National Park Service
U.S. Department of the Interior

Gulf Coast Inventory and Monitoring Network
Lafayette, Louisana

Vegetation Classification and Mapping Project Report, San Antonio Missions National Historical Park

Natural Resource Technical Report NPS/GULN/NRTR—2007/074

ON THE COVER
Mission Concepción
Photograph by: Dan Cogan

Vegetation Classification and Mapping Project Report, San Antonio Missions National Historical Park

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A Report for the Gulf Coast Inventory and Monitoring Network

National Park Service
Gulf Coast Network
646 Cajundome Blvd. Room 175
Lafayette, LA 70506

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May 2007

U.S. Department of the Interior
National Park Service
Natural Resource Program Center
Fort Collins, Colorado

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Please cite this publication as:

Cogan, D. 2007. Vegetation Classification and Mapping Project Report, San Antonio Missions National Historical Park, National Park Service, Gulf Coast Network. Natural Resource Technical Report NPS/GULN/NRTR—2007/074. National Park Service, Fort Collins, Colorado.
D-68

NPS D-068, May 2007

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Acknowledgements

This project represents a joint effort begun by Dusty Perkins, the network coordinator for the adjoining Southern Plains Network (SOPN), in conjunction with the Gulf Coast Network (GULN) coordinator, Martha Segura. Both networks were a pleasure to work with and I would like to especially recognize Dusty for his help in kicking-off this project and for his assistance throughout. I would also like to acknowledge the GIS and imagery assistance provided by Heidi Sosinski at the SOPN. Tomye Folts-Zettner at SOPN was also a great asset during the field data collection. Together Dusty, Martha, Heidi, and Tomye formed a wonderful team in which to work. I am grateful for their support and their time to review this document and associated work.

The staff at San Antonio Missions National Historical Park (SAAN) provided excellent support for this project. Always professional and extremely helpful, Greg Mitchell and his staff provided assistance collecting field data and adding their knowledge to the project. I appreciate Greg's time to help with logistics and making everyone fully acquainted. I would also like to thank Greg for providing comments and feedback on this report.

Jim Drake of NatureServe in the Minneapolis, MN office was once again a pleasure to work with. His professionalism, dedication, and ecological and botanical knowledge was integral to the data collection, analysis, report writing/reviewing, and implementation of the National Vegetation Classification System for SAAN and the other parks in the Southern Plains Network-without him this project would not have been possible.

I would like to acknowledge the assistance that my former colleagues provided at the BOR. A special thank you goes to David Salas who backed me throughout the project by fielding questions and reviewing materials. I would also like to thank Mike Pucherelli for his continued support on these projects and for his companionship on one of the first trips to SAAN.

Special recognition goes to Karl Brown, Mike Story and Chris Lea with NPS for prioritizing and funding this project happen and being there for help with coordination, logistics, and financial matters.

I would like to give a big thank you to Roger Sanders for providing an extremely rich data-set of invaluable plot, accuracy assessment and photo verification data. I would also like to acknowledge the work of Dick Davis and Steve Windhanger with Lady Bird Johnson Wildflower Center for their help with collecting accuracy assessment points and helping to facilitate this project.

Finally, let me conclude by apologizing to anyone I may have inadvertently left off this list. Please know that I had a great experience working and meeting with everyone associated with this endeavor and I really appreciate all the effort that went into this project. - Dan.

List of Abbreviation and Acronyms

AA	Accuracy Assessment
AML	Arc Macro Language
BOR	Bureau of Reclamation (also USBR)
BRD	Biological Resource Division (of the USGS)
BRIT	Botanical Research Institute of Texas
CBI	Center for Biological Informatics (of the USGS/BRD)
CIR	Color Infrared Imagery
CTI	Cogan Technology, Inc.
FGDC	Federal Geographic Data Committee
FSA	Farm Service Agency
GIS	Geographic Information System(s)
GPS	Global Positioning System
GULN	Gulf Coast Inventory and Monitoring Network
MMU	Minimum Mapping Unit
NAD	North American Datum
NAIP	National Agriculture Imagery Program
NBII	National Biological Information Infrastructure
NPS	U.S. National Park Service
NRCS	Natural Resources Conservation Service
NVC	National Vegetation Classification
NVCS	National Vegetation Classification System
RSGIG	Remote Sensing and Geographic Information Group
SAAN	San Antonio Missions National Historical Park
SOPN	Southern Plains Inventory and Monitoring Network
TNC	The Nature Conservancy
USBR	United States Bureau of Reclamation (also BOR)
USDA	United States Department of Agriculture
USGS	United States Geological Survey
UTM	Universal Transverse Mercator

Links

http://www.nature.nps.gov/im/units/guln/index.cfm	Gulf Coast Inventory and Monitoring Network
http://www.nature.nps.gov/im/units/sopn/index.cfm	Southern Plains Inventory and Monitoring Network
http://biology.usgs.gov/npsveg/index.html	USGS-NPS Vegetation Mapping Program
http://www.nps.gov	The National Park Service
http://usgs.gov	United States Geologic Survey
http://biology.usgs.gov/cbi	USGS Center for Biological Informatics
http://biology.usgs.gov/cbi/nbii	National Biological Information Infrastructure
http://www.nps.gov/saan	San Antonio Missions National Historical Park
http://www.usbr.gov	United States Bureau of Reclamation
http://www.natureserve.org	NatureServe
http://www.natureserve.org/explorer	NatureServe Explorer® online database server
http://plants.usda.gov	NRCS PLANTS Database

Executive Summary

San Antonio Missions National Historical Park (SAAN) encompasses approximately 844 acres in the city of San Antonio and rural Wilson County, Texas. The park preserves and celebrates the largest collection of Spanish colonial resources in the U.S., including four missions, two acequias (irrigation ditches), and one ranch remnant. The four missions are located in the southern portion of San Antonio along the San Antonio River and the ranch site is located approximately 5 miles southwest of Floresville, Texas and 35 miles southeast of San Antonio. SAAN was created to protect and commemorate these historical structures and in addition it also contains rich and varied natural resources including native flora common to the Tamaulipan thornscrub and southern tallgrass prairie ecoregions. To better understand the distribution of these plant assemblages the National Park Service's (NPS) Southern Plains Inventory and Monitoring Network (SOPN) in conjunction with the NPS's Gulf Coast Inventory and Monitoring Network (GULN) begun a vegetation mapping and classification effort at SAAN in 2005.

A three-year program was initiated to complete the task of mapping and classifying the vegetation at SAAN. Phase one, directed by the Botanical Research Institute of Texas (BRIT) in conjunction with NatureServe developed a vegetation classification using the National Vegetation Classification System (NVCS). Phase two, directed by the U.S. Bureau of Reclamation's (BOR) Remote Sensing and GIS group in conjunction with Cogan Technology, Inc. (CTI) produced a digital vegetation map. To classify the vegetation, 35 representative plots located throughout the approximately 6,784 acre project area (parks + environs) were sampled during the summer of 2005. Analysis of the plot data by NatureServe in the winter of 2005-2006 identified 10 distinct plant associations and alliances, one of which was newly described in the National Vegetation Classification (NVC). In addition, CTI described an additional alliance and two distinctive stands of vegetation (i.e. Park Specials) that primarily occurred outside of the park boundary in the environs. Descriptions and a field key for all 13 unique plant assemblages for SAAN are included in this report.

To produce the digital map, a combination of 1:12,000-scale ortho imagery acquired in 2003, 2004, and 2005 and all of the GPS-referenced ground data were used to interpret the complex patterns of vegetation and land-use. All imagery was acquired from the U.S. Department of Agriculture - Farm Service Agency's Aerial Photography Field Office and the National Agriculture Imagery Program. In the end, 32 map units (13 vegetated and 19 land-use) were developed and directly cross-walked or matched to corresponding plant associations and land-use classes. All of the interpreted and remotely sensed data were converted to Geographic Information System (GIS) databases using ArcGIS© software. Draft maps were printed, field tested, reviewed, and revised. One hundred-twenty four accuracy assessment (AA) data points were collected in 2006 and used to determine the map's accuracy. After final revisions, the accuracy assessment revealed an overall thematic accuracy of 89%.

Products developed for SAAN are described and presented in this report, and are stored on the accompanying DVD. These include:

- A *Final Report* that includes keys to the vegetation and imagery signatures, AA information, and all of the methods and results of the project;
- A *Spatial GIS Database* containing spatial data for the vegetation, plots, and AA points;
- *Digital Photos* from sample plots, accuracy assessment points and miscellaneous park views;
- *Metadata* for all spatial data [Federal Geographic Data Committee (FGDC)-compliant];
- *Vegetation Descriptions and Photo Signature Key* to the map classes and associations/alliances.

In addition, SAAN and the GULN both received copies of:

- Digital data files and hard copy data sheets of the observation points, vegetation field plots, and accuracy assessment points;
- Hardcopy vegetation maps.

Additional data not included in this report can be found on the attached DVD. These data include text and metadata files, keys, lists, field data, spatial data, the vegetation map, and ground photos. Please access the following USGS website for posting of this information: http://biology.usgs.gov/npsveg/index.html

For more information on the NVCS and NVC alliances/associations in the United States please visit NatureServe's website: http://www.natureserve.org.

The Espada Aqueduct at SAAN
Photograph by: Dan Cogan

Project Statistics

Field Work Summers of 2005 and 2006:

Plot Sampling = 35 Plots:
Plots sampled between June and October by Roger Sanders from the Botanical Research Institute of Texas and Greg Mitchell from SAAN

Accuracy Assessment Points = 124
Points collected in 2006 by Roger Sanders from the Botanical Research Institute of Texas and Dick Davis from the Lady Bird Johnson Wildflower Center.

Classification:

11 NVC Plant Associations and Alliances

GIS Database 2002-2005:

Project Size = 6,784 acres
San Antonio Missions National Historical Park = 844 acres

Base Imagery acquired from the USDA FSA Aerial Photography Field Office acquired through the National Agriculture Imagery Program:
2005 - 1:12,000-scale true color ortho-rectified imagery, compressed county mosaic, 2 meter pixel resolution
2004 - 1:12,000-scale color infrared digital ortho-imagery, compressed county mosaic, 1 meter pixel resolution
2003 - 1:12,000-scale color infrared digital ortho-imagery, compressed county mosaic, 1 meter pixel resolution

Map Classes = 32
13 Vegetated
19 Non-vegetated

Minimum Mapping Unit = ½ hectare is the program standard but this was modified at SAAN to ¼ acre.

Total Size = 1,122 Polygons

Average Polygon Size = 6 acres

Overall Thematic Accuracy = 89%

Project Completion Date: 05/31/07

Introduction

Background

In 1994, the U.S. Geological Survey (USGS) and NPS formed the USGS-NPS Vegetation Mapping Program to cooperatively inventory and map the vegetation in the United States National Parks. The goals of this program are to provide baseline ecological data for park resource managers, obtain data that can be examined in a regional and national context, and provide opportunities for future inventory, monitoring, and research activities (FGDC 1997, Grossman et al. 1998).

In the same year, the USGS-NPS Vegetation Mapping Program also adopted the U.S. National Vegetation Classification (USNVC) (The Nature Conservancy and Environmental Systems Research Institute 1994a, Grossman et al. 1998) as a basis for the *a priori* definition of vegetation units to be inventoried. The Federal Geographic Data Committee adopted a modified version of the upper (physiognomic) levels as a federal standard (FGDC-STD-005)(FGDC 1997). This standard was hereafter termed the National Vegetation Classification Standard (NVCS). The NVCS established a federal standard for a complete taxonomic treatment of vegetation in the United States at physiognomic levels. It also established conceptual taxonomic levels for the floristic units of alliance and association, largely following the USNVC, but did not offer a taxonomic treatment for the floristic levels because of the immense scope of establishing robust floristic units for the entire United States. The FGDC standard requires that federally funded vegetation classification efforts collect data in a manner that enables crosswalking the data to the NVCS (i.e., the physiognomic levels) and sharing between agencies, but does not require use of that standard by agencies for internal mission needs. NatureServe maintains a treatment of floristic units (alliances and associations), which, though not a federal standard, are used as classification and mapping units by the vegetation mapping program whenever feasible. For purposes of this document, the federal standard (FGDC 1997) is denoted as the NVCS; the USNVC will refer exclusively to NatureServe's treatment for vegetation floristic units (alliances and associations only).

Use of the NVCS as the standard vegetation classification system is central to fulfilling the goals of this national program. This system:

- is vegetation based;
- uses a systematic approach to classify a continuum;
- emphasizes natural and existing vegetation;
- uses a combined physiognomic-floristic hierarchy;
- identifies vegetation units based on both qualitative and quantitative data;
- is appropriate for mapping at multiple scales.

The use of the NVC and the USGS-NPS vegetation mapping protocols facilitate effective resource stewardship by ensuring compatibility and widespread use of the information throughout the NPS as well as by other federal and state agencies. These vegetation maps and associated information support a wide variety of resource assessment, park management, and planning needs. In addition they can be used to provide a structure for framing and answering critical scientific questions about vegetation communities and their relationship to environmental conditions and ecological processes across the landscape.

The NVC has primarily been developed and implemented by The Nature Conservancy (TNC) and the network of State Natural Heritage Programs over the past twenty years (TNC 1994a; Grossman et al. 1998). The NVC is currently supported and endorsed by multiple federal agencies, the FGDC, NatureServe, State Heritage Programs, and the Ecological Society of America. Refinements to the classification occur in the process of application, leading to ongoing proposed revisions that are reviewed both locally and nationally. TNC and NatureServe have made available a 2-volume publication presenting the standardized classification, providing a thorough introduction to the classification, its structure, and the list of vegetation types found across the United States as of April 1997 (Grossman et al. 1998). *Volume I: The National Vegetation Classification Standard* can be found on the Internet at: http://www.natureserve.org/publications/library.jsp.

NatureServe has since superseded Volume II of the publication (the classification listing), providing regular updates to ecological communities in the United States and Canada. This online database server, NatureServe Explorer®, can also be found on the Internet at: http://www.natureserve.org/explorer.

San Antonio Missions National Historical Park

In the 18th century, Spanish missionaries created a network of churches, ranches, farms, fields, and housing settlements centered on the San Antonio River. These sites were chosen to take advantage of the natural water supply provided by the river. Self-sufficient, the missions grew into small communities supporting soldiers, priests, lay people, and Native Americans. The first mission renamed San Antonio de Valero (the Alamo) was relocated to what is now San Antonio from Coahuila. Shortly thereafter, the four missions that make up the current SAAN were either founded or relocated to this area. These include San José, Concepción, San Juan, and Espada Missions. All four Missions are located in the southern portion of San Antonio and are linked by the Mission Trail Road (Figures 1 and 2).

SAAN encompasses four missions occurring within the city limits of San Antonio including their historic churches, grounds, and walled communities. In addition, the national historical park also contains some of the *labores*, or farm lands, *acequias* or gravity-fed irrigation ditches, and one former mission ranch, Rancho de las Cabras. The Rancho unit of SAAN is located in rural Wilson County approximately 5 miles southwest of Floresville, Texas and 35 miles southeast of San Antonio (Figure 1). Together these sites total about 844 acres and in 1978 were designated a National Historical Park to preserve and interpret their historical importance.

Natural Setting

SAAN contains a network of historical sites located in the urban setting of San Antonio continuing south following the San Antonio River. As you travel from San Antonio's Mission Concepción in the north to Rancho de las Cabras in the south, the landscape changes dramatically as you leave the city. The metropolitan nature of the lands surrounding the Missions with the residential and industrial complexes gradually reverts to more ranch and farm lands to the south. Situated on both the southern tallgrass prairie ecoregion in the north and the Tamaulipan thornscrub ecoregion in the south, SAAN contains an interesting mix of natural and introduced vegetation and plant communities.

The close proximity of the park to the city and the historical use of the lands for farming and ranching have greatly altered the appearance and composition of the southern tallgrass prairie type. Much of the original prairie with its characteristic vast expanses of tall grasses and oak has been altered or cleared for home/factory building, grazing and planting. Vegetation characteristic of the Tamaulipan thornscrub with its thick stands of thorny shrubs are also present at both sites. Near the Missions, it occurs on the deeper soils that support tall mesquite, huisache and spiny hackberry shrubs. On the Rancho unit it occurs on the shallow, upland caliche soils where it supports dense brush. Significant to this transformation from grass to thornscrub has been the suppression of fire. Although a great deal of the vegetation remains as it was during the Spanish Colonial times, the vegetative landscape has been altered by the increase of settlement bringing increased exotic vegetation, artificial increases in the vegetation along the historic acequias, and the rechannelization of the San Antonio River.

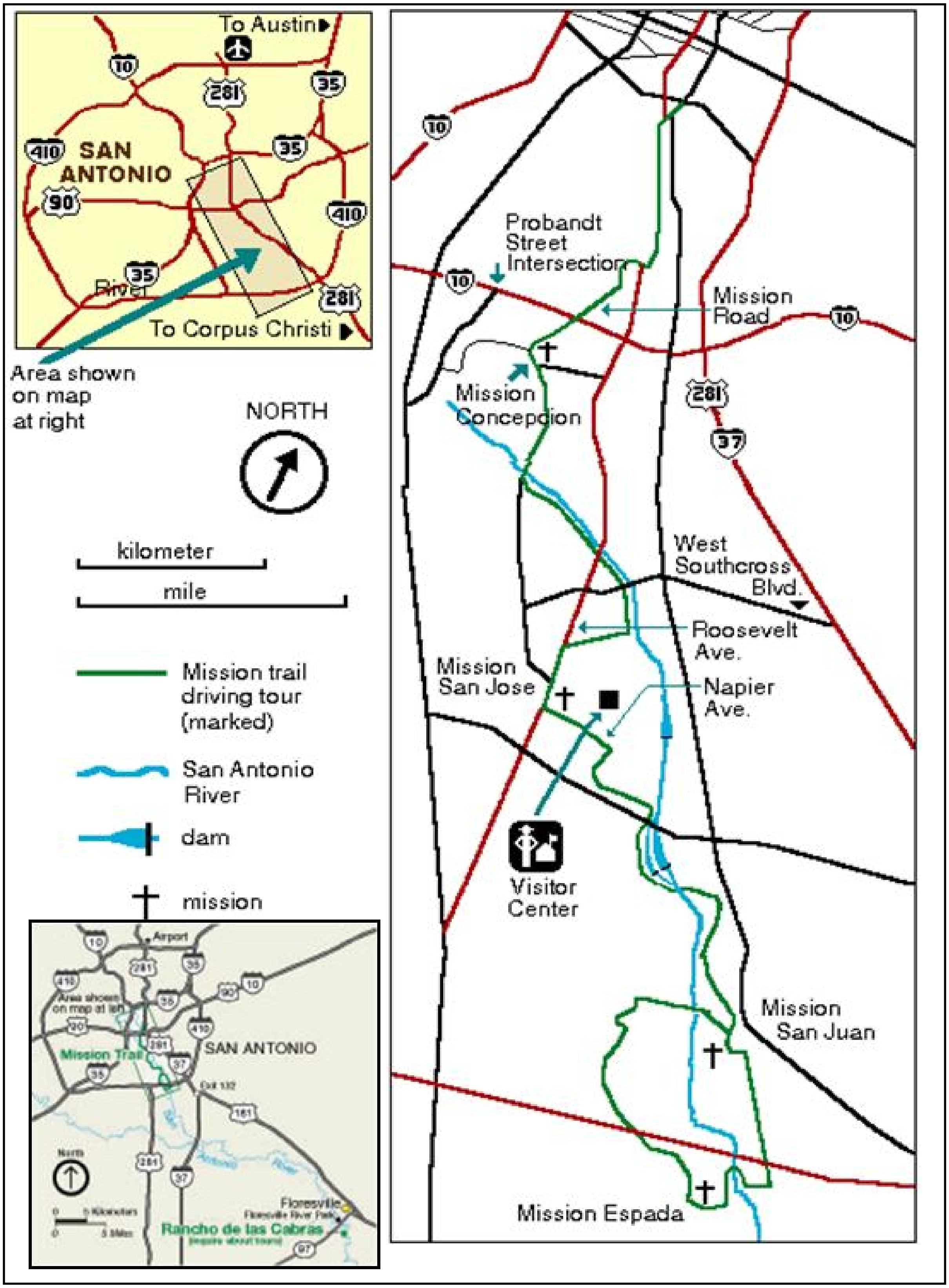

Figure 1. Maps of SAAN and vicinity.

Figure 2. Images of the Four Missions and Ranch Unit at SAAN.
From the top: Mission Concepción, Mission San José, Mission San Juan, Mission Espada, and Rancho de las Cabras
Photographs by: Dan Cogan

Although it is difficult to appreciate the natural setting at SAAN before the Spanish colonization, the current ecology does give insight into the plant diversity and community composition. The availability of water is probably the most important influence on the distribution of vegetation. Both units of SAAN contain upland and riparian areas with water being a limiting factor in this semi-arid landscape. Where water is plentiful such as along the San Antonio River, intermittent streams, and historic acequias, multi-layered vegetation occurs, characterized by tall deciduous trees, shrubs, and wetland herbaceous species. As the soils become drier the vegetation changes abruptly to grasslands and low-growing thorny brush. These floristically diverse areas represent converging elements areas owe their diversity to converging elements of the Chihuahuan Desert to the west, the Tamaulipan thornscrub and subtropical woodlands along the Rio Grande, and the coastal grasslands to the east. Affecting all upland vegetation are the anthropogenic disturbances of planting, clearing, plowing, grazing, and especially fire suppression. Disturbance is most evident in the abandoned and fallow fields where the non-native grasses are rapidly being replaced by plains of thorny shrubs and trees. The succession from grasslands to shrublands is occurring on both units of the park. Around the Missions succession is extremely variable ranging from thick mature stands to very short, sparse shrubs. At the Rancho site, the uplands are true scrublands with homogeneous stands of shrubs interspersed with grassland pockets.

Vegetation

Separated by strata and physiognomic types, SAAN contains a variable mix of trees, shrubs and herbaceous vegetation, both native and introduced. In the riparian, along the San Antonio River and its tributaries large stands of trees occur primarily pecan (*Carya illinoinensis*), black willow (*Salix nigra*), sugarberry (*Celtis laevigata*), and box elder (*Acer negundo*). The riparian woodlands at the Rancho de las Cabras are more extensive and in addition to the previously mentioned trees support cedar elm (*Ulmus crassifolia*) and eastern cottonwood (*Populus deltoides*). The upland woodlands at both sites are in different stages of early succession. Trees including hackberry (*Celtis pallida*), huisache (*Acacia farnesiana*), and mesquite (*Prosopis glandulosa*) are common on the old fields. Scattered throughout both units of SAAN are pockets of large live oaks (*Quercus fusiformis*). In addition to the natives, a few non-native trees such as chinaberry (*Melia azedarach*) and privet (*Ligustrum japonicum*) are present but are actively being removed by the park and will likely not be a component of the park in the future.

In and around the missions, shrubs are common both as associates to the woodlands and as small stands interspersed among old fields. Common species include blackbrush acacia (*Acacia rigidula*), Texas hogplum (*Colubrina texensis*), rough leaf dogwood (*Cornus drummondii*), and Brazilian bluewood (*Condalia hookeri*). Some of the trees are also present as shrubs; these include black willow, hackberry, and husisache. At the Rancho site shrubs occur both as associates to the riparian vegetation and in the upland scrublands. The scrublands support tall shrubs primarily blackbrush acacia and mesquite.

The grasses and forbs for SAAN are varied and diverse and include both native and naturalized species. At Rancho site, perennials include sideoats grama (*Bouteloua curtipendula*), yellow bluestem (*Bothriochloa ischaemum* var. *songarica*), Texas wintergrass (*Nassella leucotricha*), and Virginia wildrye (*Elymus virginicus*). Common annuals include Carolina canarygrass (*Phalaris caroliniana*) and browntop signalgrass (*Urochloa fasciculate*). Around the Missions, Virginia wildrye, Ozarkgrass (*Limnodea arkansana*), and purple threeawn (*Aristida purpurea*) are common. Widespread naturalized grasses are also present at both sites, including bermudagrass (*Cynodon dactylon*), yellow bluestem, Kleberg's bluestem (*Dichanthium annulatum*), and Johnsongrass (*Sorghum halepense*).

SAAN Vegetation Mapping Project

The specific decision to classify and map the vegetation at SAAN was made in response to guidelines set forth by the NPS Natural Resources Inventory and Monitoring Program and implemented by the GULN in conjunction with SOPN. The GULN consists of 8 National Park units spread across 6 states in the southeast portion of the United States (Figure 3). This network of parks was formed to create and centralize much-needed information about the nature and status of selected biological resources occurring within park boundaries so as to be used for making management decisions, for scientific research, and for educating the public. One of the goals of this network is to provide baseline inventory information for resource management and to help monitor the health of park ecosystems. Stemming from this goal, developing a vegetation classification to the plant community level and associated GIS map and database for each park was viewed as a high priority.

