	0.7	0.6	0.55
	0	2.7	3.3	Suburban	0.6	0	1	0.55	0.6	0.55
Circle C Ranch Metro Park	338497	31.2	3.95	Barton Springs Zone	0.8	0.7	0.55	0.55	0.8	0.55
Colony District Park	214117	27.3	3.15	Suburban	0.6	0	0.55	0.85	0.6	0.55
Dick Nichols District Park	324380	44.3	4.05	Barton Springs Zone	0.8	0.7	0.55	0.85	0.6	0.55
East Boggy Creek Greenbelt	193874	20.8	2.95	Urban	0.6	0	0.55	0.85	0.4	0.55
Hielscher Tract Greenbelt	750092	6.5	3.9	Barton Springs Zone	0.6	0.55	0.55	0.85	0.8	0.55
	750094	20.1	3.9	Barton Springs Zone	0.6	0.55	0.55	0.85	0.8	0.55
Little Walnut Creek District Park	214064	51.0	2.75	Urban	0.6	0	0	1	0.6	0.55
Lower Bull Creek Greenbelt	423981	1.9	4.3	Water Supply Suburban	0.6	0.7	0.7	1	0.6	0.7
Mary Moore Searight Metro Park	346898	42.7	3	Suburban	0.6	0	0.55	0.7	0.6	0.55
	346899	38.0	3.2	Suburban	0.8	0	0.55	0.7	0.6	0.55
Roy G. Guerrero Metro Park	283148	6.7	3.1	Suburban	0.6	0	0.55	1	0.4	0.55
	287813	11.6	3.1	Suburban	0.6	0	0.55	1	0.4	0.55
	287931	33.1	3.1	Suburban	0.6	0	0.55	1	0.4	0.55
Shoal Creek Greenbelt	211.98	3.9	3.1	Suburban	0.6	0.7	0.55	0.7	0	0.55
Slaughter Creek Greenbelt	755878	4.7	3.3	Suburban	0.6	0	0.85	0.7	0.6	0.55
South Park Meadows Greenbelt	732322	14.4	3.45	Suburban	0.6	0	0.85	0.85	0.6	0.55
	732333	2.1	3.15	Suburban	0	0	0.85	1	0.6	0.7

Sample Site	TCAD Property ID	Hectares	Property Prioritization Value	Watershed Regulation Area	Aesthetic Prioritization Value	Endangered Species Habitat Prioritization Value	Critical Environmental Features Prioritization Value	PARD Unmanaged Areas Prioritization Value	Wildfire Risk Prioritization Value	Creek Density Prioritization Value
Springfield Neighborhood Park / Marble Creek	297283	18.4	3.45	Suburban	0.6	0	0.55	1	0.6	0.7
Tanglewood Neighborhood Park	498022	3.9	3.8	Water Supply Suburban	0.6	0.7	0.55	1	0.4	0.55
Upper Bull Creek Greenbelt 1	161164	1.6	4.05	Water Supply Suburban	0.6	0.85	0.55	0.55	0.8	0.7
	164673	7.6	4.05	Water Supply Suburban	0.6	0.7	0.55	0.85	0.8	0.55
	164736	2.1	3.75	Water Supply Suburban	0.6	0.85	0	1	0.6	0.7
	167968	9.8	3.7	Water Supply Suburban	0.6	0.7	0.55	0.7	0.6	0.55
	367253	16.3	4.15	Water Supply Suburban	0.6	0.85	0.7	0.85	0.6	0.55
Upper Bull Creek Greenbelt 2	153814	2.9	3.9	Water Supply Suburban	0.6	0.7	0.55	0.55	0.8	0.7
Walnut Creek Greenbelt 1	264386	5.9	3.1	Suburban	0.6	0	0.55	1	0.4	0.55
Walnut Creek Greenbelt 2	503146	6.3	3.65	Suburban	0.6	0.55	0.55	1	0.4	0.55
	503320	0.1	3.35	Suburban	0	0.55	0.7	1	0.4	0.7
	503321	0.2	3.05	Suburban	0	0.55	0.55	1	0.4	0.55
	526861	3.3	3.65	Suburban	0.6	0.55	0.55	1	0.4	0.55
Walnut Creek Greenbelt / Copperfield Neighborhood Park	254787	23.9	3.15	Suburban	0.6	0	0.55	0.7	0.6	0.7
Walnut Creek Metro Park	258582	115.9	3.1	Suburban	0.6	0	0.55	1	0.4	0.55
	258587	2.5	3.1	Suburban	0.6	0	0.55	0.85	0.4	0.7
Walter E. Long Metro Park	214240	113.0	3.15	Suburban	0.6	0	0.55	0.85	0.6	0.55
Williamson Creek East Greenbelt	335762	7.4	3.1	Suburban	0.6	0	0.55	0.85	0.4	0.7