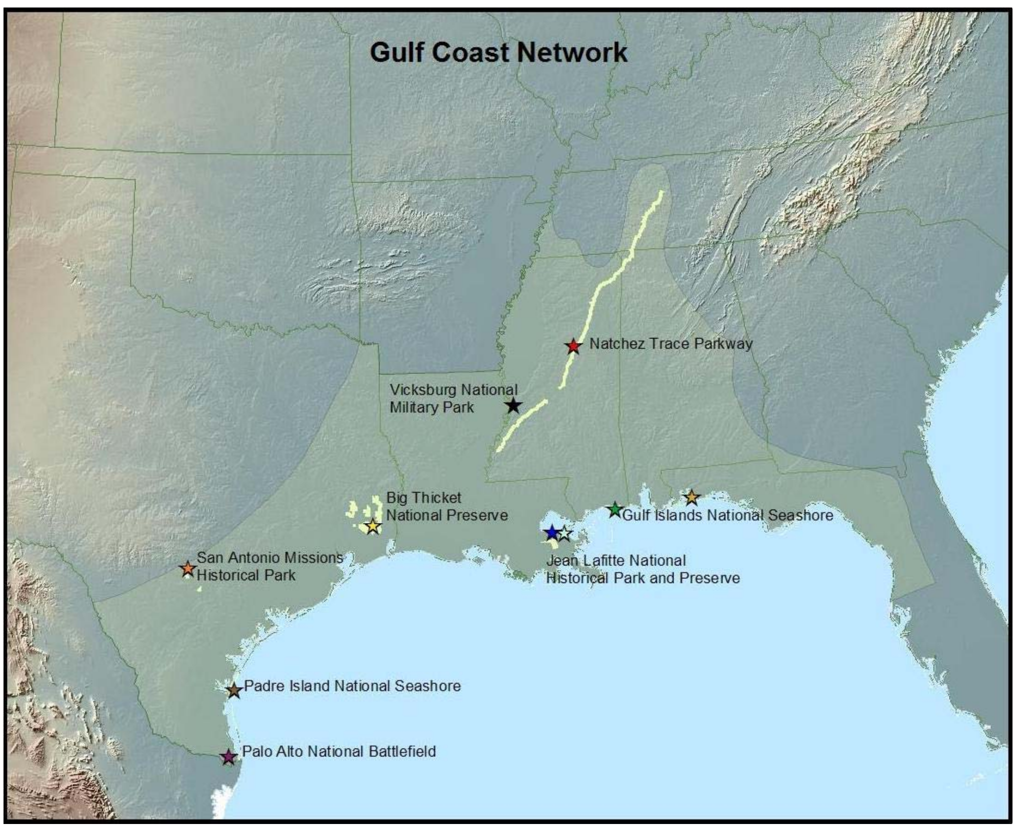

Figure 3. Map of GULN showing the location of the park units in the network.

In 2005 Dusty Perkins, the network coordinator for SOPN at that time contacted the Bureau of Reclamation's Remote Sensing and Geographic Information Group (RSGIG) requesting a proposal for creating vegetation spatial databases for three park units in the SOPN. These parks included Fort Larned National Historic Site, Washita Battlefield National Historic Site, and Lyndon B. Johnson National Historical Park. In addition SAAN in the GULN was added due to its proximity to Lyndon B. Johnson National Historical Park. All four units totaled approximately 11,800 acres and included a 0.25-mile buffer into the surrounding environs. Upon acceptance of the RSGIG proposal, work was started by acquiring existing imagery and visiting the respective sites. In conjunction with the mapping portion, ecologists were contracted by SOPN to collect vegetation sample plots and observation points. These data were used by NatureServe to classify the vegetation to the association and alliance levels of the National Vegetation Classification System (NVCS). For SAAN the ecological sampling was conducted by Roger Sanders, formerly with the Botanical Research Institute of Texas and Dick Davis from the Lady Bird Johnson Wildflower Center. After the project was started, Dan Cogan the principal investigator left the BOR to start his own company, Cogan Technology, Inc. (CTI). All of the subsequent mapping and GIS work was sub-contracted to CTI through existing contracts with Science Applications International Corp.

Together CTI, BRIT, NatureServe, BOR, SOPN, GULN and SAAN formed a team, each responsible for a specific portion of the project as outlined in the program standards and flowchart provided by the Center for Biological Informatics (USGS/BRD) (Appendix A). BRIT and SOPN took the lead in collecting the standardized field samples and writing the field key and descriptions for the natural and semi-natural vegetation types. They also helped cross-walk the associations/alliances to map classes. NatureServe's Midwest Regional Office was tasked with training the BRIT field personnel in the standardized field collection techniques, classifying the field data, using the NVC, and reviewing the vegetation descriptions, field key, and vegetation database. CTI and BOR were responsible for the imagery interpretation and creating a digital vegetation map and spatial database. GULN, SOPN and SAAN staff reviewed and evaluated the draft classification, entered field data into a database and wrote and field-tested the key to the vegetation classification. SAAN staff also provided logistical and technical support, and helped coordinate activities.

The objectives of this team were to produce final products consistent with the national program's mandates. These included:

- A Vegetation Classification based on the National Vegetation Classification System;
- A Map Unit Classification based on SAAN-specific requirements;
- A spatial database of SAAN's vegetation, using remote sensing and GIS techniques;
- Digital and hard copy vegetation maps with a minimum 80% accuracy per map class.

Scope of Work

Vegetation mapping for SAAN occurred within an approximate 6,784 acre project boundary, encompassing the authorized boundary of SAAN (both the Missions and the Rancho Units), a general 0.25-mile environ radius, and some small extensions to better match the project boundary with roadways, streams and other natural breaks (Figure 4). The final project area determination was based on management needs, financial constraints, and time limitations. Due to access constraints no ground sampling was proposed for the environs although these areas would be mapped using the same parameters as those areas inside the park.

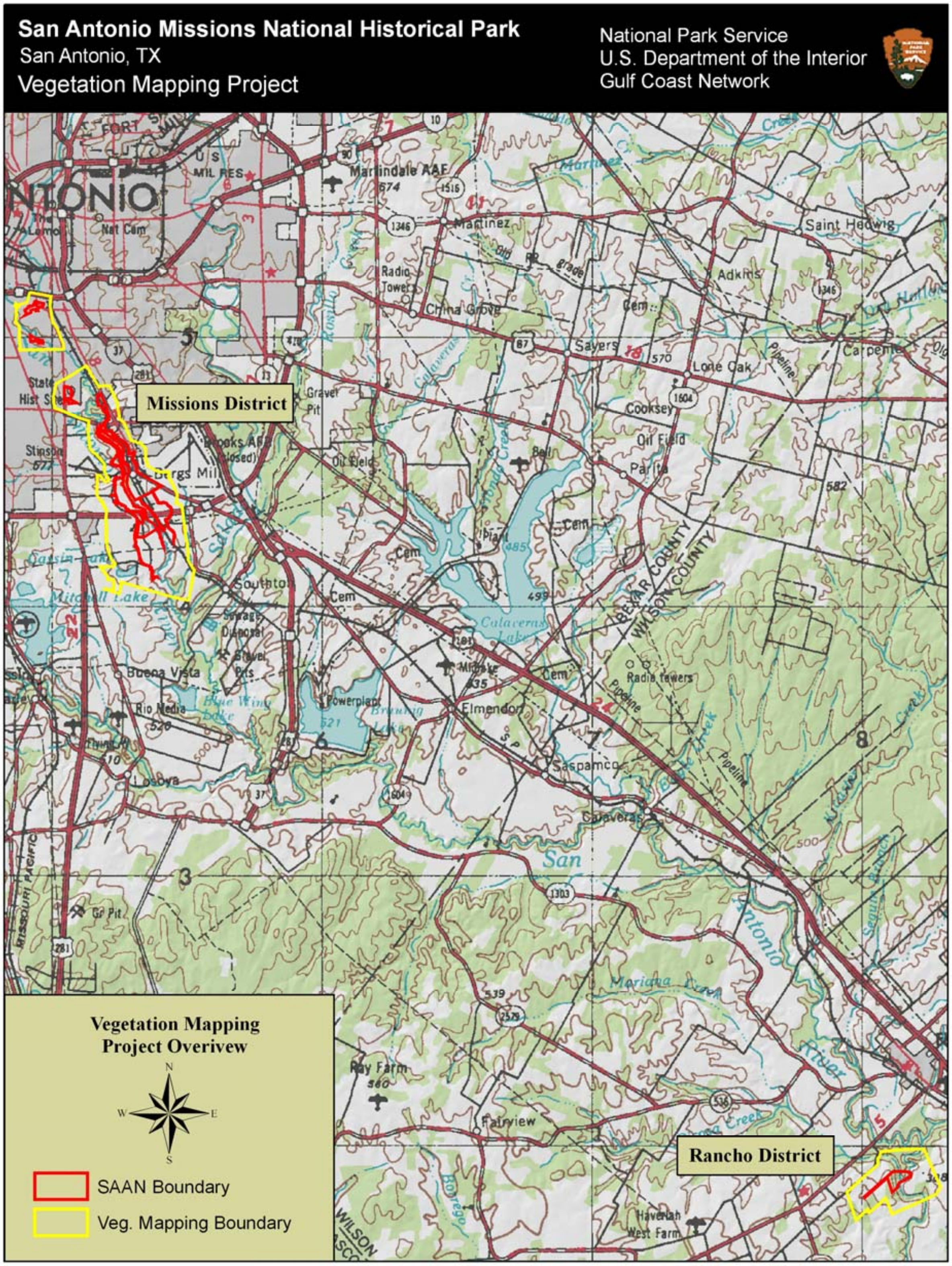

Figure 4. Map of the vegetation project boundary and park boundaries.

Methods

The vegetation mapping project at SAAN was considered to be in the "medium park" category based on the overall size of the project area (TNC 1994b). As such, the standard methodology for sampling and mapping is to visit the entire park and select representative sites. These sites are used to characterize the vegetation types and explain their distribution across the park without having to survey each stand of vegetation. Based on this approach the assignment of responsibilities was divided into five major steps following the flowchart of major steps produced for the national program by the USGS (Appendix A). These responsibilities included the following:

1. Plan, gather data, and coordinate tasks;
2. Survey SAAN to understand and sample the vegetation;
3. Classify the vegetation using the field data to NVC standard associations and alliances and crosswalk these to recognizable map units;
4. Acquire current digital imagery and interpret the vegetation from these using the classification scheme and a map unit crosswalk;
5. Assess the accuracy of the final map product.

All protocols for this project as outlined in the following sections can be found in documents produced by The Nature Conservancy (1994a, 1994b, and 1994c) for the USGS-NPS Vegetation Mapping Program and are found at this website: http://biology.usgs.gov/npsveg.

Planning, Data Gathering and Coordination

A series of planning conference calls were held during 2005 attended by representative USGS, NPS, NatureServe, BOR, and SOPN staff. The goals of these calls were to (1) inform the SAAN staff about the National Vegetation Mapping Program, (2) learn about the park's management issues and concerns, (3) review existing data, (4) develop a schedule and assign tasks, (5) obtain a commitment from SOPN/SAAN, (6) define possible cooperation with others, and (7) define a project boundary.

Planning calls in addition to follow-up meetings, conference calls, and e-mails helped determine the project boundary and base imagery. Once the boundary was finalized all of the latest NAIP imagery for this area was ordered from the USDA Geospatial Gateway website (http://datagateway.nrcs.usda.gov). Imagery included both the county mosaics acquired in 2003, 2004, and 2005 and the corresponding individual quarter quadrangles. Upon review by BOR and CTI, the 2003, 2004, and 2005 imagery were all deemed useful for this project since the 2003 imagery was color infrared acquired in the winter, the 2004 imagery was color infrared acquired in the summer and the 2005 imagery was true color and was the most recent.

The remaining work responsibilities were assigned to the following participants:

SAAN-SOPN-GULN-NPS Responsibilities

- Provide oversight and project funding;
- Supply digital boundary files and ancillary data files;
- Assist with fieldwork and logistical considerations;
- Work with NatureServe to develop the vegetation classification;
- Compile, review, and update drafts of the vegetation map, classification and report;
- Accept the final products and close the project.

BRIT Responsibilities

- Coordinate the field work with SAAN;
- Collect representative plot data;
- Collect less detailed observations about the draft vegetation map;
- Write descriptions of the vegetation types found at SAAN;
- Write a field key to the vegetation types of SAAN;
- Collect accuracy assessment data;
- Write a summary report.

NatureServe Responsibilities

- Work with NPS to develop a vegetation classification for the study area based on the NVC using quantitative analysis and ecological interpretation of the field data;
- Provide guidance regarding the crosswalk of vegetation types to map units;
- Train BRIT staff on the field data collection methods for the project;
- Review the local vegetation descriptions and field key;
- Review the final database containing the field data.

CTI-BOR Responsibilities

- Help with overall project facilitation and coordination;
- Verify vegetation and land use/land cover signatures on the imagery;
- Develop map units linked to the NVC;
- Provide field maps and GIS support to the field crews;
- Interpret and delineate the final vegetation and land-use types;
- Transfer and automate interpreted data to a digital spatial database;
- Produce spatial layers of plot and accuracy assessment site locations;
- Assist with the accuracy assessment by picking the stratified random target points, creating field maps and providing GIS support;
- Provide a final report describing all aspects of the project;
- Provide a visual guide to the photo signatures of each map unit;
- Document FGDC-compliant metadata for all vegetation data;
- Create a DVD with reports, metadata, guides, vegetation classification, plot data, spatial data, the vegetation database (map), graphics, and ground photos.

Field Survey

Overall, the field methods used for developing the classification and conducting the accuracy assessment at SAAN followed the methodology outlined by the USGS-BRD/NPS Vegetation Mapping Program (TNC 1994b) for medium sized parks. First, NatureServe provided a preliminary list of vegetation associations and alliances from the NVC based on previous studies and local knowledge. The resulting list was initially used to set targets for data collection with each association marked for 3-5 plots. This list was then taken in the field during the summer of 2005 by BRIT botanists who surveyed the entire site for representative stands of vegetation either fitting this list or for new types.

Once a stand of vegetation was located that appeared to be representative of the plant communities in the area, a Relevé macroplot was laid out to capture its characteristics. In this manner transitional areas such as ecotones were avoided. Once a plot was laid out all data were recorded on a modified plot form (Appendix B). Environmental information included: elevation, slope, aspect, landform, topographic position, soil texture and drainage, hydrologic (flooding) regime, and evidence of disturbance or wildlife use. The unvegetated surface was recorded as percent cover of each of the following classes: bedrock, litter and duff, wood, bare soil, large rocks (>10 cm), small rocks (0.2-10 cm), sand (0.1-2 mm), lichens, mosses, and fungi. Vegetation structure and species composition were sampled using plots that varied in size depending on the dominant physiognomy of the vegetation. Forest and woodland plots were 400 m^2, while shrubland, dwarf-shrubland, and herbaceous vegetation plots were 100 m^2. Plot dimensions were recorded on the forms and the plot shape usually was square, but was modified to best represent the vegetation (e.g. narrow, linear rectangles for riparian vegetation).

Within each plot, BRIT visually divided the vegetation into strata, with the height and canopy cover of vegetation estimated for each stratum. Physiognomic class, leaf phenology, and type of dominant stratum were recorded. The species of each stratum were then listed and percent canopy cover estimated using a twelve-point cover scale (e.g. <1%, 1-5%, >5-15% …) (Daubenmire 1959). Additional species within the vegetation unit that occurred outside of sampled plots were listed separately. No attempt was made to identify individual non-vascular plant species. Species that were not identifiable in the field were collected for later identification. Species were recorded by scientific epithet familiar to researchers. For plots with trees, the diameter at breast height (DBH) was measured and recorded for trees with DBH greater than 10 cm. Trees with stems 5-10 cm DBH were also tallied. Finally, a provisional vegetation type was assigned to the plot.

After all the physiognomic and environmental information was collected researchers used a Garmin GPS receiver to record the plot center. Universal Transverse Mercator (UTM) NAD83 X-Y coordinates and elevation were recorded both manually on the plot forms and stored as waypoints in the GPS receiver. Finally four or five representative photos were taken in the four cardinal directions (N, E, S, and W) of the plot for monitoring purposes.

During the summer of 2005 a total of 35 plots were sampled across both districts of the park (Figure 5).

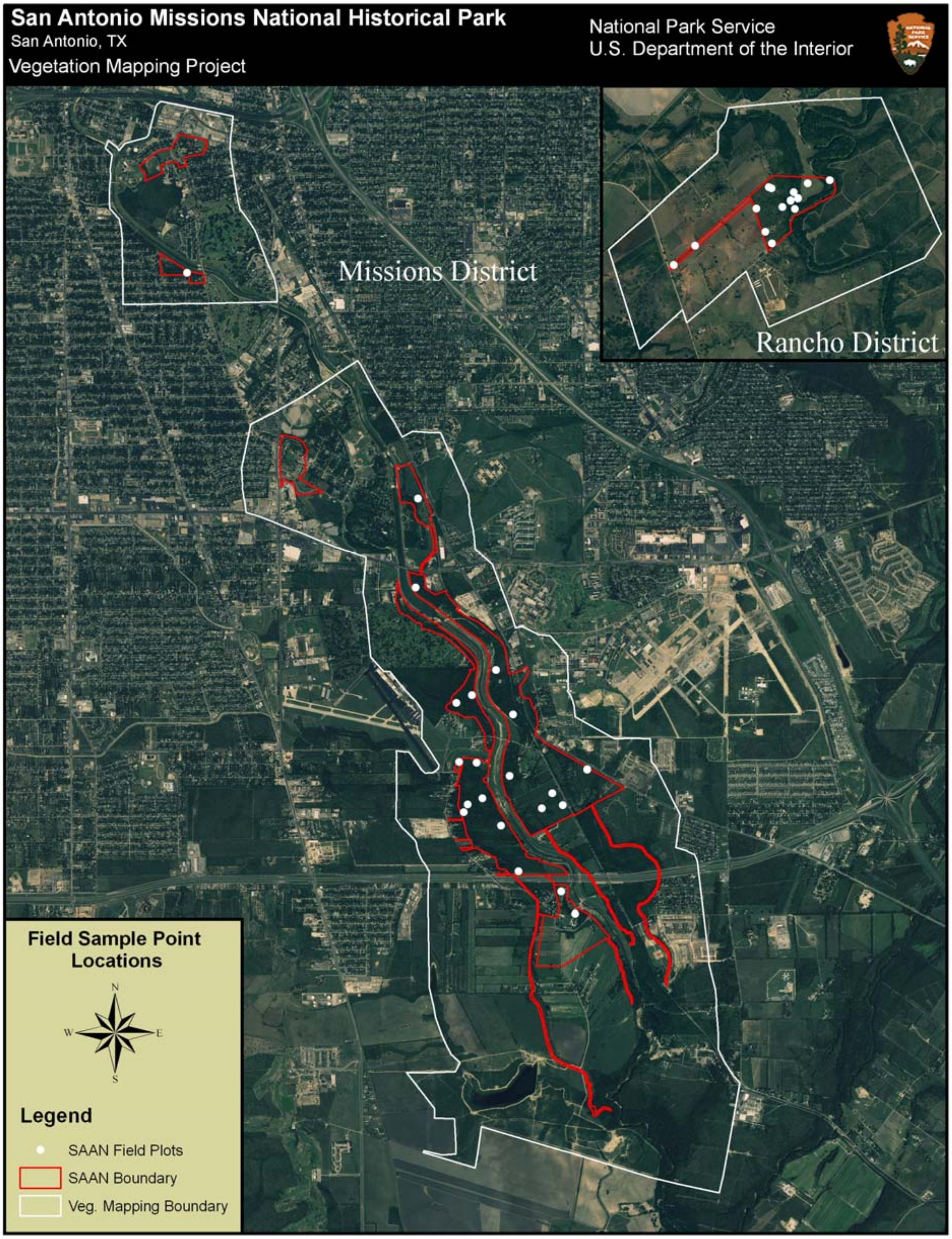

Figure 5. Location of all vegetation plots collected at SAAN in 2005.

Vegetation Classification

Upon completion of field surveys, all recorded data were entered into the NPS PLOTS2 database (NatureServe 2005), a MS Access-derived program. The PLOTS2 database was developed specifically for the NPS vegetation and mapping program so that the electronic data entry fields mirror the standard field form. Data entry was facilitated by assigning each plant taxon a unique, standardized code and name based on the PLANTS database developed by Natural Resources Conservation Service in cooperation with the Biota of North America Program (see website at http://plants.usda.gov). After data entry, checking was performed to minimize errors associated with duplicate entries or erroneously selected plant names. Problems regarding unknown species, especially those with high cover, were resolved, as were other taxonomic issues such as grouping subspecies and varieties judged to be ecologically similar.

Prior to quantitative analysis the database was prepared for use in the analytical programs. Data preparation followed these steps:

1). Standardize strata for certain taxa. Some taxa are listed in different strata in different plots even though they should all be the same, especially if there are multiple field crews. For example cacti may sometimes be listed as shrubs and sometimes listed as herbaceous;

2). Create “pseudospecies” for each taxon by appending the stratum in which it was found in each plot to a code for the taxon. For example, *Celtis laevigata* (CELA) found in the subcanopy (T3 stratum) would be converted to the code CELAT3 for analyses. Seedlings (H stratum) of the same species would be converted to the code CELAH for analyses. These two codes would be treated as separate entities during the quantitative analyses;

3). Simplify the strata for woody species. The strata for trees and shrubs were collapsed from three for each to just one for each. This reduces complexity in the data that does not add to the quality of the classification (though these distinctions do add to the ability to describe the plots and vegetation communities). The field crew might see *Carya illinoinensis* in the canopy (T2) and subcanopy (T3) in a plot. These two are combined into one “T” stratum observation so that plots are not separated based on fine differences;

4). Remove plots with grossly incomplete or missing data.

Many of the preliminary plant associations as identified in the field were simply matched to existing NVC associations. The remaining types were analyzed in a series of runs in PC-ORD Multivariate Analysis software package (McCune and Mefford 1997) using Indicator Species Analysis (Dufrêne and Legendre 1997, as cited in McCune and Grace 2002). Further analysis using Agglomerative Clustering with Sørensen distance and Flexible beta linkage functions (McCune and Grace 2002) was used to explore each of the indicator groups, and define plant associations. Preliminary plant associations were then compared with the NVC (NatureServe 2006). Throughout, care was taken not to over-emphasize local variations found at SAAN compared to more extensive information compiled at the regional level. Nevertheless, several types in the NVC were revised based on these analyses and a new association was identified from SAAN’s data.

NPS and BRIT staff worked with NatureServe to refine and finalize the classification for SAAN. Plant association descriptions and literature references contained within the NVC were compared to SAAN results. Quantitative tables of cover and constancy by SAAN associations were generated by the PLOTS database, and compared to published tables. Based on qualitative comparisons, some associations were changed, and some plots were moved from one association to another and in some cases new associations were created.

SAAN plot data were then used to update and improve the world-wide (i.e. global) descriptions for the associations. SAAN specific (i.e. local) descriptions were then written based on SAAN plot and accuracy assessment data. When the associations were finalized, a dichotomous key was developed for use during the Accuracy Assessment (Appendix C).The final SAAN classification contains 11 plant associations and alliances. The full NVC hierarchical classification and local descriptions are available in Appendix D. In addition, the final associations were linked to map classes for use in the photo-interpretation and mapping portions of the project.

Digital Imagery and Interpretation

Since SAAN represented a fairly small and accessible site no new imagery or aerial photography was acquired. Instead, existing sources of imagery were evaluated and three NAIP products were selected. These included the 2003, 2004, and 2005 NAIP ortho-photos (Figure 6). The 2003 and 2004 imagery had 1-meter resolution and the 2005 had 2-meter resolution and all were acquired at 1:12,000-scale. The 2003 and 2004 were acquired in color infrared format and the 2005 was true color. Color infrared imagery is useful in vegetation mapping since it highlights subtle changes in reflectance. This can be very helpful when differentiating between grasslands or herbaceous types. Further, since the 2003 imagery was acquired in the winter, deciduous and evergreen trees could be easily distinguished and separated. The 2005 imagery was the most recent at the time of mapping and it did highlight all of the recent changes to the landscape such as new roads, tree removals, etc.

After obtaining all three sets, the 2003 imagery was color balanced in Imagine Software to removed some of the edge-matching issues and sharpen the image. The 2004 and 2005 imagery was also color balanced but edge-matching was not necessary. The resulting images from all three sets were mosaiced and clipped to just beyond the project boundary extent.

Interpretation of the vegetation at SAAN involved a three step process: (1) image segmentation, (2) cleaning and smoothing, and (3) ground-truthing of the data. First the 2003 imagery was re-sampled to a 3-meter pixel resolution to reduce noise and to generalize the vegetation signatures. Next this imagery was segmented using eCognition software to delineate obvious landforms (e.g. open water and fields) and physiognomic features (e.g. grasslands versus woodlands). The initial segments were created using a series of trial-and-error multi-resolution segmentation routines in the software. The settings for scale and shape were manipulated until a desired network of image objects resulted. The objective of the segmentation was to create a system of lines with as coarse a scale as possible without omitting most of the small, important and obvious land-cover patches. By iteratively increasing segmentation size within the program small image objects (i.e. preliminary polygons) were continuously merged into larger ones. Completion of the segmentation was based on visual judgment of the analyst when obvious, distinct features were lost. At this point in the process the previous segmentation was adopted as the final treatment.

2003 Color Infrared

2004 Color Infrared

2005 True Color

Figure 6. Examples of the NAIP 2003, 2004, and 2005 imagery for the Rancho District.

Following segmentation, the lines were exported as ArcInfo shapefiles and converted to ArcInfo coverages. The resulting coverages were run through a series of smoothing routines provided in the ArcGIS software. Smoothing was conducted to reduce the stair-stepping pattern of the lines resulting from the large pixels. Smoothing ended when no obvious artificial and relict breaks in the lines were visible. Following smoothing, the linework was manually cleaned to remove extraneous lines, small polygons, and polygons that obviously split a homogenous stand of vegetation. The cleaning stage was considered complete when all resulting polygons matched homogenous stands of vegetation apparent on the 2003 imagery

The lines resulting from the 2003 imagery segmentation were visually inspected in ArcInfo comparing them to the 2004 and 2005 imagery. Any obvious changes in the landscape between the three years were added or edited. Review of the merged polygon layer revealed that the roads and the facilities were not adequately separated from the surrounding vegetation. To resolve this, all large buildings, roads, streams and other linear and rectangular features were manually digitized directly off the 2005 imagery and incorporated into the final segmentation. After merging the digitized lines with the segmented linework the resulting preliminary GIS layer was considered complete and ready to be ground-truthed in the field.

Once the preliminary vegetation layer for SAAN was completed, 1:6,000-scale hard copy maps were printed for review. These contained both the 2003 and 2005 basemaps and the linework as an overlay. During three days in 2006, researchers from CTI and BOR visited almost every polygon at both districts of SAAN. Ground-truthing consisted of verifying the maps against the actual vegetation on the ground to ensure that the polygons were labeled properly and to locate any extra or missing vegetation polygons. More general observations were also taken during this trip to help write descriptions for this report and create map units. All the information from this trip was subsequently added to the final GIS layer to correct any errors.

Upon return from the field, CTI researchers used the final NVC classification supplied by NatureServe to create map units. In all cases the map units were derived on a 1 association or alliance to 1 map unit basis. To round-out the mapping scheme, map units were created for land-use types not covered by the NVC based on a mapping system developed by Anderson et al. (1976). This included all of the unvegetated lands not included in the NVC, such as roads, facilities, and agricultural fields. A separate class of map modifiers or “Park Specials” was also defined especially for SAAN to cover types that were not sampled either because they were too small or they occurred outside of the park boundary. This included Chinaberry, privet, and black willow stands. In some cases NVC alliances were matched to the park specials. All of the resulting map unit names, map unit codes, NVC information, and other relevant attributes were then added to each polygon in the GIS layer (Table 1).

Table 1. Polygon attribute items and descriptions used in the SAAN GIS coverage.

ATTRIBUTE	DESCRIPTION
AREA*	Surface area of the polygon in meters squared
PERIMETER*	Perimeter of the polygon in meters
SAAN_VEG#*	Unique code for each polygon
SAAN_VEG-ID*	Unique identification code for each polygon
MAP_CLASS	Final Map Unit Codes – Project specific
MAP_DESC	Map Unit Common Description Name – Project specific
DENS_MOD	Modifier - Percent cover of the upper stratum layer in the polygon Percent cover classes: Sparse **10 - 25%,** Open **25 - 60%,** Discontinuous - Closed > **60%**
PTRN_MOD	Modifier - Vegetation pattern within the polygon Vegetation pattern classes: Evenly Dispersed **= Homogeneous, Alternating,** Grouped Stands of Vegetation = **Bunched / Clumped,** String of Vegetation **= Linear**
HT_MOD	Modifier - Height range of the dominant vegetation layer Height classes: **0-0.5, 0.5-1, 1-5, 5-15, 15-30, >30 meters**
CES_CODE	Ecological Systems Code – NVC derived (NatureServe)
CES_NAME	Ecological Systems Name – NVC derived (NatureServe)
IDENTIFIER	Corresponding Association or Alliance Name Code – NVC derived (NatureServe) Association **=** Community Element Global Code – Elcode link to the NVC Alliance = Alliance Global Code – Alliance Link to the NVC
ASSN_NAME	Project Community Name - NVC Association(s)
ASSN_CNAME	Project Common Community Name - synonym name of Association(s)
NVCS_CODE	NVC Code - to NVC Formation level
ALL_NAME	Project Alliance Name = NVC Alliance(s)
ALL_CNAME	Project Common Alliance Name = NVC Alliance(s)
FORMATION	NVC Formation = Formation name NVC Code – Formation name
SUBGROUP	NVC Formation Subgroup = NVC Code – Subgroup name
GROUP	NVC Formation Group = NVC Code – Group name
SUBCLASS	NVC Formation Subclass = NVC Code – Subclass name
CLASS	Formation Class = NVC Code – Class name
LUC_II_GEN	General Land Use and Land Cover Classification System Name – Project specific based on Level II of Anderson et al. (1976)
LUC_II	Specific Land Use and Land Cover Classification System Name – Project specific Level II of Anderson et al. (1976)
ACRES	Surface area of the polygon in acres

(***ArcInfo© default items)

Accuracy Assessment

Once the vegetation layer was completed and finalized the accuracy assessment (AA) was conducted. Typically in mapping exercises both thematic or attribute map accuracy as well as the positional or polygon line accuracy are considered. In the case of the USGS-NPS National Vegetation Mapping Program however, the positional accuracy is usually omitted since rarely does vegetation split on discrete edges that can be positively located in the field. The subjectivity involved in this effort plus the high resolution and accuracy of the NAIP basemaps usually allows for the assumption that all products derived from them are well within National Map Accuracy Standards for 1:12,000-scale maps (±30 feet). Further since no additional funding was budgeted or available the positional accuracy was not assessed.

The thematic accuracy of the vegetation map was assessed using the methodology following the standards provided by the USGS-NPS National Vegetation Mapping Program's Accuracy Assessment Procedures manual (TNC 1994c). This included a four step process consisting of a sample design, sample site selection, data collection, and data analysis. The design of the AA process followed the five possible scenarios provided in the field manual with stratified random targets placed in each map class based on their respective frequency and abundance (Table 2).

These parameters were loaded into a custom GIS program along with the vegetation layer. This program picked the random target locations and also buffered them 10 meters away from any polygon boundary and 50 meters away from any other point. Being able to choose minimum distance to polygon boundaries helped to minimize confusion and accounted for the horizontal error typically encountered in common GPS receivers (±5 m). The resulting target locations were restricted to only within the boundaries of SAAN due to private land access constraints.

Once the target locations were selected, BRIT botanists were provided with draft field maps, overview maps, map unit definitions, the key to the associations (Appendix C), and digital GPS files containing the location of the target AA sites. During the summer of 2006, botanists traveled to the AA target sites and determined the vegetation association using the field key. At each target they recorded the primary and secondary associations that occurred within a roughly 50-meter radius. They also recorded height and cover of vegetative strata, environmental data, and percent canopy cover of the major species (see AA point form in Appendix B). Other nearby vegetation types outside the 50-meter radius and any recent disturbance were also recorded. To better assist the analysis a minimum of 4 photographs were taken at each AA point, in the sequence of cardinal directions, N-E-S-W. If the point was too close to dense, especially shrubby vegetation, one or more optional photographs were taken at a distance to show the character of the vegetation. In such cases, the site of the optional photograph was given a GPS waypoint which was recorded as UTM coordinates along with the aspect of the photograph at that point.

Table 2. Target number of AA samples per map class based on number of polygons and area.

Scenario	Description	Polygons in class	Area occupied by class	Recommended number of samples in class
Scenario A:	The class is abundant. It covers more than 50 hectares of the total area and consists of at least 30 polygons. In this case, the recommended sample size is 30.	> 30	> 50 ha	30
Scenario B:	The class is relatively abundant. It covers more than 50 hectares of the total area but consists of fewer than 30 polygons. In this case, the recommended sample size is 20. The rationale for reducing the sample size for this type of class is that sample sites are more difficult to find because of the lower frequency of the class.	< 30	> 50 ha	20
Scenario C:	The class is relatively rare. It covers less than 50 hectares of the total area but consists of more than 30 polygons. In this case, the recommended sample size is 20. The rationale for reducing the sample size is that the class occupies a small area. At the same time, however, the class consists of a considerable number of distinct polygons that are possibly widely distributed. The number of samples therefore remains relatively high because of the high frequency of the class.	> 30	< 50 ha	20
Scenario D:	The class is rare. It has more than 5 but fewer than 30 polygons and covers less than 50 hectares of the area. In this case, the recommended number of samples is 5. The rationale for reducing the sample size is that the class consists of small polygons and the frequency of the polygons is low. Specifying more than 5 sample sites will therefore probably result in multiple sample sites within the same (small) polygon. Collecting 5 sample sites will allow an accuracy estimate to be computed, although it will not be very precise.	5-30	<50 ha	5
Scenario E:	The class is very rare. It has fewer than 5 polygons and occupies less than 50 hectares of the total area. In this case, it is recommended that the existence of the class be confirmed by a visit to each sample site. The rationale for the recommendation is that with fewer than 5 sample sites (assuming 1 site per polygon) no estimate of level of confidence can be established for the sample (the existence of the class can only be confirmed through field checking).	< 5	< 50 ha	Visit all and confirm

During 2006 a total of 124 AA points were sampled (Figure 7). The data recorded on the field forms were subsequently entered into the PLOTS2 database and reviewed for data entry errors by NPS and NatureServe staff. Incomplete data on the field sheets were corrected if possible. The results were imported from the database into a GIS layer where they were visually compared in two stages to the vegetation map coverage. The first step was to compare the AA points to the original target locations to check for erroneous points and remove these from further analysis. General errors in the data were recorded at this time, including documenting points that had GPS and location errors. The most common GPS receiver error included transposing two UTM coordinate numbers. Location errors involved having the final AA point occur in the wrong target polygon either due to bad GPS satellite positioning or the point occurred too close to a polygon boundary. Through this process UTM coordinates for two points were corrected and one point was removed since it was located in the wrong target polygon.

The second review step involved deciding between the primary and secondary call for the plant association as recorded by the field crew. In larger vegetation mapping projects such as Rocky Mountain National Park (Salas et al. 2004), AA analysis has involved fuzzy logic which assigns different levels of accuracy based on the primary, secondary and sometimes even the tertiary calls. However due to the small size of this project and the confusion that fuzzy logic can cause for the end user, a simple binary assessment was conducted. To accomplish this, CTI had to

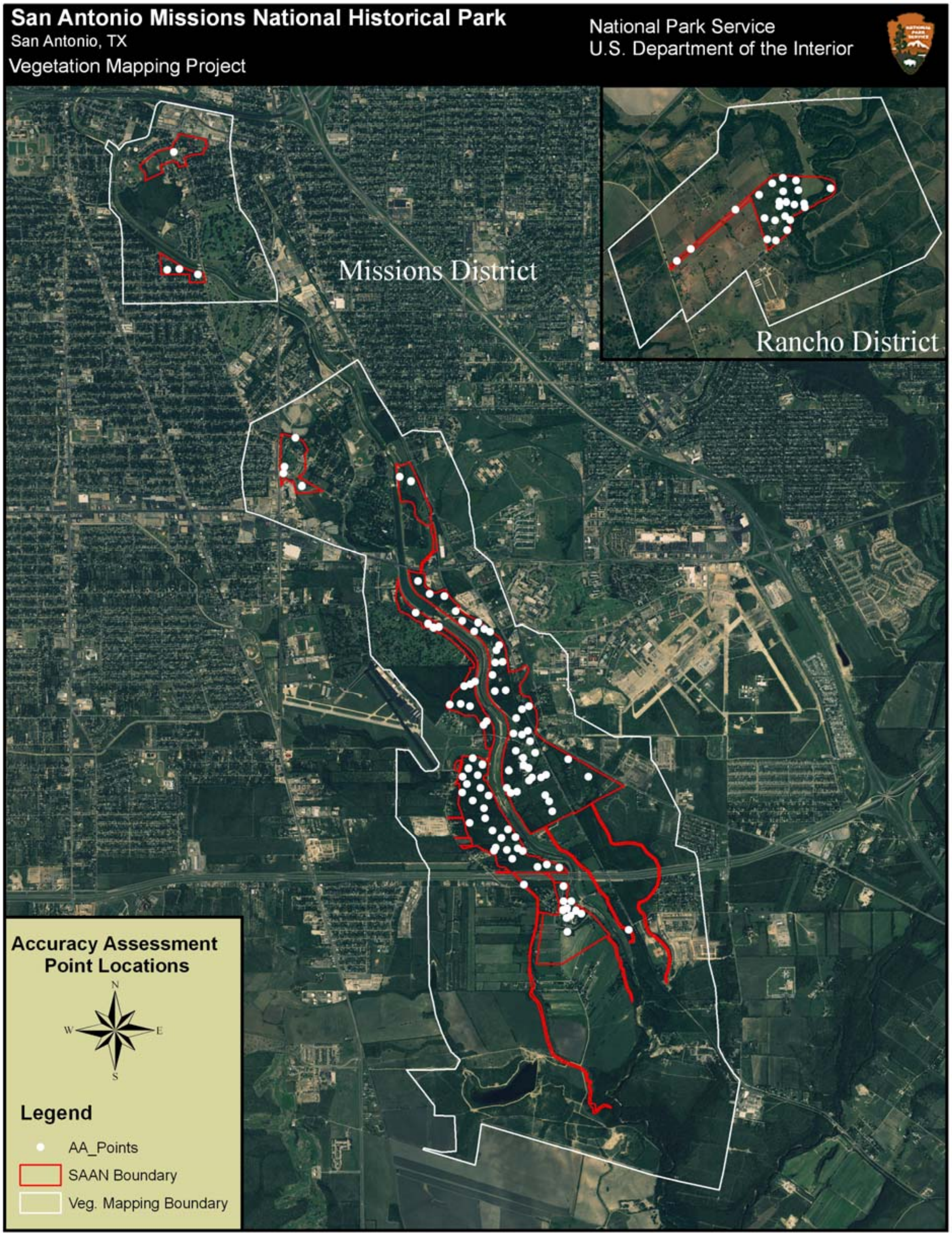

Figure 7. Location of all accuracy assessment points collected at SAAN in 2006.

assign a final map unit for every point by choosing between the primary and secondary field calls. This was accomplished by first adding a new attribute to the point layer labeled "Final_Code and then by comparing the assigned field names of the point with its corresponding location on the digital imagery. In most cases the primary vegetation map unit name assigned by the field crew was used. However some points were assigned their secondary field call based on one of the following reasons: (1) it appeared that the second call was the better choice due to the overhead perspective (e.g. a stand judged to be sparse woodland on the imagery vs. called herbaceous vegetation in the field), 2) the data were actually recorded in a stand that was too small (i.e. inclusion), or 3) the second call better matched the ecological context (e.g. riparian woodland located next to a stream vs. upland woodland located next to a stream). Overall, roughly 10-20 points were reassigned to their secondary field call instead of their primary identification.

Once the data were reviewed the accuracy analysis was conducted. In the case of SAAN, the process was streamlined using methods developed from previous studies at Rocky Mountain National Park (Salas et al. 2004) and Wupatki National Monument (Hansen et al. 2004). Specifically many of the in-house GIS programs developed for these projects were used to compare the AA data, generate confidence intervals, Kappa statistics, and error matrices (contingency tables). Through this automated process, the final map units in the AA layer were compared to the map unit designations for their corresponding polygons. All of the statistics and calculations used to analyze these data are described at length in the program manuals (TNC 1994c) and are summarized in Table 3. Final assessments for each point were recorded using an error matrix.

Table 3. Summary of the AA Statistics used at SAAN.

Statistic	Formula	Description
User's - accuracy:	$\frac{n_{ii}}{n_{i+}}$	Where *i* is the land cover type, n_{ii} is the number of matches between map and reference data and n_{i+} is the total number of samples of *i* in the map. This formula is the number of "correct" observations divided by the sum of the row.
Producer's accuracy	$\frac{n_{ii}}{n_{+i}}$	Where n_{+i} = total number of sample of *i* in the reference data. This formula is the number of "correct" observations divided by the sum of the column.
Confidence Interval	$\hat{p} \pm \left\{ z_\alpha \sqrt{\frac{\hat{p}(1-\hat{p})}{n}} + \frac{1}{(2n)} \right\}$	Where $z_{\alpha =}$ 1.645 (this comes from a table of the z-distribution at the significance level for a two-sided limit with a 90% confidence interval). The term 1/ (2n) is the correction for continuity. The correction should be applied to account for the fact the binomial distribution describes discrete populations $\hat{p}$ = the sample accuracy (0 -1.0), *n* = the number of sites sampled.
Kappa Index	$k = \frac{N\sum_{i=1}^{r} x_{ii} - \sum_{i=1}^{r}(x_{i+} \text{ x } x_{+i})}{N^2 - \sum(x_{i+} \text{x } x_{+i})}$	Where *N* is the total number of sites in the matrix, *r* is the number of rows in the matrix, x_{ii} is the number in row *i* and column *i*, x_{+i} is the total for row *i*, and x_{i+} is the total for column *I*.

Results

Vegetation Classification

The final classification for SAAN resulted in 6 associations and 4 alliances, two of which were newly described in the NVC. In addition, during ground-truthing efforts, CTI described an additional alliance and two distinctive stands of vegetation (i.e. Park Specials) that primarily occurred either as small stands at SAAN or were outside of the park boundary in the environs. The classification results reflect both the moderate amount of diversity in the park and a respectably high number of native species. It is also notable that three of vegetation classes, *Cynodon dactylon* Herbaceous Vegetation, *Bothriochloa laguroides – Sorghum halepense* Herbaceous Vegetation, and the Old Field Weedy Herbaceous Vegetation represent disturbed vegetation. The NVC is best developed for natural/semi-natural vegetation and new exotic species-dominated communities are often found during applications such as this. Table 4 contains the complete list of SAAN plant associations that were described in this study, and Appendix D provides complete descriptions for each association. During the sampling efforts a total of 214 species were recorded (Appendix E).

Digital Imagery and Interpretation

For SAAN, 32 map units were developed and directly cross-walked or matched to corresponding plant associations and land-use classes (Table 5). The types included 13 vegetation based map units and 19 land use classes. All vegetation units had a direct 1 map unit to 1 NVC association/alliance relationship. Since the two park special map units were not classified to the NVC these do not have a corresponding NVC association or alliance. Please reference Appendix F for detailed descriptions and representative photographs for all vegetation map units.

Relationship between Map Units and Plant Associations/Alliances

The SAAN map units represent a compromise between the detail of the NVC, the needs of the park and the limitations of the imagery. As a result, the mapping scheme does not exactly match the NVC. Rather, the vegetation map units are linked (i.e. "crosswalked") to the NVC plant associations or alliances when possible. When the NVC link was not feasible other map units were created.

The following represent the possible map scenarios encountered at SAAN: (1) when a plant association or alliance had a unique photo signature and could be readily delineated on the photos, the map unit adopted the plant association/alliance name (one-to-one relationship). (2) When unique stands of vegetation did not have a corresponding NVC association or alliance these were considered "park specials". (3) Finally, non-vegetated areas and vegetation types not recognized by the NVC received Anderson et al. (1976) Land Use – Land Cover map unit designations.

Table 4. List of NVC Plant Associations and Alliances found at SAAN.

Scientific Name	**Common Name**	**Elcode**[1]
Forest and Woodlands		
Carya illinoinensis - Celtis laevigata Forest	Pecan - Sugarberry Forest	CEGL002087
Populus deltoides Temporarily Flooded Forest Alliance	Eastern Cottonwood Temporarily Flooded Forest Alliance	A.290
Ulmus crassifolia - Celtis laevigata / Ilex decidua / Elymus virginicus Forest	Cedar Elm - Sugarberry / Possum-haw / Virginia Wild Rye Forest	CEGL008468
Prosopis glandulosa - *Celtis pallida / Opuntia* spp. - *Xylothamia palmeri* Woodland	Honey Mesquite - Granjeno / Prickly-pear species - South Texas Ericameria Woodland	CEGL007787
Acacia farnesiana - (Prosopis glandulosa) Woodland	Huisache - (Honey Mesquite) Woodland	CEGL002131
Quercus virginiana Temporarily Flooded Forest Alliance	Live Oak Temporarily Flooded Forest Alliance	A.57
Shrublands		
Acacia rigidula Shrubland	Chaparro - Prieto Shrubland	CEGL003874
**Salix nigra* Temporarily Flooded Shrubland Alliance	Black Willow Temporarily Flooded Shrubland Alliance	A.948
Herbaceous Vegetation		
Cynodon dactylon Herbaceous Alliance	Bermuda Grass Herbaceous Alliance	A.1279
Bothriochloa laguroides - Sorghum halepense Herbaceous Vegetation	Silver Beardgrass - Johnsongrass Herbaceous Vegetation	New Association
(no scientific name)	Old Field Weedy Herbaceous Vegetation	New Association

*Represents discrete stands of vegetation that were not sampled either due to their small size or they occurred outside of the park boundary.
[1] **ELCODE** represents NatureServe's internal database tracking code for each recognized plant association or alliance.

Table 5. Map units identified in SAAN.
The units are organized into ecological groups. "Level" refers to whether the map unit represents a NVC plant association/alliance (NVC unless otherwise noted) or a local plant community/plant population (Park Special), or a land use class. Anderson Land Use Classes are identified by Roman numerals.

Map Code	Map Unit Name	Map Unit Common Name	Level
Forest and Woodlands			
F -PECN	*Carya illinoinensis - Celtis laevigata* Forest	Pecan - Sugarberry Forest	Association
F-COTW	*Populus deltoides* Temporarily Flooded Forest Alliance	Eastern Cottonwood Temporarily Flooded Forest Alliance	Alliance
F-CELM	*Ulmus crassifolia - Celtis laevigata / Ilex decidua / Elymus virginicus* Forest	Cedar Elm - Sugarberry / Possum-haw / Virginia Wild Rye Forest	Association
F-LOAK	*Quercus virginiana* Temporarily Flooded Forest Alliance	Live Oak Temporarily Flooded Forest Alliance	Alliance
W-MESQ	*Prosopis glandulosa - Celtis pallida / Opuntia* spp. - *Xylothamia palmeri* Woodland	Honey Mesquite - Granjeno / Prickly-pear species - South Texas Ericameria Woodland	Association
W-HUCH	*Acacia farnesiana - (Prosopis glandulosa)* Woodland	Huisache - (Honey Mesquite) Woodland	Association
*W-CHIN	*Melia azedarach* Woodland Stand	Chinaberry Woodland Stand	Park Special
Shrublands			
S-CHAP	*Acacia rigidula* Shrubland	Chaparro - Prieto Shrubland	Association
*S-PRVT	*Ligustrum japonicum* Shrubland Stand	Privet Shrubland Stand	Park Special
*S-BLWL	**Salix nigra Temporarily* Flooded Shrubland Alliance Stand	Black Willow Temporarily Flooded Shrubland Alliance Stand	Park Special
Herbaceous Vegetation			
H-BERM	*Cynodon dactylon* Herbaceous Vegetation	Bermuda Grass Herbaceous Alliance	Alliance
H-SVJN	*Bothriochloa laguroides - Sorghum halepense* Herbaceous Vegetation	Silver Beardgrass - Johnsongrass Herbaceous Vegetation	Association
H-OFLD	No Scientific Name	Old Field Weedy Herbaceous Vegetation	Association

*Park Special: Represents discrete stands of vegetation that were too small and/or occurred too infrequently to classify.

Land Use – Land Cover			
L-STRM	(No Scientific Name)	Stream / River	Level III
L-CANL	(No Scientific Name)	Canal / Ditch	Level III
L-POND	(No Scientific Name)	Lake / Pond	Level III
L-RESD	(No Scientific Name)	Residential	Level II
L-LINY	(No Scientific Name)	Commercial / Light Industry	Level III
L-HINY	(No Scientific Name)	Heavy Industry	Level III
L-COMM	(No Scientific Name)	Communications and Utilities	Level III
L-CEMT	(No Scientific Name)	Cemeteries	Level VI
L-AGRI	(No Scientific Name)	Agricultural Business	Level II
L-ROAD	(No Scientific Name)	Transportation	Level III
L-GOLF	(No Scientific Name)	Golf Course	Level VI
L-PARK	(No Scientific Name)	Urban Parks	Level VI
L-URBN	(No Scientific Name)	Mixed Urban	Level II
L-TRAN	(No Scientific Name)	Transitional	Level II
L-FLAT	(No Scientific Name)	Flats	Level II
L-DISP	(No Scientific Name)	Disposal	Level II
L-ORCH	(No Scientific Name)	Orchards / Vineyards / Groves	Level II
L-FILD	(No Scientific Name)	Planted / Cultivated	Level III
L-FACL	(No Scientific Name)	Park Facilities	Level II

Below is a comprehensive breakdown of the crosswalking of the NVC associations to the map units for SAAN:

-Map Units Representing Single NVC Units (either existing or new)
(One Alliance/Association-to-One Map Class)

The following map units were created from the NVC and represent established or provisional plant alliances that could be discerned and delineated on the imagery.