Appendix C
Workflow Diagrams for the AIM 2013 Summer Sampling Study

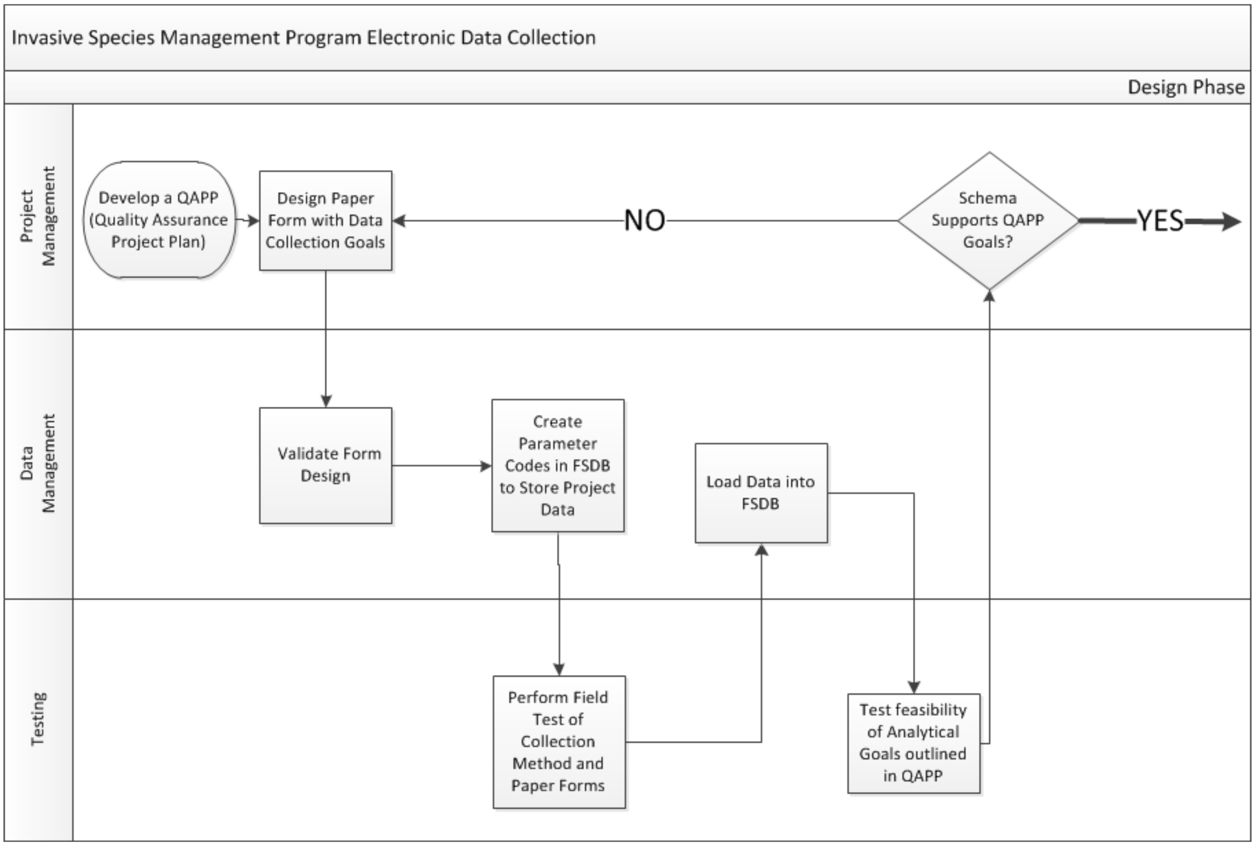

Figure 1. This diagram represents steps taken during the design phase of the AIM 2013 Summer Sampling Study.