Map Code	Map Unit / *NVC Plant Alliance / Association(s)*
F -PECN	*Carya illinoinensis – Celtis laevigata* Forest
	Carya illinoinensis – Celtis laevigata Forest
F-COTW	*Populus deltoides* Temporarily Flooded Forest Alliance
	Populus deltoides Temporarily Flooded Forest Alliance
F-CELM	*Ulmus crassifolia - Celtis laevigata / Ilex decidua / Elymus virginicus* Forest
	Ulmus crassifolia - Celtis laevigata / Ilex decidua / Elymus virginicus Forest
F-LOAK	*Quercus virginiana* Temporarily Flooded Forest Alliance
	Quercus virginiana Temporarily Flooded Forest Alliance
W-MESQ	*Prosopis glandulosa - Celtis pallida / Opuntia* spp. - *Xylothamia palmeri* Woodland
	Prosopis glandulosa - Celtis pallida / Opuntia spp. - *Xylothamia palmeri* Woodland
W-HUCH	*Acacia farnesiana - (Prosopis glandulosa)* Woodland
	Acacia farnesiana - (Prosopis glandulosa) Woodland
S-CHAP	*Acacia rigidula* Shrubland
	Acacia rigidula Shrubland
S-BLWL	*Salix nigra* Temporarily Flooded Shrubland Alliance
	Salix nigra Temporarily Flooded Shrubland Alliance
H-BERM	*Cynodon dactylon* Herbaceous Vegetation
	Cynodon dactylon Herbaceous Vegetation
H-SVJN	*Bothriochloa laguroides – Sorghum halepense* Herbaceous Vegetation
	Bothriochloa laguroides – Sorghum halepense Herbaceous Vegetation
H-OFLD	Old Field Weedy Herbaceous Vegetation
	Old Field Weedy Herbaceous Vegetation

-Map Units Representing No Association

These map units were created for SAAN to describe vegetation that had no corresponding NVC association for the following reason:

Local Stands - Represents infrequent or rare types that were observed primarily in the environs during the photo interpretation and could not be classified to an association since no plots or points were collected;

Map Code	Map Unit
W-CHIN	*Melia azedarach* Woodland Stand (Local Stands)
S-PRVT	*Ligustrum japonicum* Shrubland Stand (Local Stands)

Vegetation Map

Just over 6,784 acres including 849 acres in the current (i.e. authorized) boundary of SAAN and an additional 5,935 acres in the environs were mapped using 32 map classes. The map included 19 land cover classes and 13 vegetation classes. Of all the map units, the most frequent was the Bermuda Grass Herbaceous Alliance with 163 polygons. The most abundant map unit in terms of area was the Planted / Cultivated Field type covering 986 acres (398 hectares) or about 15% of the project area. The most common natural community was Huisache – (Honey Mesquite) Woodland covering 845 acres (341 hectares) or about 12% of the project area. All of the frequencies for each map unit (i.e., number of polygons) along with their acreages are listed in Table 6.

Normally the standard minimum mapping unit for NPS vegetation mapping projects is defined as 0.5 hectare. However this is a nominal unit and due to the small size of SAAN and the resolution of the imagery it was reduced to ¼ acre. This size allowed for more detail in the mapping and allowed for better delineation of important stands of vegetation such wetlands, weedy patches and riparian vegetation. This ability to recognize small patches of vegetation is reflected in the high number of polygons created (1,129) and the average size of the polygons for this project, ~6 acres (2 hectares).

Table 6. Total acreage and frequency of map units for SAAN.

Map Code	**Map Unit**	**Missions Unit**			**Rancho Unit**			**Total Project Area**		
		Freq.	**Acres**	**HA**	**Freq.**	**Acres**	**HA**	**Freq.**	**Acres**	**HA**
F-PECN	Pecan - Sugarberry Forest	38	175.2	71.0	0	0	0	77	490.4	198.6
F-COTW	Eastern Cottonwood Temporarily Flooded Forest Alliance	0	0	0	4	8.1	3.3	14	64.3	26.0
F-CELM	Cedar Elm – Sugarberry / Possum-haw / Virginia Wild Rye Forest	26	44.3	17.9	8	21.8	8.8	100	531.6	215.3
F-LOAK	Live Oak Temporarily Flooded Forest Alliance	4	2.1	0.9	3	2.3	0.9	32	91.5	37.1
W-MESQ	Honey Mesquite - Granjeno / Prickly-pear species - South Texas Ericameria Woodland	27	24.6	10.0	4	28.9	11.7	82	379.7	153.8
W-HUCH	Huisache – (Honey Mesquite) Woodland	59	136.3	55.2	1	1.3	0.5	130	844.8	342.1
W-CHIN	Chinaberry Woodland Stand	2	3.2	1.3	0	0	0	3	3.8	1.5
S-CHAP	Chaparro - Prieto Shrubland	7	3.4	1.4	4	13.1	5.3	51	356.0	144.2
S- PRVT	Privet Shrubland Stand	13	12.4	5.0	0	0	0	35	58.3	23.6
S- BLWL	Black Willow Temporarily Flooded Shrubland Alliance Stand	0	0	0	1	0.6	0.2	1	0.9	0.4
H- BERM	Bermuda Grass Herbaceous Alliance	95	78.9	32.0	1	0.3	0.1	162	602.0	243.8
H- SVJN	Silver Beardgrass - Johnsongrass Herbaceous Vegetation	14	53.9	21.8	1	4.1	1.7	25	111.6	45.2
H- OLFD	Old Field Weedy Herbaceous Vegetation	6	19.4	7.9	1	2.3	0.9	19	158.1	64.0
L- AGRI	Agricultural Business	3	1.2	0.5	0	0	0	16	52.2	21.1
L- CANL	Canal / Ditch	2	1.3	0.5	0	0	0	5	11.0	4.5
L- CEMT	Cemeteries	1	3.5	1.4	0	0	0	1	119.2	48.3
L-COMM	Communications and Utilities	2	2.1	0.9	0	0	0	3	17.5	7.1
L-DISP	Disposal	0	0	0	0	0	0	1	3.5	1.4
L-FACL	Park Facilities	10	22.1	9.0	1	1.0	0.4	12	25.0	10.1
L-FILD	Planted / Cultivated	23	57.4	23.2	10	14.7	6.0	48	985.7	399.2
L-FLAT	Flats	0	0	0	0	0	0	3	7.8	3.2
L-GOLF	Golf Course	0	0	0	0	0	0	3	73.7	29.8
L-HINY	Heavy Industry	3	0.9	0.4	0	0	0	12	145.1	58.8
L-LINY	Commercial / Light Industry	6	0.9	0.4	0	0	0	32	147.9	59.9
L-ORCH	Orchards / Vineyards / Groves	2	1.9	0.8	0	0	0	2	19.6	7.9
L-PARK	Urban Parks	3	7.4	3.0	0	0	0	7	70.7	28.6
L-POND	Lake / Pond	2	1.2	0.5	0	0	0	13	47.5	19.2
L-RESD	Residential	47	44.3	17.9	0	0	0	149	646.7	261.9
L-ROAD	Transportation	41	45.5	18.4	0	0	0	16	367.1	148.7
L-STRM	Stream / River	3	0.1	0.0	1	2.0	0.8	14	121.0	49.0
L-TRAN	Transitional	6	2.5	1.0	1	0.2	0.1	47	183.0	74.1
L-URBN	Mixed Urban	1	2.5	1.0	0	0	0	7	47.0	19.0
Total Land-Use / Land Cover		155	195	79	13	18	7	391	3,091	1,252
Total Natural Vegetation		291	554	224	28	83	34	731	3,693	1,496
Totals		**446**	**749**	**303**	**41**	**101**	**41**	**1,122**	**6,784**	**2,748**

Accuracy Assessment

The 2006 accuracy assessment effort yielded 124 points that were distributed throughout SAAN with none sampled in the environs due to access constraints. Due to location issues, one point was removed from the final analysis. In addition to their use in the AA analysis many of the points were also used to update the classification (such as the Black Willow Shrubland type) and to revise the local descriptions. These data helped strengthen the classification for SAAN and added to the global perspective of the individual types.

Actual analysis of the AA points involved a point-by-point review in two stages. During stage one, an AA GIS point file was created from the AA point coordinates recorded in the field. The point files were then overlaid on the vegetation map and a comparison of the final AA field call versus the vegetation polygon label was conducted by CTI staff. Analyses resulted in a preliminary error matrix that was sent to SOPN for review. The first binary assessment revealed an overall accuracy of 89% with 4 map classes below the 80% standard. However, following review by SOPN and SAAN, these classes were deemed important for management and the accuracy was considered low probably due to their small sample size. Based on SAAN recommendations the vegetation GIS layer was accepted and the preliminary analysis was finalized.

Examination of the final error matrix (Table 7) reveals that areas of confusion were found between map classes that had overlap in common species. Species overlap is evidenced by the following errors: (1) Bermuda Grass Herbaceous Alliance was confused with the Old Field Weedy Herbaceous type, (2) the Pecan – Sugarberry Forest type was confused with the Cedar Elm – Sugarberry / Possum-haw / Virginia Wild Rye Forest, (3) the Eastern Cottonwood Temporarily Flooded Forest Alliance was confused with the Pecan - Sugarberry Forest, and (4) the Honey Mesquite - Granjeno / Prickly-pear species - South Texas Ericameria Woodland was confused with the Chaparro-Prieto Shrubland. In all cases these types had species that were common to both classes. Species commonality made it difficult to accurately map the different classes, especially when variations may have made one species more locally dominant than was typically found throughout the rest of the study area.

Another general trend of the accuracy reveals the difficulty in accurately delineating between deciduous woodland/forest types. Such difficulty is partially due to similar types containing the same species but it also points out the difficulty in distinguishing among deciduous trees on overhead imagery. Other errors likely resulted from mowing and maintenance of some types for lawns and parks. This regular disturbance makes it difficult to determine if it should be mapped as a vegetation type or a land-use class. Finally, some errors in the map can be explained by the difficulty in resolving the difference in scale and perspective between viewing the vegetation on the imagery and assessing it on the ground. For example, sampling could have occurred in inclusions or openings in woodland canopies and documented smaller units than were mapped, as was the case for the confusion between the Silver Beardgrass - Johnsongrass Herbaceous Vegetation and the Cedar Elm – Sugarberry / Possum-haw / Virginia Wild Rye Forest types.

Table 7. Contingency table (error matrix) for vegetation mapping at SAAN.

Sample Data (Polygon Map Data) / Producer' Error

Map Units	F-PECN	F-COTW	F-CELM	W-MESQ	W-HUCH	F-LOAK	W-CHIN	S-CHAP	S-PRVT	S-BLWL	H-BERM	H-SVJN	H-OFLD	Totals	User's Error: Commission Accuracy	90% Conf. Interval -	90% Conf. Interval +
	Reference Data (Accuracy Assessment Field Data)																
F-PECN	**43**	0	2	0	0	0	0	0	0	0	0	0	0	**45**	96%	89%	100%
F-COTW	1	**2**	0	0	0	0	0	0	0	0	0	0	0	**3**	67%	5%	100%
F-CELM	3	0	**4**	0	0	0	0	0	0	0	0	0	0	**7**	57%	19%	95%
W-MESQ	0	0	0	**8**	0	0	0	1	0	0	0	0	0	**9**	89%	66%	100%
W-HUCH	1	0	0	0	**14**	0	0	0	0	0	0	0	1	**16**	88%	71%	100%
F-LOAK	0	0	0	0	0	**2**	0	0	0	0	0	0	0	**2**	100%	75%	100%
W-CHIN	1	0	0	0	0	0	**2**	0	0	0	0	0	0	**3**	67%	5%	100%
S-CHAP	0	0	0	2	0	0	0	**4**	0	0	0	0	0	**6**	67%	27%	100%
S-PRVT	0	0	0	0	0	0	0	0	**1**	0	0	0	0	**1**	100%	50%	100%
S-BLWL	0	0	0	0	0	0	0	0	0	**1**	0	0	0	**1**	100%	50%	100%
H-BERM	0	0	0	0	0	0	0	0	0	0	**19**	0	1	**20**	95%	84%	100%
H-SVJN	0	0	1	0	0	0	0	0	0	0	0	**5**	0	**6**	83%	50%	100%
H-OFLD	0	0	0	0	0	0	0	0	0	0	0	0	**5**	**5**	100%	90%	100%
Totals	**49**	**2**	**7**	**10**	**14**	**2**	**2**	**5**	**1**	**1**	**19**	**5**	**7**				
Omission Accuracy	88%	100%	57%	80%	100%	100%	100%	80%	100%	100%	100%	100%	71%	**110 Total Correct Points**			
90% Conf. Level -	78%	75%	22%	54%	96%	69%	75%	55%	17%	39%	84%	85%	44%	**124 Total Points**			
90% Conf. Level +	97%	100%	92%	100%	100%	100%	100%	100%	100%	100%	100%	100%	99%				

Overall Total Accuracy = 89% Overall Kappa Index = 86% Overall 90% Upper and Lower Confidence Interval = 80% and 92%

Please Note: Two correct points were removed from the analysis since they occurred on Land Use types likely due to incorrect GPS receiver coordinates.

Instructions on Using the Accuracy Assessment Contingency Table:

The contingency table or error matrix found above presents an array of numbers set out in rows and columns corresponding to a particular vegetation map unit relative to the actual vegetation type as verified on the ground. The column headings represent the vegetation classification as determined in the field and the row headings represent the vegetation classification taken from the vegetation map. The highlighted diagonal indicates the number of points assessed in the field that agree with the map label. Conversely, the inaccuracies of each map unit are described as both errors of inclusion (user's or commission errors) and errors of exclusion (producer's or omission errors). By reading across this table (i.e., rows) one can calculate the percent error of commission, or how many polygons for each map unit were incorrectly labeled when compared to the field data. By reading down the table (i.e., columns) one can calculate the percent error of omission, or how many polygons for that type were left off the map. Numbers "on the diagonal" tell the user how well the map unit was interpreted and how confident they can be in using it. Numbers "off the diagonal" yield important information about the deficiencies of the map including which types were: 1) over- mapped - commission errors on the right or 2) under-mapped - omission errors on the bottom

Discussion

San Antonio Missions National Historical Park is truly a special place celebrating some of the oldest European settlements in the United States. This rich history and culture is beautifully preserved, and in some ways is still on-going as evidenced by the active Catholic parishes at all of the Mission churches, the building of a new visitor center, and the high visitation afforded by its location in and near San Antonio. This enduring legacy has also greatly altered the natural vegetation creating a very fragmented landscape. The multiple uses of the land in and around SAAN made it very challenging to both classify and map the vegetation into meaningful context for all levels of interest (local, regional, and national). However, due to the small size of the park and the accessibility afforded to the sampling and verifying efforts a highly accurate classification and map was completed. Even though the accuracy is high there are still some areas were improvements can be made, which are summarized below.

Field Survey

The vegetation data presented in this project should be used as a “baseline” to build upon. New survey work on a timely manner would greatly improve both the classification and mapping efforts. Using the accuracy assessment as a guide, map classes with lower accuracy could be further surveyed in the field to create more accurate delineations. While it may appear that there are a large number of associations and alliances described for this small study area, some of the associations/alliances were either only minimally sampled or not sampled at all due to access constraints. It is recommended that these types receive additional survey work to further define their classification. For example some of the early successional types such as the Old Field herbaceous type should be examined throughout multiple years to better understand this complex system and determine the vegetation that ultimately becomes established. This process may lead to new associations for the park or the creation of multiple associations that better define this type. Also, accessing neighboring private lands would allow additional plot samples to be obtained increasing the confidence in not only the Old Field class but all associations, thereby strengthening the entire classification.

NVC Classification

Along with access onto private lands the other main classification challenge at SAAN is keeping up with the rapid changes to plant life resulting from natural succession and anthropogenic disturbances. Specifically, activities including exotic removals, restoration, flooding, wildfires, and new construction would all rapidly alter the vegetation. At all times, but especially after these events, new data should be collected to reflect changes. For example, as the park continues to remove chinaberry and privet stands these areas may need to be re-classified using a more natural association such as a the Pecan - Sugarberry Forest association. Overall more specialized and targeted data collection in these areas would help document any changes and would greatly increase our understanding of these types in general.

Digital Imagery and Interpretation

The decision to use existing NAIP imagery as the basemap for this project was based on cost savings. Although the imagery proved adequate, it was not acquired by the USDA for this purpose. In the future it may be beneficial to purchase new orthophotos or aerial photos exclusively for mapping the vegetation at SAAN. This would allow the timing to better match the phenology of the vegetation and due to the small size of the park a finer scale (such as 1:6,000) could be acquired allowing for more precise delineations.

Inherent to all vegetation mapping projects is the need to produce both a consistent vegetation classification and a comprehensive set of map units. Typically the systems are very similar, but when using a national classification such as the NVC there is usually not a strict one-to-one correspondence. Nonconformity is due to the remote sensing nature of the interpretation and its ability to delineate map units based on complex photo signatures. Subtle vegetation characteristics that can be seen on the ground are not necessarily the same as those apparent on the imagery. Canopy closure, shadows, and timing of the imagery acquisition can all impact the vegetation signatures. At SAAN these issues can be offset not only by acquiring new imagery but also by conducting more map verification or ground-truthing. Increasing the amount of time and money budgeted for verification of the map would greatly improve the accuracy and level of detail. This is witnessed at SAAN in the Pecan-Sugarberry type and its two distinct phases. During the plot sampling it was noted that the species that make up this class occur in both a late and mid succession stage. The late successional stage represents old-growth with large pecan trees while the mid succession stage primarily includes pole-size sugarberry trees. Unfortunately the imagery was not adequate to separate these phases. More ground-truthing of this type may allow for both phases to be accurately mapped as separate classes and possibly warrant classification as new NVC associations.

Finally, it is important to remember that this work should only be viewed as an initial mapping effort. Any changes in the landscape will impact the accuracy and reliability of the classification and the map. The products presented here are based on 2005 imagery and field work. Any subsequent changes should be used to refine and periodically update this work. Updates could be accomplished by performing re-occurring field checks of the map and field key by qualified NPS or contracted staff. To perform field checking, the existing map could be examined in the field, changes could be made to the map and these could be incorporated into new versions that would keep the GIS product current over the years.

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Accuracy Assessment

An important and necessary aspect of this project is the accuracy assessment. Collecting independent ground data determines the usefulness of the vegetation map. As such, users of this database should remember that the GIS mapping and classification portions of the project were conducted separately from both the plot and AA field data collection. These three divisions in work created some challenges related to communication among all the teams, including: (1) adequately conveying changes to the classification based on revising the preliminary associations as recorded in the field into the NVC by NatureServe, (2) mapping some types less than the one-quarter acre minimum mapping unit, (3) mapping new associations/alliances found in the environs but not found in the park, and (4) generally providing enough instruction and interaction to the field crews to explain how these changes would affect the AA.

Specifically at SAAN, some new associations and alliances were found after the plot data was collected. These represented types that were observed by CTI during map verification efforts. Unfortunately the timing of their discovery, their small size, and/or their location on private lands prevented them from being classified in the NVC. These included the Chinaberry Woodland, Privet Shrubland and Black Willow Shrubland types. To address these deficiencies, these types were included as park specials but were not included in the field key. Adding them to the field key would have indicated to the crews that these associations would be new and should be sampled with a full plot and not an AA point. Additional plot sampling of these types during the AA would have allowed for a more robust classification.

Finally, insufficient interaction between the field and GIS teams created some scale-related issues. As mentioned previously, looking at vegetation from an overhead perspective varies greatly from seeing it on the ground. Because of the extensive field exposure to the vegetation at SAAN, the field team was very knowledgeable about the park habitats. Onsite knowledge included a thorough understanding of when associations changed due to succession or due to an ecotone. Since the mapping team was tasked to provide a map of the existing vegetation the delineation on the map did not always match what the field team viewed as the break between plant associations. Similarly, small stands of vegetation that were accurately mapped on the aerial photography were seen by the field crews as actually being inclusions in larger units and vice versa. This discrepancy could also be defined as stemming from the fundamental difference between deriving vegetation from imagery signatures versus ecological or field experience. In the future it would be helpful if more communication could occur between all teams involved. Communication would at a minimum include multiple field visits by all teams at the same time and possibly reducing the number of researchers by finding participants that could conduct multiple tasks.

Future Recommendations

In summary, this project represents the best efforts put forth by a multi-disciplined team over a relatively short period in time. In order to create the best possible “long-term” vegetation classification for SAAN and the most accurate and detailed GIS layer, this project should be viewed as a place to start rather than an end product. In other words, present and future NPS staff should be encouraged to scrutinize this project, building from its strengths and bolstering its weaknesses. By keeping in mind that this project was only a snapshot in time, future efforts can help complete our understanding of the vegetation in and around SAAN and how it changes. It is the hope of the producers that the products presented here will help focus and direct future efforts. The following recommendations are summarized below.

1. The diversity of plant species and dynamic nature of the park with respect to its urban setting warrants periodic **field surveys** by experienced ecologists. Further the inaccessibility of the private lands in the environs should be addressed by seeking permission to sample and verify the vegetation. In this way new plant associations could be discovered and existing types could be updated.

2. Remote sensing does not replace on-the-ground knowledge provided by GPS-linked plots, observations and ground verification. Time and funding limitations curtailed the amount of map **ground-truthing** performed. As opportunities arise, maps should be examined in the field by experienced crews. Also GPS receiver data and other GIS layers should be used to improve and update the spatial data. This map product should not be viewed as static but should be updated with more current and accurate information.

3. To better understand the limitations of the map, the **accuracy assessment** data presented in Table 7 should be thoroughly reviewed by the park staff. Map classes with low accuracy should be examined to see if they could be improved with future studies using ground-truthing or other remote-sensing formats (i.e. fine-scale imagery, hyperspectral, etc). Also, landscape modeling may help to tease out the location of specific types based on specific habitat information. Finally for some applications it may make sense to combine map classes into higher units, such as alliances or ecological systems to improve their accuracy**.**

4. For monitoring purposes, **change over time** could be addressed by similar remote sensing projects. New aerial photos or NAIP imagery acquired every year could be used in regular intervals to capture change. Specifically this new imagery could be used to create up-to-date vegetation layers that could be used to compare changes in both individual vegetation stands and across the entire park.

5. In the future, resource management personnel could link the habitat for **species of concern** to specific associations and map units. These map units could then be used to help locate potential sites of endangered or threatened species in the field or identify areas for non-native plant removal or treatment.

Research Opportunities

Having an accurate and current vegetation classification and map presents many new and exciting research opportunities. Research could include expanding or linking the GIS layer to derive other information such as fire models, habitat monitoring locations, guides for rare plant surveys, and inventorying areas that likely contain exotic or invasive species. The map could also be enhanced by overlaying other existing GIS layers such as geology, hydrology, elevation, and soils. In this manner complex interactions between these layers could be examined and yield important information about growth rates, regeneration after disturbance, biomass distribution, and stream morphology. Finally, through innovative analyses the vegetation layer could possibly be used as a springboard for other ecological studies such as examining how the vegetation interacts with soil chemistry, pollution, archeological sites, weather patterns, etc.

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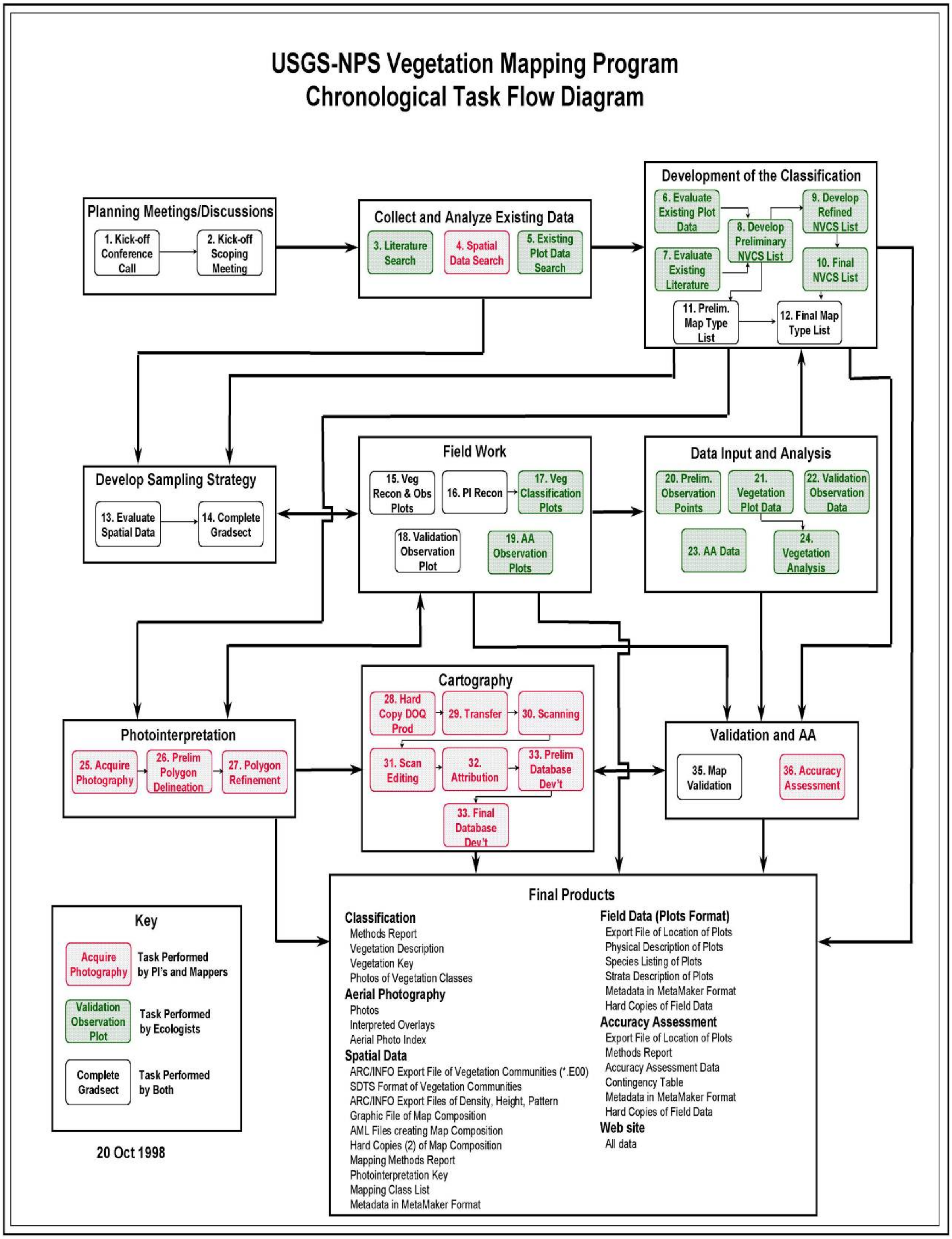
APPENDIX A: Components and Flow Diagram of the Vegetation Classification and Mapping Program

(Developed by Tom Owens USGS – BRD)



APPENDIX B: Field Data Forms and Instructions

General instructions for filling out fields in the PLOT SURVEY FORM (adapted from Salas et al. 2004)

IDENTIFIERS/LOCATORS

Plot Code
Code indicating the specific plot within the vegetation polygon.

Surveyors
Names of surveyors, with principal surveyor listed first.

Date
Date the survey was taken; year, month, day.

BPU Code
The biophysical unit identified.

Provisional Community Name
Using the provisional classification of the Park that was provided, assign the name of the vegetation type which most closely resembles this type. Enter the finest level of the classification possible. If it's a new type, name it based on the two or three most dominant species in the plot.

Quad Name
Appropriate name/scale from survey map used; use 7.5-minute quadrangle if possible.

Park Site Name
Provisional name assigned by field worker that describes where the data were collected. It should represent an identifiable feature on a topographic map.

GPS Rover File
Record the number of the file from the GPS unit.

Field UTM X
Use GPS; do not estimate. If you can't get a GPS reading, estimate coordinates from a topo map and note on the form that this method was used.

Field UTM Y
Use GPS; do not estimate. If you can't get a GPS reading, estimate coordinates from a topo map and note on the form that this method was used.

Error
Record this off the GPS unit.

Plot Length and Plot Width
Enter width and length dimensions for square or rectangular plots. Choose the appropriate plot size based on the following:

Vegetation Class	Standard Plot Dimensions	PLOT AREA
Forest	20 m x 20 m	400 m^2
Woodland	20 m x 20 m	400 m^2
Shrubland	20 m x 20 m	400 m^2
Dwarf-shrubland (heath)	10 m x 10 m	100 m^2
Herbaceous	10 m x 10 m	100 m^2
Nonvascular	5 m x 5 m	25 m^2

Photo numbers
If photos of the plot have been taken at the time of sampling, indicate their numbers from the ones the camera assigns.

Plot Permanent
Note if the plot has been permanently marked.

Plot Representativeness
Does this plot represent the full variability of the polygon? If not, were additional plots taken? Note: we distinguish in this section the plot's ability to represent the stand or polygon you are sampling as one component, and the ability of this sample to represent the range of variability of the association in the entire mapping area. The former comment may be ascertained by reconnaissance of the stand. The latter comment comes only after some familiarity with the vegetation type throughout the mapping area and may be left blank if you have no opinion at this time.

ENVIRONMENTAL DESCRIPTION

Elevation
Elevation of the plot obtained from the GPS

Slope
Measure the slope in percent using a clinometer.

Aspect
Measure the aspect using a compass (be sure compass is set to correct for the magnetic declination).

Topographic Position
Choose one:

INTERFLUVE (crest, summit, ridge). Linear top of ridge, hill, or mountain; the elevated area between two fluves (drainageways) that sheds water to the drainageways.

SHOULDER (shoulder slope, upper slope, convex creep slope). Geomorphic component that forms the uppermost inclined surface at the top of a slope. Includes the transition zone from backslope to summit. Surface is dominantly convex in profile and erosional in origin.

BACKSLOPE. Subset of midslopes that are steep, linear, and may include cliff segments (fall faces).

FOOTSLOPE (lower slope, foot slope, colluvial footslope). Inner gently inclined surface at the base of a slope. Surface profile is generally concave and a transition between backslope, and toeslope.

TOESLOPE (alluvial toeslope). Outermost gently inclined surface at base of a slope. In profile, commonly gentle and linear and characterized by alluvial deposition.

TERRACE Valley floor or shoreline representing the former position of an alluvial plain, lake, or shore.

CHANNEL (narrow valley bottom, gully arroyo). Bed of single or braided watercourse commonly barren of vegetation and formed of modern alluvium.

BASIN FLOOR (depression). Nearly level to gently sloping, bottom surface of a basin.

Describe Topographic Position (Optional)
Give more details here, if needed.

Cowardin System
Indicate “upland” if the system is not a wetland. If the system is a wetland, check off the name of the USFWS system which best describes its hydrology and landform.

- Riverine: Below the high water mark on a moving water system (a creek bed). A community of *Eleocharis* on a sand bar would be in this category.
- Palustrine: In the riparian zone. Plants regularly have wet roots through much of the summer. A community of willows and sedges would be in this category.
- Lacustrine: Below the high water mark of a lake. The marshy stuff on the edge of a lake would be in this category.

Assess the hydrologic regime of the plot using the descriptions below (adapted from Cowardin et al. 1979).

PERMANENTLY FLOODED - Water covers the land surface at all times of the year in all years. Equivalent to Cowardin's “permanently flooded.”

SEMIPERMANENTLY FLOODED - Surface water persists throughout growing season in most years except during periods of drought. Land surface is normally saturated when water level drops below soil surface. Includes Cowardin's Intermittently Exposed and Semipermanently Flooded modifiers.

SEASONALLY FLOODED - Surface water is present for extended periods during the growing season, but is absent by the end of the growing season in most years. The water table after flooding ceases is very variable, extending from saturated to a water table well below the ground surface. Includes Cowardin's Seasonal, Seasonal-Saturated, and Seasonal-Well Drained modifiers.

SATURATED - Surface water is seldom present, but substrate is saturated to surface for extended periods during the growing season. Equivalent to Cowardin's Saturated modifier.

TEMPORARILY FLOODED - Surface water present for brief periods during growing season, but water table usually lies well below soil surface. Often characterizes flood-plain wetlands. Equivalent to Cowardin's Temporary modifier.

INTERMITTENTLY FLOODED - Substrate is usually exposed, but surface water can be present for variable periods without detectable seasonal periodicity. Inundation is not predictable to a given season and is dependent upon highly localized rain storms. This modifier was developed for use in the arid West for water regimes of Playa lakes, intermittent streams, and dry washes but can be used in other parts of the U.S. where appropriate. This modifier can be applied to both wetland and non-wetland situations. Equivalent to Cowardin's Intermittently Flooded modifier.

UNKNOWN - The water regime of the area is not known. The unit is simply described as a non-tidal wetland.

Unvegetated Surface
Estimate the approximate percentage of the *total* surface area covered by each category.

Soil Texture
Using the key below, assess average soil texture.

<u>Simplified Key to Soil Texture</u>
Soil does not remain in a ball when squeezed...sand
Soil remains in a ball when squeezed...2

Squeeze the ball between your thumb and forefinger, attempting to make a ribbon that you can push up over your finger.

2. Soil makes no ribbon............................……………………..………loamy sand
2. Soil makes a ribbon (may be very short)..3

3. Ribbon extends less than 1 inch before breaking..4

Add excess water to small amount of soil:

4. Soil feels smooth..silt loam
4. Soil feels at least slightly gritty………………....…………………5

Squeeze a moistened ball:

5. Cast is formed which can be handled CAREFULLY without breaking………. sandy loam
5. Cast is formed which can be handled FREELY without breaking…… ………………loam

3. Ribbon extends 1 inch or more before breaking..6

5. Soil makes a ribbon that breaks when 1 to 2 inches long; cracks if bent into a ring...7

Add excess water to small amount of soil:

7. Soil feels at least slightly gritty……………………………….......clay loam
7. Soil feels smooth..silt

6. Soil makes a ribbon 2+ inches long; does NOT crack when bent into a ring………… 8

Add excess water to a small amount of soil:

8. Soil feels at least slightly gritty......................……….clay
8. Soil feels smooth...silty clay

HANDBOOK ON SOILS

In the field, soil texture is determined by the feel of a moist soil when it is rubbed between the thumb and fingers. Since sand particles feel gritty, silt particles have a smooth velvety feel and clay is both sticky and plastic, an estimate of the relative proportions of the separates may be made. This procedure, of course, will not give the exact percentage of sand, silt, and clay, but, with a little practice on samples of known composition, the relative proportions of the individual separates can be closely estimated. Practice with known samples is the only way to acquire this knowledge.

The outstanding physical characteristics of the main textural grades as determined by the feel of the soil are described below.

1. Sandy Soil. A sandy soil is loose and single grained. The individual grains can be seen readily or felt. Squeezed in the hand when dry, it will fall apart when pressure is released. Squeezed when moist, it will form a cast, but will crumble when touched.

2. Sandy Loam Soil. A sandy loam soil contains much sand, but has enough silt and clay to make it somewhat coherent. Individual sand grains can be easily seen and felt. Squeezed when dry, it will form a cast which will readily fall apart; but if squeezed when moist a cast can be formed which will bear careful handling without breaking.

3. Loam Soil. A loam soil is about an equal mixture of the sand and silt with the clay content being between 7 and 27 percent. A loam is mellow with a somewhat sandy feel, yet fairly smooth and slightly plastic. Squeezed when moist, it will form a cast which can be handled freely without breaking.

4. Silt Loam Soil. A silt loam soil, when dry, may appear cloddy, but lumps are readily broken, and when pulverized, it feels soft and floury. When wet, the soil readily runs together. Either dry or moist, it will form casts which can be handled freely without breaking, but when moistened and extruded between the thumb and fingers, it will not form a ribbon, but will give a broken appearance.

5. Clay Loam Soil. A clay loam soil is fine-textured and usually breaks into clods or lumps that are hard when dry. When moist and extruded between the thumb and fingers, it will form a thin "ribbon" which will break readily, barely sustaining its own weight. The moist soil is plastic and will form a cast that will bear much handling. When kneaded in the hand, it does not crumble readily, but tends to work into a heavy, compact mass.

6. Clay Soil. A clay soil is fine-textured and usually forms very hard lumps or clods when dry and is plastic and sticky when wet. When the moist soil is ribboned out between the thumb and fingers, it will form a long flexible strip. A clay soil leaves a "slick' surface on the thumb and fingers when rubbed together and tends to hold the thumb and fingers together due to the stickiness of the clay.

The characteristics described above are suggestive only, and will only apply to a group of similar soils. The characteristics of clay vary with the kind of clay mineral. For this reason, textural grades may exhibit different properties from region to region. For instance, clays of the montmorillonite group are very sticky and plastic; those of the oxide group are plastic and waxy with relatively little stickiness.

The preceding discussion has been directed to those soil particles whose diameters are less than 2 millimeters--the sands, silts, and clays. Soils may also contain larger sized particles that may be collectively called coarse fragments. These large particles may on occasion exceed the smaller soil particles in volume.

Soil Drainage

The soil drainage classes are defined in terms of (1) actual moisture content (in excess of field moisture capacity) and (2) the extent of the period during which excess water is present in the plant-root zone. It is recognized that permeability, level of groundwater, and seepage are factors affecting moisture status. However, because these are not easily observed or measured in the field, they cannot generally be used as criteria of moisture status. It is further recognized that soil profile morphology, for example mottling, normally, but not always, reflects soil moisture status. Although soil morphology may be a valuable field indication of moisture status, it should not be the overriding criterion. Soil drainage classes cannot be based solely on the presence or absence of mottling. Topographic position and vegetation as well as soil morphology are useful field criteria for assessing soil moisture status.

> WELL DRAINED - The soil moisture content does not normally exceed field capacity in any horizon (except possibly the C) for a significant part of the year.
>
> MODERATELY WELL DRAINED - The soil moisture content is in excess of field capacity for a small but significant period of the year.
>
> POORLY DRAINED - The soil moisture content is in excess of field capacity in all horizons for a large part of the year.

VEGETATION DESCRIPTION

Leaf Phenology
Select the value which best describes the leaf phenology of the dominant stratum. The dominant stratum is the uppermost stratum that contains at least 10% cover.

> EVERGREEN - Greater than 75% of the total woody cover is never without green foliage.
>
> COLD DECIDUOUS - Greater than 75% of the total woody cover sheds its foliage in connection with an unfavorable season mainly characterized by winter frost.

MIXED: EVERGREEN & COLD DECIDUOUS - Evergreen and deciduous species generally contribute 25-75% of the total woody cover. Evergreen and cold-deciduous species are mixed.

PERENNIAL - Herbaceous vegetation composed of more than 50% perennial species.

ANNUAL - Herbaceous vegetation composed of more than 50% annual species.

Leaf Type
Select the value which best describes the leaf form of the dominant stratum. The dominant stratum is the uppermost stratum that contains at least 10% cover.

BROAD-LEAVED - Woody vegetation primarily broad-leaved (generally contributes greater than 50 percent of the total woody cover).

NEEDLE-LEAVED - Woody vegetation primarily needle-leaved (generally contributes greater than 50 percent cover).

GRAMINOID - Herbaceous vegetation composed of more than 50 percent graminoid/stipe leaf species.

FORB (BROAD-LEAF-HERBACEOUS) - Herbaceous vegetation composed of more than 50% broad-leaf forb species.

PTERIDOPHYTE - Herbaceous vegetation composed of more than 50 percent species with frond or frond-like leaves. (Ferns)

Physiognomic Class
Choose one:
Forest: Trees with their crowns overlapping (generally forming 60-100% cover).

Woodland: Open stands of trees with crowns not usually touching (generally forming 25-60% cover). Canopy tree cover may be less than 25% in cases where it exceeds shrub, dwarf-shrub, herb, and nonvascular cover.

Shrubland: Shrubs generally greater than 2.5 feet tall with individuals or clumps overlapping to not touching (generally forming more than 25% cover, trees generally less than 25% cover). Shrub cover may be less than 25% where it exceeds tree, dwarf-shrub, herb, and nonvascular cover.

Dwarf-Shrubland: Low-growing shrubs usually under 2.5 feet tall. Individuals or clumps overlapping to not touching (generally forming more than 25% cover, trees and tall shrubs generally less than 25% cover). Dwarf-shrub cover may be less than 25% where it exceeds tree, shrub, herb, and nonvascular cover.

Herbaceous: Herbs (graminoids, forbs, and ferns) dominant (generally forming at least 25% cover; trees, shrubs, and dwarf-shrubs generally with less than 25% cover). Herb cover may be less than 25% where it exceeds tree, shrub, dwarf-shrub, and nonvascular cover.

Nonvascular: Nonvascular cover (bryophytes, non-crustose lichens, and algae) dominant (generally forming at least 25% cover). Nonvascular cover may be less than 25% where it exceeds tree, shrub, dwarf-shrub, and herb cover.

Sparse Vegetation: Abiotic substrate features dominant. Vegetation is scattered to nearly absent and generally restricted to areas of concentrated resources (total vegetation cover is typically less than 25% and greater than 0%).

Strata, Height Class, Cover Class, Diagnostic Species
Visually divide the community into vegetation layers (strata). Indicate the average height class of the stratum in the first column, using the Height Scale on the form. Enter the average percent cover class of the whole stratum in the second column, using the Cover Scale on the form. Height and Cover classes are also listed below.

Trees are defined as single-stemmed woody plants, generally 15 feet in height or greater at maturity and under optimal growing conditions. Shrubs are defined as multiple-stemmed woody plants generally less than 15 feet in height at maturity and under optimal growing conditions.

List the dominant species in each stratum.

Animal Use Evidence
Comment on any evidence of wildlife (i.e., tracks, scat, gopher or prairie dog mounds, etc.). Notes on domestic animals should be made in the field below.

Natural and Anthropogenic Disturbance
Comment on any evidence of natural or anthropogenic disturbance and specify the source.

Environmental Comments
Enter any additional noteworthy comments on the environmental setting. This field can be used to describe site history such as fire events (date since last fire or evidence of severity) as well as other disturbance or reproduction factors

Other Comments
Any miscellaneous comments.

Species/Strata/Percent Cover Table

The main use of the strata information is to categorize the plots by life form, in order to subset the data into forest, woodland, shrublands, and herbaceous plots for analysis. It is imperative that things be called the same throughout the data set.

Starting with the uppermost stratum, list all the species present and their cover class using the scale provided below. If a species is in the tree layer (single-stemmed woody plants, generally 15 feet in height or greater at maturity), list whether it is T1 (emergent tree), T2 (tree canopy), or T3 (tree sub-canopy). If a species is in the shrub layer, note if S1 (tall shrub), or S2 (short shrub), or S3 (dwarf shrub). If in the ground layer, note if H (herbaceous), N (nonvascular). Some species will be in more than one layer. For example, Cottonwoods might have one or two especially tall specimens, which would be in the T1 (emergent tree) layer. Then the majority of the mature trees would be in T2 (tree canopy). The saplings that are coming up in the understory would be in the T3.

Seedlings are defined as trees less than "breast height" or less than 4.5 feet tall. Seedlings between knee height and breast height should be labeled as being in the short shrub layer (S2), and those below knee height should be labeled as being in the dwarf shrub layer (S3).

Cover Scale for Species Percent Cover

Use the cover scales provided on the forms.

NATIONAL PARK VEGETATION MAPPING PROGRAM: PLOT SURVEY FORM

IDENTIFIERS/LOCATORS

Plot Code____________________________________ Polygon Code________________________   Provisional Community Name____   State ___ Park Name___________________ Park Site Name____________________   Quad Name____ Quad Code__________________
GPS file name____________ Field UTM X__ __ __ __ __ __ m E Field UTM Y__ __ __ __ __ __ __ m N   Error +/-_____ m   *please do not complete the following information when in the field*   Corrected UTM X__ __ __ __ __ __ m E Corrected UTM Y__ __ __ __ __ __ __ m N UTM Zone_______
Survey Date__________ Surveyors____
Directions to Plot
Plot length_____ Plot width_____ Plot Photos (y/n) ___ Roll Number ____ Frame Number ____ Plot Permanent (y/n) ___
Plot representativeness

ENVIRONMENTAL DESCRIPTION

Elevation _________________ Slope ________________ Aspect___________________
Topographic Position
Landform
Surficial Geology

Cowardian System ___Upland ___Riverine ___Palustrine ___Lacustrine	Non-Tidal ___Permanently Flooded ___Semipermanetly Flooded ___Seasonally/Temporarily Flooded	___Saturated ___Seasonally Flooded/Saturated ___Intermittently Flooded	

Environmental Comments:	Soil Taxon/Description
	Unvegetated Surface: *(please use the cover scale on next page)* ___ Bedrock ___ Litter, duff ___ Wood (> 1 cm) ___ Large rocks (cobbles, boulders > 10 cm) ___ Small rocks (gravel, 0.2-10 cm) ___ Sand (0.1-2 mm) ___ Bare soil ___ Other:____________________________
Soil Texture ___ sand ___ loamy sand ___ sandy loam ___ loam ___ silt loam ___ silt ___ clay loam ___ silty clay ___ clay ___ peat ___ muck	Soil Drainage ___ Rapidly drained ___ Well drained ___ Moderately well drained ___ Somewhat poorly drained ___ Poorly drained ___ Very poorly drained

VEGETATION DESCRIPTION

Leaf phenology (of dominant stratum)	Leaf Type (of dominant stratum)	Physiognomic class	Cover Scale for Strata & Unvegetated Surface	Height Scale for Strata
Trees and Shrubs ___Evergreen ___Cold-deciduous ___Drought-deciduous ___Mixed evergreen - cold-deciduous ___Mixed evergreen - drought-deciduous Herbs ___Annual ___Perennial	___Broad-leaved ___Needle-leaved ___Microphyllous ___Graminoid ___Forb ___Pteridophyte	___Forest ___Woodland ___Shrubland ___Dwarf Shrubland ___Herbaceous ___Nonvascular ___Sparsely Vegetated	01 5% 02 10% 03 20% 04 30% 05 40% 06 50% 07 60% 08 70% 09 80% 10 90% 11 100%	01 <0.5 m 02 0.5-1m 03 1-2 m 04 2-5 m 05 5-10 m 06 10-15 m 07 15-20 m 08 20-35 m 09 35 - 50 m 10 >50 m

Strata	Height Class	Cover Class	Diagnostic species (if known)
T1 Emergent			
T2 Canopy			
T3 Sub-canopy			
S1 Tall shrub			
S2 Short Shrub			
H Herbaceous			
N Non-vascular			
V Vine/liana			
E Epiphyte			

please see above table for height and cover scales

Animal Use Evidence

Natural and Anthropogenic Disturbance Comments

Other Comments

Plot Code____

Species/percent cover: Starting with the uppermost stratum, list all species with % cover for each species in the stratum. For each tree species estimate seedling, sapling, mature and total cover indicating stratum. Also for forests and woodlands, on a separate page or line below each tree species, list the DBH of all trees above 5 cm diameter. Separate measurements with a comma (note if measurements are from multi-stemmed tree). Put an asterisk next to any species that are known diagnostics for a particular community in the classification. **Also list species outside the plot at the end of the table or designate with a 0 in Cover Class column.**

Stratum	Species Name	Cover Class	Stratum	Species Name	Cover Class	Stratum	Species Name	Cover Class

Cover Class Scale

T = >0-1%	5 = >45-55%
P = >1-5%	6 = >55-65%
1 = >5-15%	7 = >65-75%
2 = >15-25%	8 = >75-85%
3 = >25-35%	9 = >85-95%
4 = >35-45%	10 = >95%

Tree D.B.H Form

Plot Code:______________________________Units in cm or inches (circle one)

Record tree diameter over 5 cm at 4.5 feet (1.37 m) height for species that contribute to tree canopy.