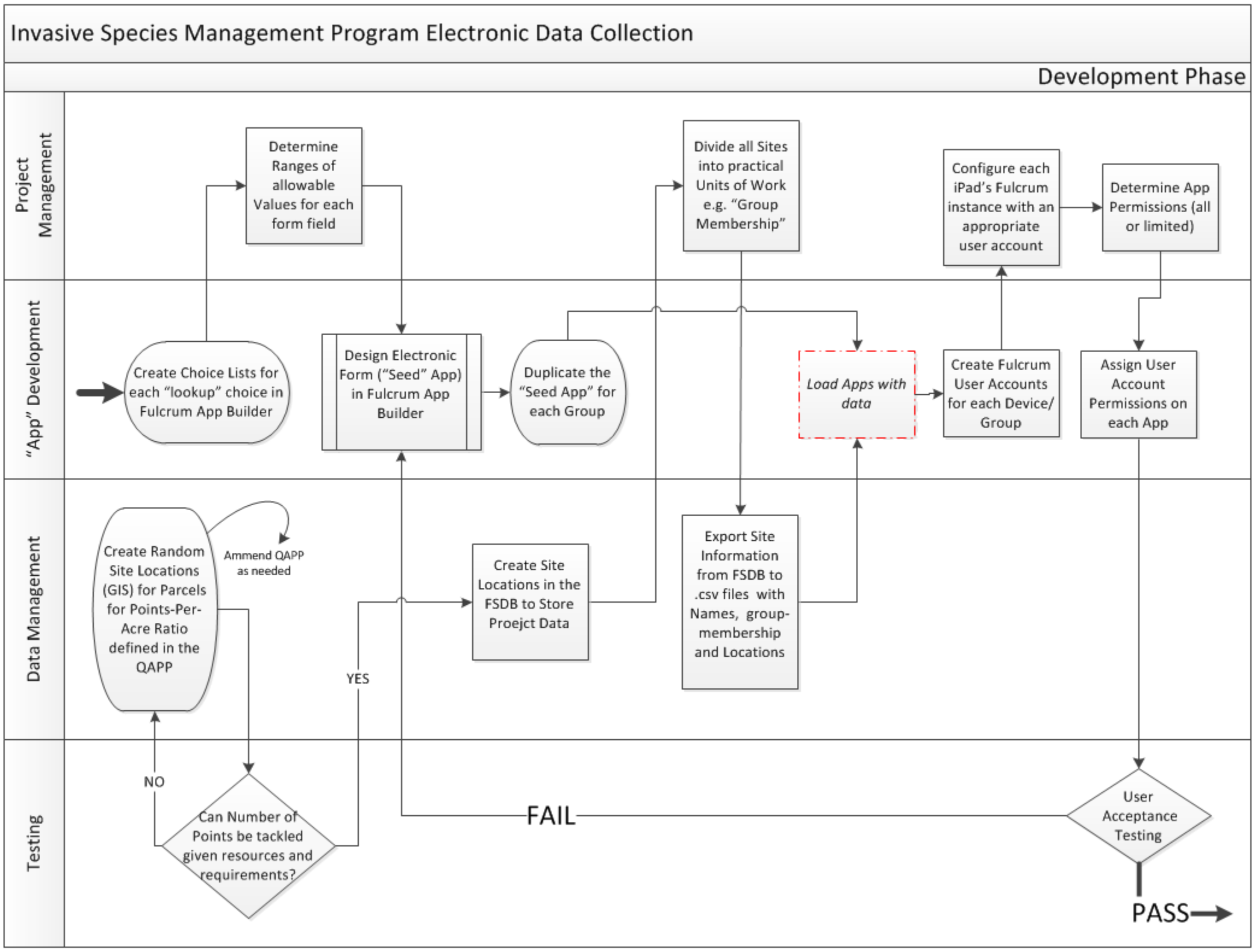

Figure 2. This diagram represents steps taken during the development phase of the AIM 2013 Summer Sampling Study.

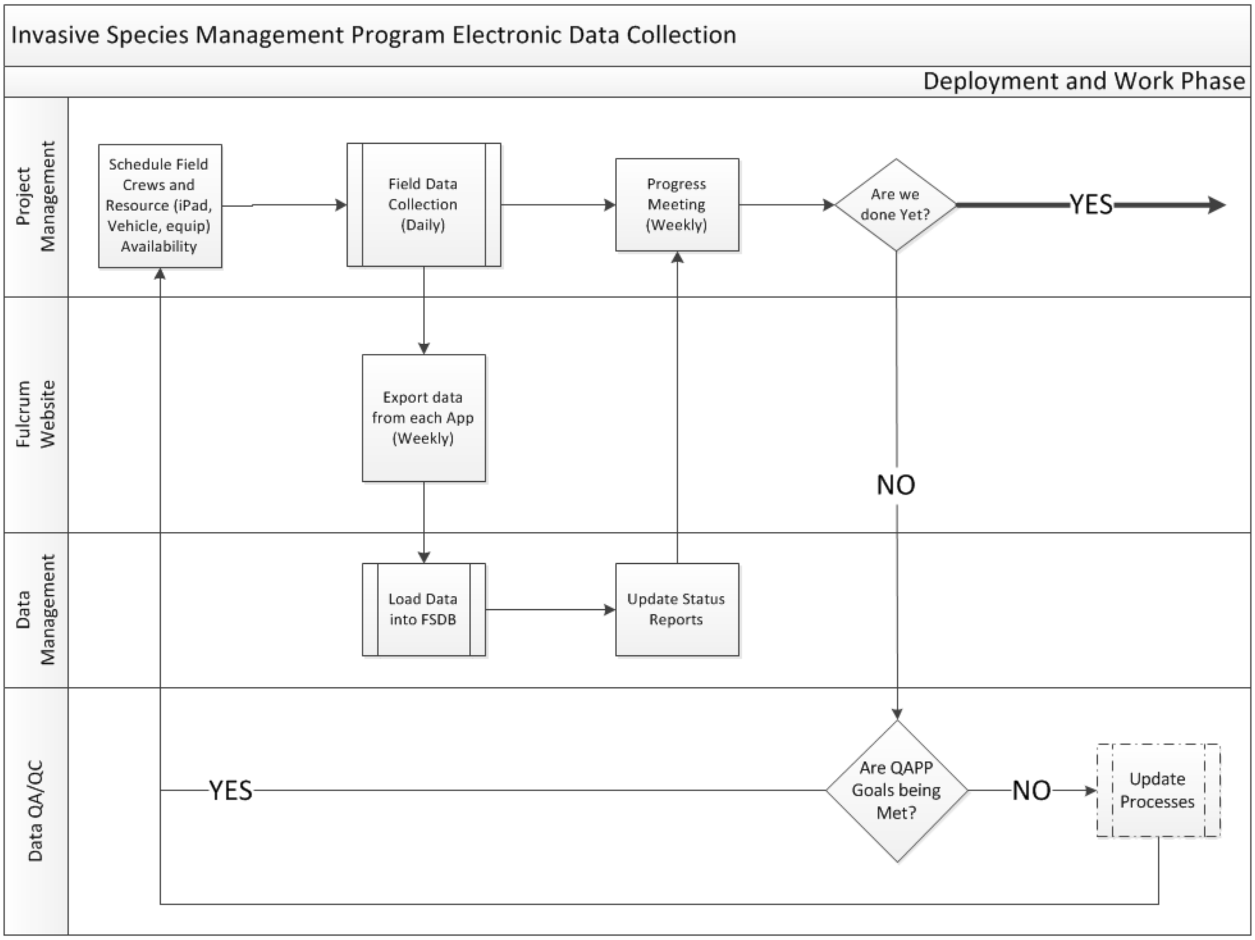

Figure 3. This diagram represents steps taken during the deployment and work phase of the AIM 2013 Summer Sampling Study.