Separate measurements of multi-stemmed trees with commas. Can estimate by 5 cm dia. classes

Species	D.B.H.(s) for multi-stems trees

Species	D.B.H.(s) for multi-stems trees

NATIONAL PARK VEGETATION MAPPING PROGRAM: OBSERVATION POINT FORM (1997)

IDENTIFIERS/LOCATORS

Plot Code____ Polygon Code__________________________

Provisional Community Name____

State ___ Park Name ___________________________________ Park Site Name _____________________

Quad Name____ Quad Code_______________________

GPS file name______________ Field UTM X__ __ __ __ __ __ __ m E Field UTM Y__ __ __ __ __ __ __ m N

please do not complete the following information when in the field
Corrected UTM X__ __ __ __ __ __ __ m E Corrected UTM Y__ __ __ __ __ __ __ m N UTM Zone__________

Survey Date___________ Surveyors____

ENVIRONMENTAL DESCRIPTION

Elevation ___________________ Slope ___________________ Aspect______________________

Topographic Position

Landform

Cowardian System	Hydrologic Regime		Salinity Modifiers
___Upland ___Riverine ___Palustrine ___Lacustrine	Non-Tidal ___Permanently Flooded ___Semipermanetly Flooded ___Seasonally Flooded	___Saturated ___Temporarily Flooded/Saturated ___Intermittently Flooded	___Saltwater ___Brackish ___Freshwater

Environmental Comments:	Unvegetated Surface: (please use the cover scale below)
	___ Bedrock ___ Litter, duff ___ Wood (> 1 cm) ___ Large rocks (cobbles, boulders > 10 cm) ___ Small rocks (gravel, 0.2-10 cm) ___ Sand (0.1-2 mm) ___ Bare soil ___ Other:_______________________________

VEGETATION DESCRIPTION

Leaf phenology (of dominant stratum)	Leaf Type (of dominant stratum)	Physiognomic class	Cover Scale for Strata & Unvegetated Surface	Height Scale for Strata
Trees and Shrubs ___Evergreen ___Cold-deciduous ___Drought-deciduous ___Mixed evergreen - cold-deciduous ___Mixed evergreen - drought-deciduous Herbs ___Annual ___Perennial	___Broad-leaved ___Needle-leaved ___Mixed broad-leaved/Needle leaved ___Microphyllous ___Graminoid ___Forb ___Pteridophyte	___Forest ___Woodland ___Shrubland ___Dwarf Shrubland ___Herbaceous ___Nonvascular ___Sparsely Vegetated	01 5% 02 10% 03 20% 04 30% 05 40% 06 50% 07 60% 08 70% 09 80% 10 90% 11 100%	01 <0.5 m 02 0.5-1m 03 1-2 m 04 2-5 m 05 5-10 m 06 10-15 m 07 15-20 m 08 20-35 m 09 35 - 50 m 10 >50 m

Strata	Height	Cover Class	Dominant species (mark any known diagnostic species with a *)	Cover Class
T1 Emergent	_____	_____	_____	
T2 Canopy	_____	_____	_____	
T3 Sub-canopy	_____	_____	_____	
S1 Tall shrub	_____	_____	_____	
S2 Short Shrub	_____	_____	_____	
S3 Dwarf-shrub H Herbaceous	_____	_____	_____	
N Non-vascular	_____	_____	_____	
V Vine/liana	_____	_____	_____	
E Epiphyte	_____	_____	_____	

please see the table on the previous page for height and cover scales for strata

Other Comments

Cover Scale for Species
01 <1%
02 1-5%
03 5-25%
04 25-50%
05 50-75%
06 75-100%

ACCURACY ASSESSMENT POINT FORM

IDENTIFIERS/LOCATORS

Field Point Code ________________________________ Database Point Code ___________________

State __ Park Name ______________________________ Park Site Name ____________________

Quad Name_______________________________________ QuadCode_______________________

Primary Name Veg Assoc: ____

Secondary Name Veg Assoc:____

Other Veg Assoc within 50 m ____

Classification Comments:

GPS file name_____________ Field UTM X__ __ __ __ __ __ m E Field UTM Y__ __ __ __ __ __ __ m N

GPS Error _____________ m

please do not complete the following information when in the field

Corrected UTM X__ __ __ __ __ __ m E Corrected UTM Y__ __ __ __ __ __ __ m N UTM Zone____

Survey Date___________
Surveyors____

ENVIRONMENTAL DESCRIPTION

Elevation __________________ Slope __________________Aspect_____________________

Topographic Position

Landform

Environmental Comments (including hydrology):	Unvegetated Surface: *(please use the cover scale below)* ___ Bedrock ___ Litter, duff ___ Wood (> 1 cm) ___ Large rocks (cobbles, boulders > 10 cm) ___ Small rocks (gravel, 0.2-10 cm) ___ Sand (0.1-2 mm) ___ Bare soil ___ Other:_____________________

VEGETATION DESCRIPTION

Leaf phenology (of dominant stratum)	Leaf Type (of dominant stratum)	Physiognomic class	HEIGHT (M) SCALE	COVER
Trees and Shrubs ___Evergreen ___Cold-deciduous ___Drought-deciduous ___Mixed evergreen - cold-deciduous ___Mixed everg. - drought-deciduous Herbs ___Annual ___Perennial	___Broad-leaved ___Needle-leaved ___Mixed broad-lvd/Needle-lvd ___Microphyllous ___Graminoid ___Forb ___Pteridophyte	___Forest ___Woodland ___Shrubland ___Dwarf-shrubland ___Herbaceous ___Nonvascular ___Sparsely Vegetated	01 -<0.5 02 - 0.5-1 03 - 1-2 04 - 2-5 05 - 5-10 06 - 10-15 07 - 15-20 08 - 20-35 09 - 35-50 10 ->50	T - <1% 01 - 1-5% 02 - 6-15% 03 - 16-25% 04 - 26-35% 05 - 36-45% 06 - 46-55% 07 - 56-65% 08 - 65-75% 09 - 76-85% 10 - 86-95% 11- 96-100%

Strata	Height Class	Cover Class	Dominant species (mark any known diagnostic species with a *)	Cover Class
T1 Emergent	_____	_____	______________________________	
T2 Canopy	_____	_____	______________________________	
T3 Sub-canopy	_____	_____	______________________________	
S1 Tall shrub	_____	_____	______________________________	
S2 Short Shrub	_____	_____	______________________________	
S3 Dwarf-shrub	_____	_____	______________________________	
H Herbaceous	_____	_____	______________________________	
N Non-vascular	_____	_____	______________________________	
V Vine/liana	_____	_____	______________________________	
E Epiphyte	_____	_____	______________________________	

APPENDIX C: Dichotomous Key to SAAN Plant Associations

Key to Vegetation types at SAAN (Developed By Roger Sanders, Botanical Research Institute of Texas, May 2006)

1. Tree (i.e., over 5 m high) cover (canopy + subcanopy) ≥ 10%: forests and woodlands **2**

1. Tree (i.e., over 5 m high) cover (canopy, but subcanopy lacking) ≤ 10% (if as much as 20%, then occurring in dry ravines adjacent to shrub-dominated vegetation): non-forested vegetation...**7**

2. Forests and woodlands dominated by broad-leaved deciduous or sclerophyllous trees.............**3**

2. Forests and woodlands dominated by thorn trees (included here are woodlands dominated by the invasive exotic *Ligustrum japonicum* with thorn trees as subdominants) **6**

3. Forest on low terraces along main channels of rivers; dominated by *Populus deltoides* accompanied by significant amount of *Ulmus americana*.

   ***Populus deltoides* Temporarily Flooded Forest Alliance**

3. Forest and woodlands on natural upper terraces along naturally flowing rivers, on low natural terraces and artificial levees along channelized rivers, on banks of intermittent tributaries, and in ravines; dominated by other species. **4**

4. Forests and woodlands dominated by a mix of *Acer negundo, Carya illinoinensis,* and/or *Celtis laevigata;* significant numbers of invasive exotic species may be present.

   ***Carya illinoinensis – Celtis laevigata* Forest**

4. Forests and woodlands dominated by other species **5**

5. Forest and woodlands dominated by *Quercus virginiana,* although *Ulmus crassifolia* may be present as subdominant or associate.

   ***Quercus virginiana* Temporarily Flooded Forest Alliance**

5. Forests and woodlands dominated by *Ulmus crassifolia,* although *Quercus virginiana* may be present as an associate.

   ***Ulmus crassifolia – Celtis laevigata / Ilex decidua / Elymus virginicus* Forest**

6. Subcanopy may or may not be developed, together with canopy usually constituting ≥ 50% cover, dominated by a mix of *Acacia farnesiana* and *Prosopis glandulosa* with *Celtis laevigata* usually common or subdominant; disturbed urban sites, especially raised artificial terraces and levees along channelized rivers or low caliche outcrops of river valley footslopes (where canopy may provide only 25% cover).

    ***Acacia farnesiana – (Prosopis glandulosa)* Woodland**

6. Subcanopy not developed, the single-layered, uniform height canopy constituting about 30-50% cover, strongly dominated by *Prosopis glandulosa*; rangeland and abandoned pastures on level or undulating uplands.

    ***Prosopis glandulosa - Celtis pallida / Opuntia* spp. - *Xylothamia palmeri* Woodland**

7. Shrubs dominant **8**
7. Herbs dominant..**9**

8. Dominated by broad-leaved deciduous shrubs; abandoned fields and raised terraces and levees along channelized rivers in urban areas.

    Old Field Weedy Herbaceous Vegetation

8. Dominated by thorn shrubs and sclerophyllous shrubs; upland slopes in more or less natural rangeland.

    ***Acacia rigidula* Shrubland**

9. Canopy usually or predominantly less than 0.5 m tall, dominated by *Cynodon dactylon*.

    ***Cynodon dactylon* Herbaceous Vegetation**

9. Canopy usually 0.5-2 m tall, dominated by *Sorghum halepense,* often with *Bothriochloa ischaemum* as a subdominant

    ***Bothriochloa laguroides – Sorghum halepense* Herbaceous Vegetation**

APPENDIX D: Vegetation Association Descriptions for SAAN

NatureServe. 2006. International Ecological Classification Standard: Terrestrial Ecological Classifications. NatureServe Central Databases. Arlington, VA. U.S.A. Data current as of December 2006.

U.S. NATIONAL VEGETATION CLASSIFICATION

San Antonio Missions National Historical Park

December 31, 2006

By
NatureServe
1101 West River Parkway Suite 200
Minneapolis, Minnesota 55415

And
NPS - Southern Plains Network Coordinator
P.O. Box 329, 100 Lady Bird Lane
Johnson City, TX 78636

This subset of the U.S. National Classification covers vegetation associations and alliances attributed to San Antonio Missions National Historical Park**.** This classification has been developed in consultation with many individuals and agencies and incorporates information from a variety of publications and other classifications. Comments and suggestions regarding the contents of this subset should be directed to Jim Drake, Regional Vegetation Ecologist, 612-331-0729, jim_drake@natureserve.org or Heidi Sosinski, Data Manager, 830-868-7128 ext. 282, heidi_sosinski@nps.gov.

Citations:
The following citation should be used in any published materials which reference ecological system and/or International Vegetation Classification (IVC hierarchy) and association data: NatureServe. 2006. International Ecological Classification Standard: Terrestrial Ecological Classifications. NatureServe Central Databases. Arlington, VA. U.S.A. Data current as of December 2006.

NatureServe
1101 Wilson Blvd, 15th floor
Arlington, VA 22209

These data are extracted from:
NatureServe. 2006. International Ecological Classification Standard: Terrestrial Ecological Classifications. NatureServe Central Databases. Arlington, VA. U.S.A. Data current as of December 2006.

This document may be cited as follows:
NatureServe1 and SAAN. 2006. U.S. National Vegetation Classification: San Antonio Missions National Historical Park: Global and Local Descriptions. NatureServe Central Databases. Arlington, VA, NatureServe Midwest Office, Minneapolis, MN and San Antonio Missions National Historical Park, San Antonio, TX. Data current as of December 2006.

1 NatureServe is an international organization including NatureServe regional offices, a NatureServe central office, U.S. State Natural Heritage Programs, and Conservation Data Centres (CDC) in Canada and Latin America and the Caribbean. Ecologists from the following organizations have contributed the development of the ecological systems classification:

CEGL002087 *Carya illinoinensis – Celtis laevigata* Forest

Translated Name: Pecan – Sugarberry Forest
Common Name: Pecan – Sugarberry Forest

ENVIRONMENTAL DESCRIPTION

The environmental factors that influence the composition and structure of this community are: climate, topography, soils, and past management. This community occurs on the original terraces and natural levees, as well as some artificial terraces and levees (from fill dredged for channelization) bordering the San Antonio River. The community occurs on silty clays and clay loam originally derived from silt and clay alluvium. Immediately adjacent to the channelized banks of the river, the clay soils overlie gravel fill dredged from the river channel. Water availability is less than in pre-urbanized times due to lowering of the water table through channelization and rising of the levees along the channel. Composition of tree species at any given site is probably largely dependent on past management, particularly tree removal, fire suppression, and introduction of exotic species. Flooding of major proportions does not occur as it once did due to impoundments and channelization along the river.

VEGETATION DESCRIPTION

This community consists of two phases–a late successional phase and a mid-successional phase. The late successional phase is the best developed and may include remnant old-growth forest. This phase occurs on the natural terraces and levees that still exist behind the raised artificial levees. These sites tend to coincide with remnants of the natural channels of the San Antonio River and courses of tributaries to the San Antonio River. Here, the canopy varies from 15 to 25 m high, producing 60 to 90 percent cover, and is dominated by *Carya illinoinensis* or *Acer negundo* with a dense subcanopy and/or understory of *Celtis laevigata*. The invasive exotic *Melia azedarach* is a common associate. The shrub layer is usually sparse, consisting of saplings and scattered shrubs of *Cornus drummondii* and *Sambucus nigra*. The ground layer is also usually sparse, not exceeding 50% cover and consisting of seedlings, low shrubs (*Toxicodendron radicans* sprouts) and vines (*Ampelopsis arborea, Rubus riograndis, Vitis mustangensis*) and shade-tolerant forbs (*Ambrosia trifida, Calyptocarpus vialis, Galium aparine, Lactuca floridana, Malvaviscus arboreus, Symphyotrichum lanceolatum, Torilis arvensis, Verbesina virginica*) and grasses (*Chasmanthium latifolium, Elymus virginicus*).

The mid-successional phase occurs on the raised artificial levees or on lower natural terraces where the forest or riverine savanna was cleared, either in conjunction with the construction of the *labores* by the Spanish missions or later in conjunction with urban development. These sites show remnants of dead thorn trees suggesting that they have progressed through **Old Field** and ***Acacia farnesiana – (Prosopis glandulosa)* Woodland** seres. Here the canopy rarely exceeds 15 m high, but the cover is consistently about 75%. It is dominated by *Celtis laevigata*, except in sites where the invasive *Melia azedarach* got an early foothold. The invasive *Ligustrum japonicum* is commonly associated. The ground layer often covers up to 70% of the surface and is heavily dominated by *Galium aparine* and *Torilis arvensis*. Otherwise, the structure is similar to the late-successional phase. On the natural terraces, this phase is expected to progress to the late successional phase. However, on the raised artificial levees, it is unknown whether there is sufficient water availability for trees of *Carya illinoinensis* or *Acer negundo* eventually to become established and dominant.

FLORISTIC COMPOSITION

Species Name	Stratum	Lifeform
Carya illinoinensis	Tree (canopy & subcanopy)	Broad-leaved deciduous tree
Celtis laevigata	Tree (canopy & subcanopy)	Broad-leaved deciduous tree
Acer negundo	Tree (canopy & subcanopy)	Broad-leaved deciduous tree
Melia azedarach	Tree (canopy & subcanopy)	Broad-leaved deciduous tree
Cornus drummondii	Shrub/sapling (tall & short)	Broad-leaved deciduous shrub
Rubus riograndis	Herb (field)	Other shrub
Toxicodendron radicans	Herb (field)	Other shrub
Ambrosia trifida	Herb (field)	Forb
Calyptocarpus vialis	Herb (field)	Forb
Galium aparine	Herb (field)	Forb
Malvaviscus arboreus	Herb (field)	Forb
Torilis arvensis	Herb (field)	Forb
Elymus virginicus	Herb (field)	Graminoid

OTHER NOTEWORTHY SPECIES

Species Name	GRank	Animal	Note (*specify Rare (geog area), Invasive, Animal, or Other*)
Galium aparine			Subinvasive alien
Ligustrum japonicum			Invasive alien
Melia azedarach			Invasive alien
Torilis arvensis			Invasive alien

CLASSIFICATION & OTHER COMMENTS

Classification Comments: Further research may support separating the mid-successional phase from the late successional phase as two distinct vegetation classes.

Other Comments:

ELEMENT DISTRIBUTION

This unit occurs in the San Antonio unit only. It is best developed on the west side of the San Antonio River south of the New Espada Dam back of the raised levees. It occurs on the east side of the river in Acequia Park on the raised levees and behind them, as well as along the nature trail below Mission San Juan. At Mission San José, it occurs north east of the mission in an area where invasive alien species were recently removed.

ELEMENT SOURCES

Inventory Notes:

Plots: SAAN.1, SAAN.5, SAAN.9, SAAN.11, SAAN.12, SAAN.14, SAAN.20

Description Author(s): R. Sanders

A.290 *Populus deltoides* Temporarily Flooded Forest Alliance

Translated Name: Eastern Cottonwood Temporarily Flooded Forest Alliance
Common Name: Eastern Cottonwood Temporarily Flooded Forest Alliance

ENVIRONMENTAL DESCRIPTION

The environmental factors that influence the composition and structure of this community are: climate, topography, soils, and chance historical events. This community occurs on the primary terraces and natural levees along the main natural channel of the San Antonio River. The community occurs on alluvial sands and sandy loams that are well drained but near the water table. Composition of tree species at any given site is probably largely dependent on chance establishment, especially following damaging floods. Flooding of major proportions does not occur as it once did due to impoundments along the river.

VEGETATION DESCRIPTION

Populus deltoides dominates over a mix of other riparian species in both density and height. Thus, the canopy extends to nearly 30 m high with a cover of 40 to 70 percent cover. The subcanopy cover almost equals or(?) exceeds that of the canopy. The species composing the subdominant mix in the canopy, as well as subcanopy include *Acer negundo, Carya illinoinensis, Celtis laevigata*, *Ulmus americana,* and *Ulmus crassifolia*. The shrub layer is very sparse. However, the ground layer may cover up to 40% of the surface and consists mostly of vines (especially *Rubus riograndis, Smilax bona-nox, and Toxicodendron radicans*) and shade-tolerant grasses (*Chasmanthium latifolium, Elymus virginicus*).

FLORISTIC COMPOSITION

Species Name	Stratum	Lifeform
Populus deltoides	Tree canopy	Broad-leaved deciduous tree
Acer negundo	Tree (canopy & subcanopy)	Broad-leaved deciduous tree
Carya illinoinensis	Tree (canopy & subcanopy)	Broad-leaved deciduous tree
Celtis laevigata	Tree (canopy & subcanopy)	Broad-leaved deciduous tree
Ulmus americana	Tree (canopy & subcanopy)	Broad-leaved deciduous tree
Ulmus crassifolia	Tree (canopy & subcanopy)	Broad-leaved deciduous tree
Rubus riograndis	Herb (field)	Other shrub
Toxicodendron radicans	Herb (field)	Other shrub
Smilax bona-nox	Herb (field)	Vine/liana
Ambrosia trifida	Herb (field)	Forb
Chasmanthium latifolium	Herb (field)	Forb
Elymus virginicus	Herb (field)	Forb

OTHER NOTEWORTHY SPECIES

Species Name	GRank	Animal	Note (*specify Rare (geog area), Invasive, Animal, or Other*)

CLASSIFICATION & OTHER COMMENTS

Classification Comments:

Other Comments:

ELEMENT DISTRIBUTION

This class occurs only at the Rancho Unit along the banks and primary terraces of the San Antonio River.

ELEMENT SOURCES

Inventory Notes:

Plots: SAAN.32, SAAN.33

Description Author(s): R. Sanders

CEGL008468 *Ulmus crassifolia – Celtis laevigata / Ilex decidua / Elymus virginicus* Forest

Translated Name: Cedar Elm – Sugarberry / Possum-haw / Virginia Wild Rye Forest
Common Name: Cedar Elm – Sugarberry / Possum-haw / Virginia Wild Rye Forest

ENVIRONMENTAL DESCRIPTION

The environmental factors that influence the composition and structure of this community are: climate, topography, soils, and possibly past management or chance events. This community occurs on the higher terraces and tributary banks along the San Antonio River. The community occurs on alluvium-derived sandy to clayey loams with good water availability. One site is on raised artificial levees (from fill dredged for channelization) and has been invaded by exotic species. Flooding of major proportions does not occur as it once did due to impoundments along the river.

VEGETATION DESCRIPTION

The canopy usually ranges from 15 to 20 m high with a cover of 70-90 percent, except upslope from the main area of this vegetation in narrow ravines where the canopy is less than 15 m with about 50% cover. The subcanopy cover is light at 30%, again except in the ravines where the smaller trees provide about 70% cover. The vegetation is strongly dominated by *Ulmus crassifolia*. Associates may include *Quercus virginiana* (observed, but not included in sample plots)*, Celtis laevigata*, *Morus alba,* and *Prosopis glandulosa. Melia azedarach* and *Ligustrum japonicum* invade in urban areas. The shrub layer is sparse except in the ravines where *Condalia hookeri, Diospyros texana*, and *Ptelea trifoliata* from the adjacent *Prosopis glandulosa* var. *glandulosa - Celtis pallida / Opuntia* spp. - *Xylothamia palmeri* Woodland are important. The ground layer ranges from 10-40% cover, and is dominated by *Elymus virginicus* in semi-natural areas and by *Torilis arvensis* in the urban sites.

FLORISTIC COMPOSITION

Species Name	Stratum	Lifeform
Ulmus crassifolia	Tree (canopy & subcanopy)	Broad-leaved deciduous tree
Quercus virginiana	Tree (canopy & subcanopy)	Evergreen sclerophyllous tree
Celtis laevigata	Tree (canopy & subcanopy)	Broad-leaved deciduous tree
Prosopis glandulosa	Tree (canopy & subcanopy)	Thorn tree
Elymus virginicus	Herb (field)	Graminoid

OTHER NOTEWORTHY SPECIES

Species Name	GRank	Animal	Note (*specify Rare (geog area), Invasive, Animal, or Other*)
Ligustrum japonicum			Invasive alien
Melia azedarach			Invasive alien
Torilis arvensis			Invasive alien
Morus alba			Subinvasive alien

CLASSIFICATION & OTHER COMMENTS

Classification Comments:

Other Comments:

ELEMENT DISTRIBUTION

This vegetation class occurs in the San Antonio Unit in an isolated parcel where Mission Road crosses the San Antonio River. It is best developed in the Rancho Unit on upper terraces along Picosa Creek and the San Antonio River.

ELEMENT SOURCES

Inventory Notes:

Plots: SAAN. 2, SAAN.27, SAAN.29, SAAN.34

Description Author(s): R. Sanders

CEGL007787 ***Prosopis glandulosa - Celtis pallida / Opuntia spp. - Xylothamia palmeri* Woodland**

Translated Name: Honey Mesquite - Granjeno / Prickly-pear species - South Texas Ericameria Woodland
Common Name: Honey Mesquite - Granjeno / Prickly-pear species - South Texas Ericameria Woodland

ENVIRONMENTAL DESCRIPTION

The environmental factors that influence the composition and structure of this community are: climate, topography, soils, and past management. This community occurs on the level uplands bordering the valley along the San Antonio River. The soils are well-drained sandy clay-loams. The disturbance climax of the site should be native prairie. However, the fairly uniform age of the dominant trees suggests that a single pulse of mesquite encroachment occurred after grazing or mowing were terminated and fire suppression was practiced..

VEGETATION DESCRIPTION

The canopy is about10 to 15 m high, and cover varies from 30-50%. A subcanopy is not well developed. The vegetation is dominated by a nearly uniform-aged stand of *Prosopis glandulosa.* The shrub layer is sparse, consisting of scattered saplings of *Celtis laevigata* and shrubs of *Celtis pallida, Colubrina texensis, Condalia hookeri, Diospyros texana*, and *Opuntia leptocaulis.* The ground layer provides about 50-70% cover and is dominated by the native grass *Nassella leucotricha*. Weedy and/or shade tolerant forbs (*Croton monanthogynus, Gutierrezia texana*, *Siphonoglossa pilosella*, and *Verbesina virginica)* are common and conspicuous. The exotic grass *Cynodon dactylon* is also associated, but it may have invaded from nearby cultivated pastures or have persisted from previous planting.

FLORISTIC COMPOSITION

Species Name	Stratum	Lifeform
Prosopis glandulosa	Tree canopy	Thorn tree
Celtis laevigata	Shrub/sapling (tall & short)	Broad-leaved deciduous tree
Celtis pallida	Shrub/sapling (tall & short)	Thorn shrub
Colubrina texensis	Shrub/sapling (tall & short)	Thorn shrub
Condalia hookeri	Shrub/sapling (tall & short)	Thorn shrub
Diospyros texana	Shrub/sapling (tall & short)	Evergreen sclerophyllous shrub
Opuntia leptocaulis	Shrub/sapling (tall & short)	Thorn shrub
Croton monanthogynus	Herb (field)	Forb
Gutierrezia texana	Herb (field)	Forb
Siphonoglossa pilosella	Herb (field)	Forb
Verbesina virginica	Herb (field)	Forb
Nassella leucotricha	Herb (field)	Graminoid

OTHER NOTEWORTHY SPECIES

Species Name	GRank	Animal	Note (*specify Rare (geog area), Invasive, Animal, or Other*)
Cynodon dactylon			Subinvasive alien

CLASSIFICATION & OTHER COMMENTS

Classification Comments:
Other Comments:

ELEMENT DISTRIBUTION

This vegetation class as a natural type occurs only at the Rancho Unit on the level upland along the west side of the unit. This type was also used to map the planted and maintained mesquite stands found throughout the San Antonio Missions area.

ELEMENT SOURCES

Inventory Notes:
Plots: SAAN.22, SAAN.25
Description Author(s): R. Sanders

CEGL002131 *Acacia farnesiana – (Prosopis glandulosa)* Woodland

Translated Name: Huisache – (Honey Mesquite) Woodland
Common Name: Honey Mesquite – Huisache Woodland

ENVIRONMENTAL DESCRIPTION

The environmental factors that influence the composition and structure of this community are: climate, topography, soils, and past management. This community occurs primarily on the artificial levees (from fill dredged for channelization) bordering the San Antonio River, as well as low caliche ridges further from the river. The community occurs on alluvium-derived clay loam or on loams overlying caliche substrate. Immediately adjacent to the channelized banks of the river, the clay loams overlie caliche gravel that was dredged from the river channel. Water availability is less than in pre-urbanized times due to lowering of the water table through channelization and rising of the levees along the channel. Transpiration appears to be high in the open sunlit phases of this community. Composition of tree species at any given site is probably largely dependent on past management, fire suppression, and introduction of exotic species. Flooding of major proportions does not occur as it once did due to impoundments and channelization along the river.