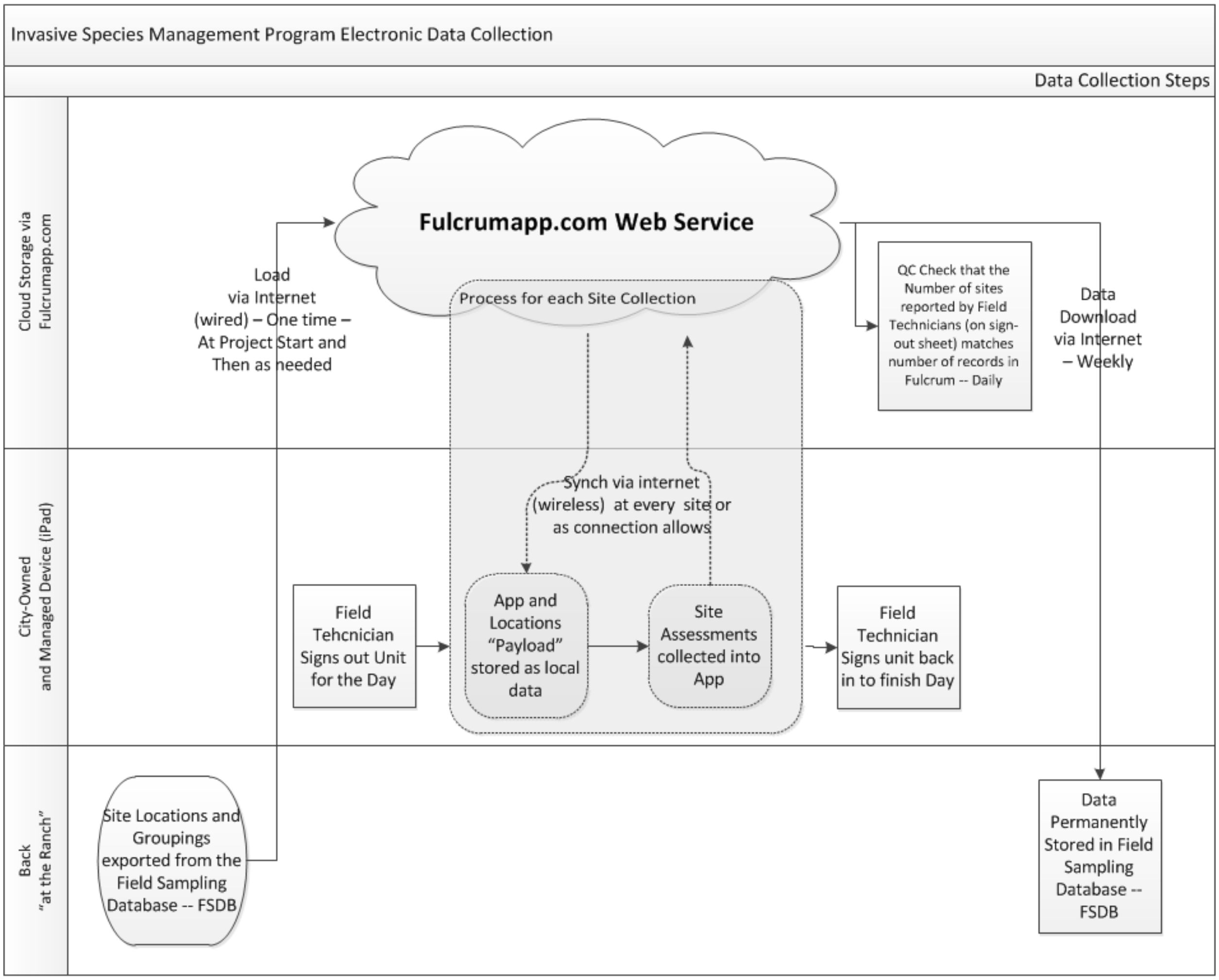

Figure 4. This diagram represents the data collection workflow of the AIM 2013 Summer Sampling Study.