VEGETATION DESCRIPTION

The canopy ranges between 5 to 15 m high, and cover varies from 10 to 60%. Where the canopy approaches 15 m, the taller trees are scattered and the subcanopy cover equals or exceeds the canopy cover. Otherwise, a subcanopy is not well differentiated where the canopy is less than 10 m high. The vegetation can be dominated by *Prosopis glandulosa, Acacia farnesiana,* or a codominant mix of both. *Celtis laevigata* is a characteristic associate, and *Melia azedarach* and *Ligustrum japonicum* often invade. The shrub layer can be sparse to dense, depending on the successional and management history of the particular site. Commonly encountered shrubs include *Celtis pallida, Condalia hookeri, Diospyros texana*, *Mahonia trifoliolata* (= *Berberis trifoliolata),* and young growth of the characteristic trees. Variable in composition and density, the ground layer ranges from 10 to 80% of the surface, depending on the amount of shading of the canopy. In some cases, native grasses (*Aristida purpurea, Nassella leucotricha*) dominate the herbs, but where the grasses are lacking, herbs are heavily dominated by *Torilis arvensis*. Other important forbs usually associated with any of the dominant herbs include *Ambrosia trifida, Calyptocarpus vialis, Clematis drummondii,* and *Viguiera dentata.*

FLORISTIC COMPOSITION

Species Name	Stratum	Lifeform
Acacia farnesiana	Tree (canopy & subcanopy)	Thorn tree
Prosopis glandulosa	Tree (canopy & subcanopy)	Thorn tree
Celtis laevigata	Tree (canopy & subcanopy)	Broad-leaved deciduous tree
Celtis pallida	Shrub/sapling (tall & short)	Thorn shrub
Condalia hookeri	Shrub/sapling (tall & short)	Thorn shrub
Diospyros texana	Shrub/sapling (tall & short)	Thorn shrub
Mahonia trifoliolata	Shrub/sapling (tall & short)	Evergreen sclerophyllous shrub
Ambrosia trifida	Herb (field)	Forb
Calyptocarpus vialis	Herb (field)	Forb
Clematis drummondii	Herb (field)	Vine/liana
Torilis arvensis	Herb (field)	Forb
Viguiera dentata	Herb (field)	Forb
Aristida purpurea	Herb (field)	Graminoid
Nassella leucotricha	Herb (field)	Graminoid

OTHER NOTEWORTHY SPECIES

Species Name	GRank	Animal	Note (*specify Rare (geog area), Invasive, Animal, or Other*)
Galium aparine			Subinvasive alien
Ligustrum japonicum			Invasive alien
Melia azedarach			Invasive alien
Torilis arvensis			Subinvasive alien

CLASSIFICATION & OTHER COMMENTS

Classification Comments:

Other Comments:

ELEMENT DISTRIBUTION

This vegetation is limited to the San Antonio Unit on the artificial raised levees bordering the San Antonio River. It also occurs in lower natural terraces (especially in the abandoned *Labores* of both the Espada and San Juan Missions), which were cleared at one time and have undergone secondary succession. It also occurs on the small bluff overlooking the Espada Aqueduct and in caliche hills along South Presa Road.

ELEMENT SOURCES

Inventory Notes:

Plots: SAAN.4, SAAN.8, SAAN.13, SAAN.16, SAAN.17, SAAN.18, SAAN.21

Description Author(s): R. Sanders

A.57 *Quercus virginiana* Temporarily Flooded Forest Alliance

Translated Name: Live Oak Temporarily Flooded Forest Alliance
Common Name: Live Oak Temporarily Flooded Forest Alliance

ENVIRONMENTAL DESCRIPTION

The environmental factors that influence the composition and structure of this community are: climate, topography, soils, and possibly past management or chance events. This community occurs on the higher terraces and tributary banks along the San Antonio River. The community occurs on alluvium-derived silt-loam with good water availability. The environmental factors appear to be very similar to those for the adjacent ***Ulmus crassifolia – Celtis laevigata / Ilex decidua / Elymus virginicus*** **Forest** and the controlling factors distinguishing the two classes is not understood. Flooding of major proportions does not occur as it once did due to impoundments along the river.

VEGETATION DESCRIPTION

The canopy ranges from 15 to 20 m high with a cover of 80 percent. The subcanopy cover is light at 30%. *Quercus virginiana* dominates over *Ulmus crassifolia*, and few other tree species are present. The shrub layer is almost lacking and the ground layer is very sparse, which may be related to periodic flash or sheet flooding. The shade-tolerant grasses, *Chasmanthium latifolium* and *Elymus virginicus* are the only common herbs.

FLORISTIC COMPOSITION

Species Name	Stratum	Lifeform
Quercus virginiana	Shrub/sapling (tall & short)	Evergreen sclerophyllous tree
Ulmus crassifolia	Tree (canopy & subcanopy)	Broad-leaved deciduous tree
Chasmanthium latifolium	Herb (field)	Graminoid
Elymus virginicus	Herb (field)	Graminoid

OTHER NOTEWORTHY SPECIES

Species Name	GRank	Animal	Note (*specify Rare (geog area), Invasive, Animal, or Other*)

CLASSIFICATION & OTHER COMMENTS

Classification Comments: Further research may suggest combining this class and the ***Ulmus crassifolia – Celtis laevigata / Ilex decidua / Elymus virginicus*** **Forest**. The live oak in this plot was called *Q. fusiformis* by the field crew. NPS and SAAN staffs do not believe *Q. fusiformis* is found in the park so specimens called *Q. fusiformis* by the field crew are believed to be *Q. virginiana*.

Other Comments:

ELEMENT DISTRIBUTION

This association occurs only on the Rancho Unit along Picosa Creek about 150 m north of the San Antonio River.

ELEMENT SOURCES

Inventory Notes:
Plots: SAAN.28
Description Author(s): R. Sanders

CEGL003874 *Acacia rigidula* Shrubland

Translated Name: Chaparro-Prieto Shrubland
Common Name: Chaparro-Prieto Shrubland

ENVIRONMENTAL DESCRIPTION

The environmental factors that influence the composition and structure of this community are: climate, topography, soils, and water availability. This community occurs on sloping convex uplands bordering the valley along the San Antonio River. Caliche, which outcrops here and there, underlies these uplands and is overlain by well-drained sandy to clayey loams. Some areas are eroded into gully-like ravines, where a phase of this vegetation class occurs in the upper slopes and courses of these ravines. There is a small limestone quarry at the site, in which this vegetation occurs more sparsely than in undisturbed neighboring sites. Otherwise, it is not know to what degree human activity has affected this vegetation class.

VEGETATION DESCRIPTION

The canopy is about 2-3 m high, providing 30-60% cover. Trees are not characteristic of this class except in the ravine phase, where scattered ones to 10 m high can provide about 20% cover. However, in the ravine phase, the shrub layer is clearly dominant with a cover of about 60%. The vegetation is dominated by a nearly equal mix of *Acacia rigidula*, *Diospyros texana, Condalia hookeri,* and *Prosopis glandulosa.* Other commonly associated shrubs include *Celtis pallida, Colubrina texensis, Eysenhardtia texana, Guajacum angustifolium, Mahonia trifoliolata (=Berberis trifoliolata), Opuntia leptocaulis* (not observed in sampled plots)*, Ptelea trifoliata*, *Yucca constricta,* and scattered saplings of *Celtis laevigata* and *Sideroxylon lanuginosum.* The ground layer provides about 60-70% cover, except in the ravines where it is very sparse (apparently due to flash flooding). It is dominated by the native grasses *Aristida purpurea* and *Nassella leucotricha*. Except for the showy forb, *Wedelia texana,* and the sedge, *Carex planostachys,* other associated herbs are present in low frequency. However, in the ravines the arid-land fern, *Pellaea atropurpurea* is common.

FLORISTIC COMPOSITION

Species Name	Stratum	Lifeform
Acacia rigidula	Shrub/sapling (tall & short)	Thorn shrub
Celtis laevigata	Shrub/sapling (tall & short)	Broad-leaved deciduous tree
Celtis pallida	Shrub/sapling (tall & short)	Thorn shrub
Colubrina texensis	Shrub/sapling (tall & short)	Thorn shrub
Condalia hookeri	Shrub/sapling (tall & short)	Thorn shrub
Diospyros texana	Shrub/sapling (tall & short)	Evergreen sclerophyllous shrub
Eysenhardtia texana	Shrub/sapling (tall & short)	Evergreen sclerophyllous shrub
Guajacum angustifolium	Shrub/sapling (tall & short)	Evergreen sclerophyllous shrub
Mahonia trifoliolata	Shrub/sapling (tall & short)	Evergreen sclerophyllous shrub
Opuntia leptocaulis	Shrub/sapling (tall & short)	Thorn shrub
Prosopis glandulosa	Shrub/sapling (tall & short)	Thorn tree
Ptelea trifoliata	Shrub/sapling (tall & short)	Broad-leaved deciduous shrub
Sideroxylon lanuginosum	Shrub/sapling (tall & short)	Broad-leaved deciduous tree
Yucca constricta	Shrub/sapling (tall & short)	Other shrub
Wedelia texana	Herb (field)	Graminoid
Aristida purpurea	Herb (field)	Graminoid
Carex planostachys	Herb (field)	Graminoid
Nassella leucotricha	Herb (field)	Graminoid

OTHER NOTEWORTHY SPECIES

Species Name	GRank	Animal	Note (*specify Rare (geog area), Invasive, Animal, or Other*)

CLASSIFICATION & OTHER COMMENTS

Classification Comments:

Other Comments:

ELEMENT DISTRIBUTION

This vegetation class occurs only at the Rancho Unit and is distributed in the western half of the unit downslope from the level ***Prosopis glandulosa*** **var.** ***glandulosa - Celtis pallida / Opuntia*** **spp. -** ***Xylothamia palmeri*** **Woodland** and upslope from the ***Ulmus crassifolia – Celtis laevigata / Ilex decidua / Elymus virginicus*** **Forest** and ***Quercus virginiana*** **Temporarily Flooded Forest**

ELEMENT SOURCES

Inventory Notes:
Plots: SAAN.23, SAAN.26, SAAN.31
Description Author(s): R. Sanders

NEW *Bothriochloa laguroides – Sorghum halepense* Herbaceous Vegetation

Translated Name: Silver Bluestem – Johnsongrass Herbaceous Vegetation
Common Name: Silver Bluestem – Johnsongrass Herbaceous Vegetation

ENVIRONMENTAL DESCRIPTION

The environmental factors that influence the composition and structure of this community are: climate, topography, soils, past management and chance historical events. This community occurs on the original terraces and natural levees, as well as some artificial levees (from fill dredged for channelization) bordering the San Antonio River. The community occurs on clay loams originally derived from silt and clay alluvium. Immediately adjacent to the channelized banks of the river, the clay loam soils overlie gravel fill that was dredged from the river channel. Water availability is less than in pre-urbanized times due to lowering of the water table through channelization and rising of the levees along the channel. Composition at any given site is probably largely dependent on past management, particularly fire suppression, and chance introduction of exotic species. Flooding of major proportions does not occur as it once did due to impoundments and channelization along the river.

VEGETATION DESCRIPTION

The canopy is typically 1-2 m high with a dense cover of about 80%, except for scattered shrubs and saplings that constitute no more than 5% cover. The vegetation is dominated by exotic mid- and tall grasses, particularly *Sorghum halepense* and *Bothriochloa ischaemum.* Native prairie grasses (*Nassella leucotricha* and *Schizachyrium scoparium*) commonly persist as important associates. Weedy forbs (*Lactuca serriola*, *Torilis arvensis*)and herbaceous vines (*Clematis drummondii, Merremia dissecta*) are frequent and often form large patches.

FLORISTIC COMPOSITION

Species Name	Stratum	Lifeform
Sorghum halepense	Herb (field)	Graminoid
Bothriochloa ischaemum	Herb (field)	Graminoid
Nassella leucotricha	Herb (field)	Graminoid
Schizachyrium scoparium	Herb (field)	Graminoid
Clematis drummondii	Herb (field)	Vine/liana
Merremia dissecta	Herb (field)	Vine/liana
Lactuca serriola	Herb (field)	Forb
Torilis arvensis	Herb (field)	Forb

OTHER NOTEWORTHY SPECIES

Species Name	GRank	Animal	Note (*specify Rare (geog area), Invasive, Animal, or Other*)
Cynodon dactylon			Subinvasive alien
Sorghum halepense			Subinvasive alien
Torilis arvensis			Invasive alien

CLASSIFICATION & OTHER COMMENTS

Classification Comments:

Other Comments:

ELEMENT DISTRIBUTION

This vegetation occurs only in the San Antonio Unit on both raised artificial and natural terraces along the San Antonio River, especially in the Espada and San Juan *Labores*.

ELEMENT SOURCES

Inventory Notes:

Plots: SAAN.3, SAAN.7, SAAN.10

Description Author(s): R. Sanders

NEW *Cynodon dactylon* Herbaceous Vegetation

Translated Name: Bermuda Grass Herbaceous Vegetation
Common Name: Bermuda Grass Herbaceous Vegetation

ENVIRONMENTAL DESCRIPTION

Environment: The environmental factors that influence the composition and structure of this community are: climate, topography, and past management. This community occurs on undulating uplands and high bottomland terraces along and paralleling the San Antonio River and its valley. The community occurs on a variety of soils with good water availability including rock-derived loams and sandy loams and alluvium-derived silty clays. The main determining factor is past management as a cultivated pasture and abandonment of that use.

VEGETATION DESCRIPTION

Vegetation: The typical canopy does not exceed 0.5 high with a dense cover of about 80-90%, except where scattered shrubs (usually *Prosopis glandulosa*), saplings, and clumps of tall grasses constitute no more than 10% cover. The vegetation is dominated by the exotic short grass, *Cynodon dactylon*. Native midgrasses (*Eragrostis intermedia, Nassella leucotricha*) and the exotic tall grasses, *Sorghum halepense,* are common associates. The remaining associates are a variable and diverse mix of low frequency forbs, especially weedy native species.

FLORISTIC COMPOSITION

Species Name	Stratum	Lifeform
Cynodon dactylon	Herb (field)	Graminoid
Eragrostis intermedia	Herb (field)	Graminoid
Nassella leucotricha	Herb (field)	Graminoid
Sorghum halepense	Herb (field)	Graminoid
Prosopis glandulosa	Shrub/sapling (tall & short)	Thorn tree

OTHER NOTEWORTHY SPECIES

Species Name	GRank	Animal	Note (*specify Rare (geog area), Invasive, Animal, or Other*)
Cynodon dactylon			Subinvasive alien
Sorghum halepense			Subinvasive alien

CLASSIFICATION & OTHER COMMENTS

Classification Comments:
Other Comments:

ELEMENT DISTRIBUTION

This class is limited to the Rancho Unit where it occurs in the abandoned cultivated pastures along the entry easement and cleared bottomland that is surrounded by a large hairpin loop of the San Antonio River in the northwest part of the unit. In the San Antonio Unit, comparable vegetation is regularly mowed and maintained as lawns and parks.

ELEMENT SOURCES

Inventory Notes:
Plots: SAAN.24, SAAN.30, SAAN.35
Description Author(s): R. Sanders

NEW Old Field Weedy Herbaceous Vegetation

ENVIRONMENTAL DESCRIPTION

The environmental factors that influence the composition and structure of this community are: climate, topography, soils, and past management. This community occurs on the natural terraces and artificial levees (from fill dredged for channelization) bordering the San Antonio River. The community occurs on alluvium-derived clay-loam. Immediately adjacent to the channelized banks of the river, the clay loams overlie caliche gravel that was dredged from the river channel. Water availability is less than in pre-urbanized times due to lowering of the water table through channelization and rising of the levees along the channel. Transpiration appears to be high in this open, sunlit community. Composition at any given site is probably largely dependent on past management, fire suppression, and introduction of exotic species. Flooding of major proportions does not occur as it once did due to impoundments and channelization along the river.

VEGETATION DESCRIPTION

The canopy is typically less than 5 m high with about 30% cover, except for scattered young trees that constitute no more than 10% cover. The vegetation is dominated by saplings. Of these, the most common species is *Celtis laevigata*, but other species to be expected in the mix include *Acacia farnesiana* (not observed in sample plot), *Diospyros texana* (not observed in sample plot), *Ligustrum japonicum* (not observed in sample plot), *Melia azedarach* (not observed in sample plot), *Prosopis glandulosa,* and *Sapindus saponaria.* The ground layer is similar to that found in the open phases of the **Thorn Tree Ruderal Woodland** in that it consists of a mix of weedy native and exotic forbs and grasses.

FLORISTIC COMPOSITION

Species Name	Stratum	Lifeform
Celtis laevigata	Shrub/sapling (tall & short)	Broad-leaved deciduous tree
Sapindus saponaria	Shrub/sapling (tall & short)	Broad-leaved deciduous tree
Prosopis glandulosa	Shrub/sapling (tall & short)	Thorn tree
Clematis drummondii	Herb (field)	Vine/liana
Torilis arvensis	Herb (field)	Forb
Viguiera dentata	Herb (field)	Forb
Nassella leucotricha	Herb (field)	Graminoid
Sorghum halepense	Herb (field)	Graminoid

OTHER NOTEWORTHY SPECIES

Species Name	GRank	Animal	Note (*specify Rare (geog area), Invasive, Animal, or Other*)
Ligustrum japonicum			Invasive alien
Melia azedarach			Invasive alien
Sorghum halepense			Subinvasive alien
Torilis arvensis			Invasive alien

CLASSIFICATION & OTHER COMMENTS

Classification Comments: This vegetation class is a sere in the succession between old field grasslands and ***Carya illinoinensis – Celtis laevigata* Forest**. It appears that ***Acacia farnesiana – (Prosopis glandulosa)* Woodland** does not develop on these sites before mature trees of *Celtis laevigata* come to dominate the site. It is not clear what the factors are that control whether seedlings/saplings of *Celtis laevigata* or other broadleaf species dominate or whether thorn trees dominate after open grasslands.
Other Comments: This vegetation unit is defined only for the old fields of San Antonio NHP.

ELEMENT DISTRIBUTION

This vegetation occurs only in the San Antonio Unit on both raised artificial and natural terraces along the San Antonio River, especially in the Espada and San Juan *Labores*.

ELEMENT SOURCES

Inventory Notes:
Plots: SAAN.15
Description Author(s): R. Sanders

APPENDIX E: SAAN Species List

This is not a complete list for SAAN. This list only contains the species recorded for the 2005 sample plots and the 2006 accuracy assessment points. Genus-only records indicate an unknown species.

Family	Scientific Name	Common Name
Acanthaceae	*Carlowrightia torreyana*	Torrey's wrightwort
	Ruellia drummondiana	Drummond's wild petunia
	Ruellia metziae	Metz's wild petunia
	Ruellia nudiflora	violet wild petunia
	Siphonoglossa pilosella	hairy tubetongue
Aceraceae	*Acer negundo*	boxelder
Agavaceae	*Yucca constricta*	Buckley's yucca
	Yucca treculeana	Don Quixote's lace
Amaranthaceae	*Amaranthus palmeri*	carelessweed
Anacardiaceae	*Toxicodendron radicans*	eastern poison ivy
Apiaceae	*Torilis arvensis*	spreading hedgeparsley
Apocynaceae	*Nerium oleander*	oleander
Aquifoliaceae	*Ilex decidua*	possumhaw
Araceae	*Colocasia esculenta*	coco yam
Arecaceae	*Sabal mexicana*	Rio Grande palmetto
Asclepiadaceae	*Asclepias oenotheroides*	zizotes milkweed
	Cynanchum barbigerum	bearded swallow-wort
	Matelea	milkvine
	Matelea reticulata	netted milkvine
Asteraceae	*Ageratina havanensis*	Havana snakeroot
	Ambrosia confertiflora	weakleaf burr ragweed
	Ambrosia psilostachya	Cuman ragweed
	Ambrosia trifida	great ragweed
	Calyptocarpus vialis	straggler daisy
	Conyza canadensis	Canadian horseweed
	Coreopsis tinctoria	golden tickseed
	Evax prolifera	bighead pygmycudweed
	Gaillardia pulchella	firewheel
	Gutierrezia texana	Texas snakeweed
	Helianthus annuus	common sunflower
	Heterotheca subaxillaris	camphorweed
	Hymenopappus	hymenopappus
	Hymenopappus scabiosaeus	Carolina woollywhite
	Iva angustifolia	narrowleaf marshelder
	Lactuca floridana	woodland lettuce
	Lactuca serriola	prickly lettuce
	Lindheimera texana	Texas yellowstar
	Mikania scandens	climbing hempvine
	Parthenium confertum	Gray's feverfew
	Parthenium hysterophorus	Santa Maria feverfew

	Ratibida columnifera	upright prairie coneflower
	Rudbeckia hirta	blackeyed Susan
	Simsia calva	awnless bushsunflower
	Solidago canadensis	Canada goldenrod
	Symphyotrichum ericoides var. ericoides	white heath aster
	Symphyotrichum lanceolatum	white panicle aster
	Symphyotrichum subulatum	eastern annual saltmarsh aster
	Verbesina virginica	white crownbeard
	Viguiera dentata	toothleaf goldeneye
	Wedelia texana	hairy wedelia
	Xanthisma texanum	Texas sleepydaisy
Berberidaceae	*Mahonia trifoliolata*	*= Berberis trifoliolata*
Bignoniaceae	*Campsis radicans*	trumpet creeper
Boraginaceae	*Ehretia anacua*	knockaway
	Onosmodium molle ssp. bejariense	softhair marbleseed
Brassicaceae	*Lepidium austrinum*	southern pepperwort
Cactaceae	*Opuntia*	pricklypear
	Opuntia engelmannii	cactus apple
	Opuntia engelmannii var. lindheimeri	Texas pricklypear
	Opuntia leptocaulis	Christmas cactus
	Opuntia macrorhiza	twistspine pricklypear
Caprifoliaceae	*Lonicera japonica*	Japanese honeysuckle
	Sambucus nigra	European black elderberry
Celastraceae	*Schaefferia cuneifolia*	desert yaupon
Chenopodiaceae	*Chenopodium album*	lateflowering goosefoot
	Chenopodium berlandieri	pitseed goosefoot
Commelinaceae	*Commelina erecta*	whitemouth dayflower
	Commelina erecta var. angustifolia	whitemouth dayflower
	Tinantia anomala	widowstears
Convolvulaceae	*Convolvulus arvensis*	field bindweed
	Convolvulus equitans	Texas bindweed
	Evolvulus sericeus	silver dwarf morning-glory
	Ipomoea cordatotriloba	tievine
	Merremia dissecta	noyau vine
Cornaceae	*Cornus drummondii*	roughleaf dogwood
Cyperaceae	*Carex*	sedge
	Carex amphibola	eastern narrowleaf sedge
	Carex planostachys	cedar sedge
	Carex tetrastachya	Britton's sedge
Ebenaceae	*Diospyros texana*	Texas persimmon
Euphorbiaceae	*Chamaesyce nutans*	eyebane
	Croton capitatus	hogwort
	Croton monanthogynus	prairie tea
	Euphorbia davidii	David's spurge
	Tragia	noseburn
	Tragia brevispica	shortspike noseburn
	Tragia ramosa	branched noseburn
Fabaceae	*Acacia farnesiana*	sweet acacia

	Acacia greggii	catclaw acacia
	Acacia rigidula	blackbrush acacia
	Acacia rigidula	blackbrush acacia
	Desmanthus virgatus	wild tantan
	Eysenhardtia	kidneywood
	Eysenhardtia texana	Texas kidneywood
	Mimosa latidens	Kairn's sensitive-briar
	Prosopis glandulosa	honey mesquite
	Rhynchosia minima	least snoutbean
Fagaceae	*Quercus fusiformis*	plateau oak
	Quercus virginiana	live oak
Juglandaceae	*Carya illinoinensis*	pecan
Lamiaceae	*Hedeoma drummondii*	Drummond's false pennyroyal
	Hedeoma hispida	rough false pennyroyal
	Monarda citriodora	lemon beebalm
	Teucrium canadense	Canada germander
Liliaceae	*Allium canadense*	meadow garlic
	Cooperia drummondii	evening rainlily
	Cooperia pedunculata	prairie lily
	Habranthus tubispathus	Rio Grande copperlily
Malvaceae	*Abutilon fruticosum*	Texas Indian mallow
	Abutilon incanum	pelotazo
	Malvastrum coromandelianum	threelobe false mallow
	Malvaviscus arboreus	wax mallow
	Rhynchosida physocalyx	buffpetal
	Sida abutifolia	spreading fanpetals
	Sida spinosa	prickly fanpetals
Meliaceae	*Melia azedarach*	Chinaberrytree
Menispermaceae	*Cocculus carolinus*	Carolina coralbead
	Cocculus diversifolius	snailseed
Moraceae	*Morus alba*	white mulberry
	Morus rubra	red mulberry
Nyctaginaceae	*Acleisanthes obtusa*	Berlandier's trumpets
	Boerhavia	spiderling
	Boerhavia diffusa	red spiderling
	Mirabilis jalapa	marvel of Peru
Oleaceae	*Forestiera angustifolia*	Texas swampprivet
	Fraxinus	ash
	Ligustrum japonicum	Japanese privet
Onagraceae	*Gaura*	beeblossom
Onagraceae	*Gaura coccinea*	scarlet beeblossom
	Gaura mollis	velvetweed
Onagraceae	*Oenothera speciosa*	pinkladies
Oxalidaceae	*Oxalis stricta*	common yellow oxalis
Passifloraceae	*Passiflora foetida*	fetid passionflower
Phytolaccaceae	*Rivina humilis*	rougeplant
Poaceae	*Aristida purpurea*	purple threeawn
	Arundo donax	giant reed

	Bothriochloa ischaemum var. *songarica*	yellow bluestem
	Bothriochloa laguroides	silver beardgrass
	Bouteloua curtipendula	sideoats grama
	Bouteloua rigidiseta	Texas grama
	Buchloe dactyloides	buffalograss
	Cenchrus spinifex	coastal sandbur
	Chasmanthium latifolium	Indian woodoats
	Chloris	windmill grass
	Chloris cucullata	hooded windmill grass
	Cynodon dactylon	Bermudagrass
	Dichanthium annulatum	Kleberg's bluestem
	Elymus canadensis	Canada wildrye
	Elymus virginicus	Virginia wildrye
	Eragrostis intermedia	plains lovegrass
	Eragrostis spectabilis	purple lovegrass
	Nassella lepida	smallflower tussockgrass
	Nassella leucotricha	Texas tussockgrass
	Pennisetum ciliare	buffelgrass
	Phyllostachys aurea	golden bamboo
	Schizachyrium scoparium	little bluestem
	Setaria leucopila	streambed bristlegrass
	Setaria scheelei	southwestern bristlegrass
	Sorghum halepense	Johnsongrass
	Tridens albescens	white tridens
	Tridens eragrostoides	lovegrass tridens
	Tridens flavus	purpletop tridens
	Tridens texanus	Texas fluffgrass
	Urochloa fasciculata	browntop signalgrass
	Urochloa maxima	guineagrass
Pteridaceae	*Pellaea atropurpurea*	purple cliffbrake
Ranunculaceae	*Clematis drummondii*	Drummond's clematis
Rhamnaceae	*Colubrina*	nakedwood
	Colubrina texensis	Texan hogplum
	Condalia hookeri	Brazilian bluewood
	Ziziphus obtusifolia	lotebush
Rosaceae	*Crataegus*	hawthorn
	Rubus aboriginum	garden dewberry
	Rubus riograndis	Rio Grande dewberry
	Rubus trivialis	southern dewberry
Rubiaceae	*Galium aparine*	stickywilly
	Hedyotis nigricans	diamondflowers
Rutaceae	*Ptelea trifoliata*	common hoptree
	Ptelea trifoliata ssp. trifoliata var. mollis	common hoptree
	Zanthoxylum hirsutum	Texas Hercules' club
Salicaceae	*Populus deltoides*	eastern cottonwood
	Salix nigra	black willow
Sapindaceae	*Sapindus saponaria*	wingleaf soapberry
Sapotaceae	*Sideroxylon lanuginosum*	gum bully

Scrophulariaceae	*Agalinis strictifolia*	stiffleaf false foxglove
Smilacaceae	*Smilax bona-nox*	saw greenbrier
	Smilax rotundifolia	roundleaf greenbrier
Solanaceae	*Bouchetia erecta*	paintedtongue
	Capsicum annuum	cayenne pepper
	Lycium berlandieri	Berlandier's wolfberry
	Physalis cinerascens	smallflower groundcherry
	Solanum elaeagnifolium	silverleaf nightshade
	Solanum triquetrum	Texas nightshade
Sterculiaceae	*Hermannia texana*	Texas burstwort
	Melochia pyramidata	pyramidflower
Tamaricaceae	*Tamarix*	tamarisk
Ulmaceae	*Celtis laevigata*	sugarberry
	Celtis pallida	spiny hackberry
	Ulmus americana	American elm
	Ulmus crassifolia	cedar elm
Urticaceae	*Boehmeria cylindrica*	smallspike false nettle
	Urtica chamaedryoides	heartleaf nettle
Verbenaceae	*Phyla nodiflora*	turkey tangle fogfruit
	Verbena halei	Texas vervain
Viscaceae	*Phoradendron tomentosum*	Christmas mistletoe
Vitaceae	*Ampelopsis arborea*	peppervine
	Cissus trifoliata	sorrelvine
	Parthenocissus quinquefolia	Virginia creeper
	Vitis	grape
	Vitis cinerea	graybark grape
	Vitis mustangensis	mustang grape
Zygophyllaceae	*Guajacum*	lignum-vitae
	Guajacum angustifolium	Texas lignum-vitae
	Tribulus terrestris	puncturevine

APPENDIX F: Photo Interpretation Mapping Conventions and Visual Key

San Antonio Missions National Historical Park - Map Units

This section describes the map units for the San Antonio Missions National Historical Park Vegetation Mapping Project. Its purpose is to:

- Describe the vegetation of each map unit;
- Provide a ground photo image for each map unit;
- Describe the link between each map unit and the U.S. National Vegetation Classification;
- Provide visual examples of each map unit with aerial photographs and delineated overlays.

The map units for SAAN were based on a combination of NVC plant associations/alliances, local requests (i.e. Park Specials), the limitations of the digital imagery, and land-use / land-cover classes. The vegetation described in this section reflects the classification designed specifically for this project. Lookup tables that include the names of each code are included on the DVD. Non-vegetated map units are not described in this key.

Each map unit is described by a variety of characteristics and features. These include vegetation descriptions, a ground photograph and typical digital imagery signatures taken from the 2003 color infrared NAIP digital orthophoto used as a basemap for this project. Many of the map unit descriptions rely heavily on the vegetation descriptions for the corresponding association/alliances provided by NatureServe. Each map unit is typically made up of one vegetation association or alliance as listed. The sample ground photographs are from a variety of sources including ground photos of the sample plots and photos taken during signature verification trips or provided by Roger Sanders.

Forests and Woodlands

F –PECN *Carya illinoinensis – Celtis laevigata* Forest
Pecan – Sugar Hackberry Forest

Range and Distribution

Associations and Alliances

Carya illinoinensis – Celtis laevigata Forest

Common Species

Carya illinoinensis
Celtis laevigata
Acer negundo
Melia azedarach
Cornus drummondii
Rubus riograndis
Toxicodendron radicans
Ambrosia trifida
Calyptocarpus vialis
Galium aparine
Malvaviscus arboreus
Torilis arvensis
Elymus virginicus

Representative Ground Photo

Description

This map class represents two successional stages that were found exclusively in the Missions area of SAAN. The late successional phase is well developed and may include remnant old-growth forest. This phase occurs on the natural terraces that still exist behind the raised artificial levees. This sub-type is characterized by a tall canopy dominated by *Carya illinoinensis* or *Acer negundo* with a dense subcanopy and/or understory of *Celtis laevigata*. The mid-successional phase occurs on the raised artificial levees or on lower natural terraces where the forest or riverine savanna was cleared. This subtype has shorter trees dominated by *Celtis laevigata.* Both subtypes can contain stands of non-natives, especially *Melia azedarach* and *Ligustrum japonicum*. The presence of *Celtis laevigata* in this type as well as in the Elm – Sugarberry / Possum-haw / Virginia Wild Rye Forest likely caused some confusion in the mapping between them. Similarly, large stands of *Melia azedarach* and *Ligustrum japonicum* present in this type may have been missed or their polygons mislabeled. On the 2003 imagery this type had a characteristic winter deciduous tree signature that was a puffy, dark gray. This type was mapped primarily based on the height of the trees and their proximity to the San Antonio River and its tributaries. The late successional phase was distinguished in the mapping from the mid successional phase based on the height and density modifiers.

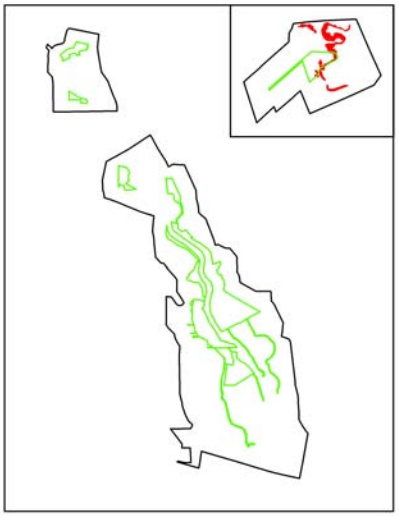
Photo Signature Example

F-COTW *Populus deltoides* Temporarily Flooded Forest Alliance
Eastern Cottonwood Temporarily Flooded Forest Alliance

Associations and Alliances
Populus deltoides Temporarily Flooded Forest Alliance

Common Species
Populus deltoides
Acer negundo
Carya illinoinensis
Celtis laevigata
Ulmus americana
Ulmus crassifolia
Rubus riograndis
Toxicodendron radicans
Smilax bona-nox
Ambrosia trifida
Chasmanthium latifolium
Elymus virginicus

Range and Distribution



Description
This type was found exclusively in the Rancho unit of SAAN, although scattered cottonwood trees are likely present around the Missions as well. This type occurred on the primary terraces and levees along the main natural channel of the San Antonio River. Cottonwood establishment in these areas is likely a result of flooding events, which are probably infrequent at SAAN due to the impoundments on the river. Where it occurs, *Populus deltoides* was the dominant over an understory containing a mix of other common deciduous species including *Acer negundo*, *Carya illinoinensis*, *Celtis laevigata*, *Ulmus americana*, and *Ulmus crassifolia*. The shrub layer is very sparse but the herbaceous layer is relatively thick consisting of vines (*Rubus riograndis*, *Smilax bona-nox*, and *Toxicodendron radicans*) and shade tolerant grasses (*Chasmanthium latifolium* and *Elymus virginicus*). The overlap in common species between this type and the other deciduous woodland and forest map classes led to some confusion in the mapping. On the 2003 imagery this type appeared gray with pink speckles and had a puffy, mottled texture.

Representative Ground Photo

Photo Signature Example

F-CELM *Ulmus crassifolia - Celtis laevigata / Ilex decidua / Elymus virginicus* Forest
Cedar Elm – Sugarberry / Possum-haw / Virginia Wild Rye Forest

Associations and Alliances
Ulmus crassifolia - Celtis laevigata / Ilex decidua / Elymus virginicus Forest

Common Species
Ulmus crassifolia
Quercus virginiana
Celtis laevigata
Prosopis glandulosa
Elymus virginicus

Description
This community occurs on the higher terraces and tributary banks along the San Antonio River in both SAAN units. The vegetation is dominated by *Ulmus crassifolia* with many associates including *Quercus virginiana*, *Celtis laevigata*, *Morus alba*, and *Prosopis glandulosa*. *Melia azedarach* and *Ligustrum japonicum* are also found in this type in urban areas. The shrub layer is sparse except in ravines where *Condalia hookeri*, *Diospyros texana*, and *Ptelea trifoliata* are common. The ground layer is primarily dominated by *Elymus virginicus* in semi-natural areas and by *Torilis arvensis* in the urban sites. This type was used to map some of the homogenous stands of *Celtis laevigata*, which may have led to some confusion between it and the Pecan - Sugarberry Forest map class. On the imagery this type was viewed as being shorter in stature than the other deciduous forest/woodland types. It also had a gray texture characteristic of winter deciduous vegetation on the 2003 imagery.

Range and Distribution

Representative Ground Photo

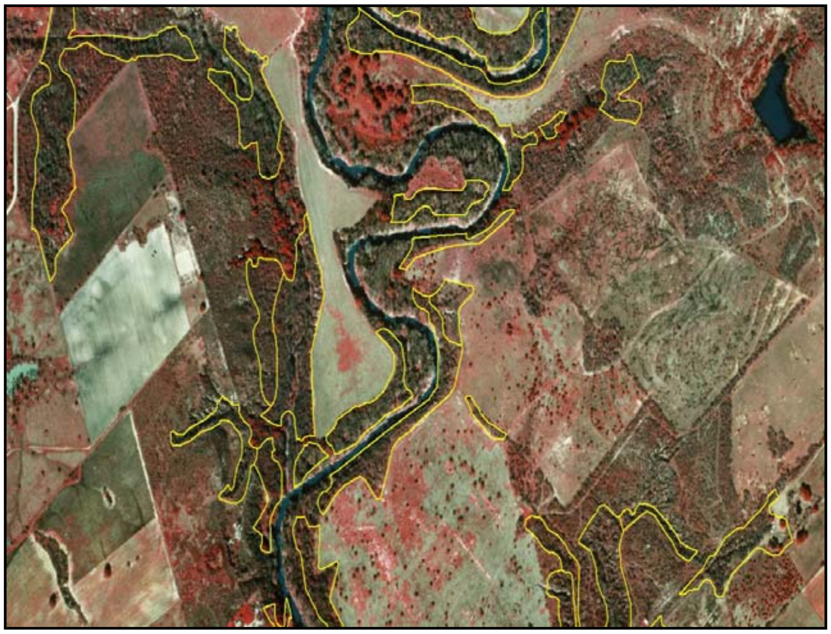


Photo Signature Example

W-MESQ *Prosopis glandulosa - Celtis pallida / Opuntia* spp. - *Xylothamia palmeri* Woodland
Honey Mesquite - Granjeno / Prickly-pear – South Texas Ericameria Woodland

Associations and Alliances
Prosopis glandulosa - Celtis pallida / Opuntia spp. - *Xylothamia palmeri* Woodland

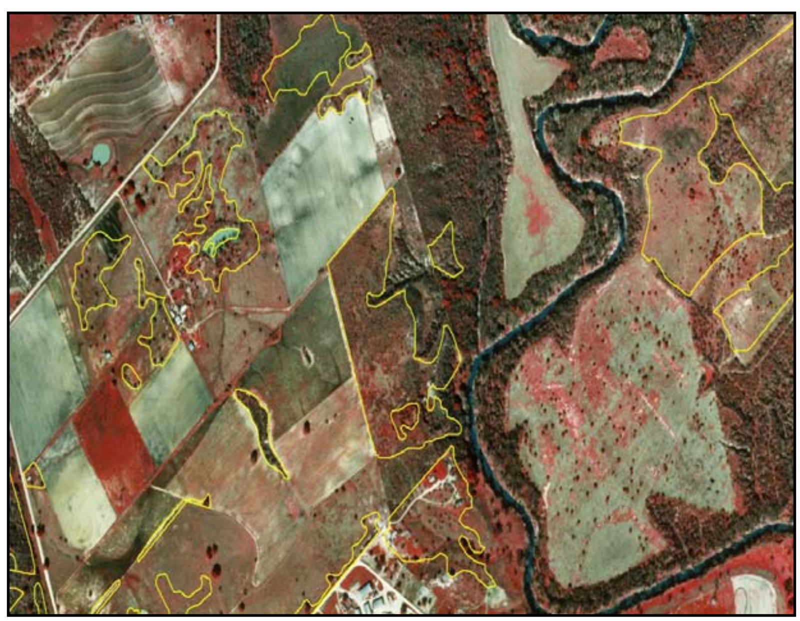
Common Species
Prosopis glandulosa
Celtis laevigata
Celtis pallida
Colubrina texensis
Condalia hookeri
Diospyros texana
Opuntia leptocaulis
Croton monanthogynus
Gutierrezia texana
Verbesina virginica
Nassella leucotricha

Range and Distribution

Description
This type occurs on the level uplands bordering the valley along the San Antonio River on both sites of SAAN. This type appeared to be early succession, rapidly encroaching on fallow fields in the absence of fire or when grazing or mowing ceased. The trees in this type are of uniform height, usually about 10 meters tall and producing about 30-50% cover. The subcanopy layer is usually absent or not well developed. This type is dominated by nearly uniform-aged stands of *Prosopis glandulosa* with a few scattered shrubs, mainly *Celtis laevigata*, *Celtis pallida, Colubrina texensis, Condalia hookeri, Diospyros texana*, and *Opuntia leptocaulis.* The ground layer is dominated by *Nassella leucotricha* and weedy and/or shade tolerant forbs (*Croton monanthogynus, Gutierrezia texana*, *Siphonoglossa pilosella*, and *Verbesina virginica*). *Cynodon dactylon* is usually present having invaded from nearby cultivated pastures or persisted from previous plantings. This type appeared as fairly sparse, dark red crowns on the color infrared imagery. The understory color was usually a mottled red and gray. This type was separated from the huisache map class on the color infrared imagery based on ground observations and its smaller crown size.

Representative Ground Photo

Photo Signature Example



W-HUCH *Acacia farnesiana - (Prosopis glandulosa)* Woodland
Huisache – (Honey Mesquite) Woodland

Range and Distribution

Associations and Alliances
Acacia farnesiana - (Prosopis glandulosa) Woodland

Common Species
Acacia farnesiana
Prosopis glandulosa
Celtis laevigata
Celtis pallida
Condalia hookeri
Diospyros texana
Mahonia trifoliolata
Ambrosia trifida
Calyptocarpus vialis
Clematis drummondii
Torilis arvensis
Viguiera dentate
Aristida purpurea
Nassella leucotricha

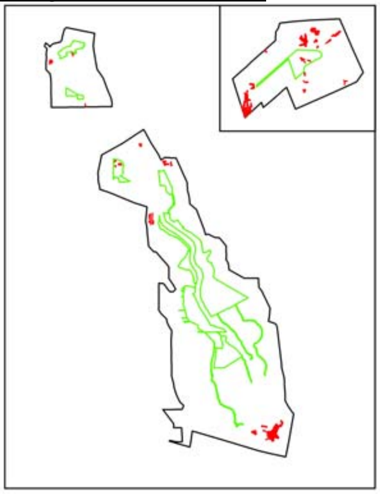
Representative Ground Photo

Description
This type was found throughout SAAN occurring in the Missions unit on the artificial raised levees bordering the San Antonio River and on lower natural terraces. On the Rancho unit this type is restricted to an isolated stand in the uplands and occurs more extensively on fallow fields in the environs. This type appears to be early successional and has much in common with the other mesquite woodland map class. The presence of huisache trees characterizes this class but the remaining species composition varies greatly from site to site dependent on past management, fire suppression, and introduction of exotic species. Trees in this class are usually between 5 to 15 meters high, providing 10 to 60% cover. The subcanopy is not well differentiated but can be dominated by *Prosopis glandulosa, Acacia farnesiana,* or a codominant mix of both. The shrub and herbaceous layers are variable. The most common species in these layers are *Celtis pallida, Condalia hookeri, Diospyros texana, Mahonia trifoliolata, Aristida purpurea,* and *Nassella leucotricha.* On the imagery this class appeared very similar to the Honey Mesquite - Granjeno / Prickly-pear - South Texas Ericameria Woodland type with small, dark red tree crowns evenly spaced.

Photo Signature Example

F-LOAK *Quercus virginiana* Temporarily Flooded Forest Alliance
Live Oak Temporarily Flooded Forest Alliance

Range and Distribution



Associations and Alliances
Quercus virginiana Temporarily Flooded Forest Alliance

Common Species
Quercus virginiana
Ulmus crassifolia
Chasmanthium latifolium
Elymus virginicus

Description
This type occurred primarily on the Rancho unit along Picosa Creek about 150 m north of the San Antonio River but it was also used to map other small stands of live oak surrounding the Missions unit. This type usually occurs as either isolated stands of live oak in urban settings or in conjunction with the Cedar Elm – Sugarberry / Possum-haw / Virginia Wild Rye Forest map class in natural environments. This type is characterized by the presence of *Quercus virginiana,* which dominates the canopy layer. Cover in the canopy stratum is usually over 80% and the subcanopy cover is about 30%. Typically *Ulmus crassifolia* and a few other deciduous tree species are present in this type. The shrub layer is almost absent and the herbaceous layer is very sparse, which may be related to periodic flash or sheet flooding. The shade-tolerant grasses, *Chasmanthium latifolium* and *Elymus virginicus* are the only common herbs. This type was very distinctive on the 2003 color infrared imagery due to the evergreen crowns of the live oaks. Live oak crowns appeared as bright red circles contrasted with the dark gray of the surrounding deciduous trees.

Representative Ground Photo

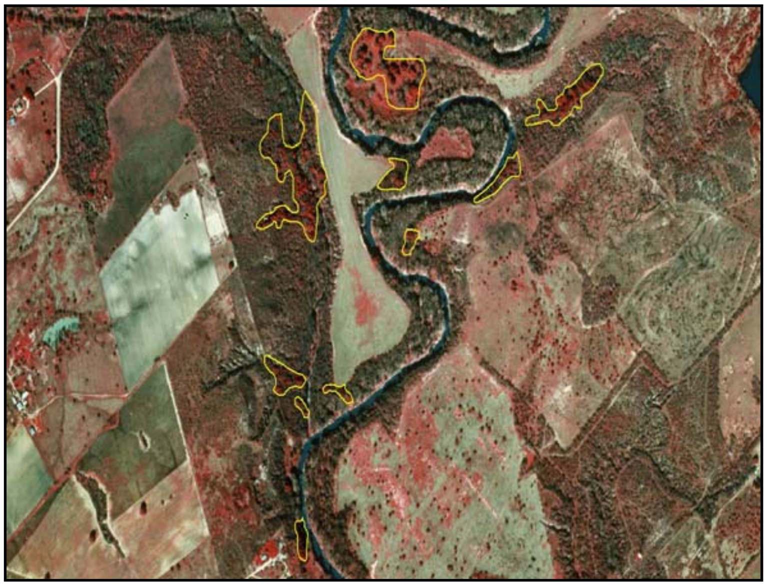


Photo Signature Example

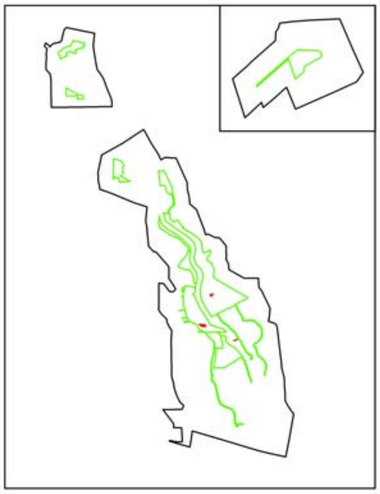
W-CHIN *Melia azedarach* Woodland Stand
Chinaberry Woodland Stand

Associations and Alliances
Local Stand (no NVC Alliance at this time)

Common Species
Melia azedarach
Carya illinoinensis
Celtis laevigata
Acer negundo
Cornus drummondii
Rubus riograndis
Toxicodendron radicans

Description
Chinaberry trees were found throughout the river and channel bottoms in and surrounding the Missions unit. Only a few mappable stands were observed in the park but smaller, isolated patches may also exist. Since this is an exotic species, removal efforts may dramatically effect its distribution over time. On the color infrared imagery this type appeared as bright pink trees intermixed with other deciduous trees.

Range and Distribution



Representative Ground Photo

Photo Signature Example

Shrublands

S-CHAP ***Acacia rigidula*** **Shrubland**
Chaparro-Prieto Shrubland

Associations and Alliances

Chaparro - Prieto Shrubland

Common Species

Acacia rigidula
Celtis laevigata
Celtis pallida
Colubrina texensis
Condalia hookeri
Diospyros texana
Eysenhardtia texana
Guajacum angustifolium
Mahonia trifoliolata
Opuntia leptocaulis
Prosopis glandulosa
Sideroxylon lanuginosum
Yucca constricta
Aristida purpurea
Nassella leucotricha

Range and Distribution

Representative Ground Photo

Description

This map class occurs on sloping convex uplands bordering the valley along the San Antonio River at the Rancho unit and a few scattered locations in the environs surrounding the Missions unit. This type occurred on similar habitat as the Huisache – (Honey Mesquite) Woodland and Honey Mesquite - Granjeno / Prickly-pear – South Texas Ericameria Woodland types and contained many of the same species. This type had 2-3 meter-tall shrubs and a sparse to open canopy of 30-60%. Trees were usually absent but a few did occur in ravines and small valleys. The composition is dominated by a nearly equal mix of *Acacia rigidula*, *Diospyros texana*, *Condalia hookeri*, and *Prosopis glandulosa.* Other commonly associated shrubs include *Celtis pallida, Colubrina texensis, Eysenhardtia texana, Guajacum angustifolium, Mahonia trifoliolata, Opuntia leptocaulis, Ptelea trifoliata*, *Yucca constricta,* and scattered saplings of *Celtis laevigata* and *Sideroxylon lanuginosum.* The herbaceous layer was dominated by *Aristida purpurea* and *Nassella leucotricha.* On the color infrared imagery this type was very similar to the other mesquite map classes having dark red shrubs against a gray background, although their shorter stature was distinctive.

Photo Signature Example

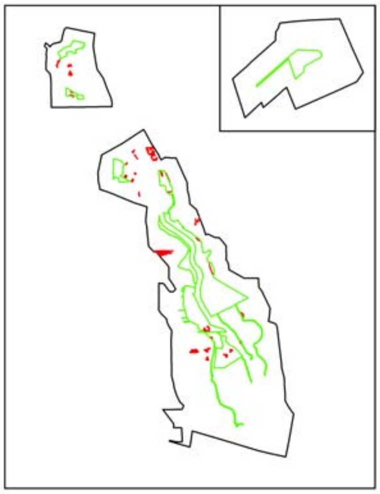
S-PRVT *Ligustrum japonicum* Shrubland Stand
Privet Shrubland Stand

Associations and Alliances
Local Stand (no NVC Alliance at this time)

Common Species
Ligustrum japonicum
Acer negundo
Carya illinoinensis
Celtis laevigata
Ulmus americana
Ulmus crassifolia
Toxicodendron radicans
Elymus virginicus

Description
Privet stands occurred throughout uplands on the Missions Unit. Privet was found at SAAN in thick, lush stands that were relatively tall ranging from 3-5 meters. Only a few mappable stands were observed in the park but smaller, isolated patches may also exist. Since this is an exotic species, removal efforts may dramatically effect its distribution over time. On the color infrared imagery this type appeared as very dark red trees and shrubs intermixed with other deciduous trees.

Range and Distribution



Representative Ground Photo

Photo Signature Example

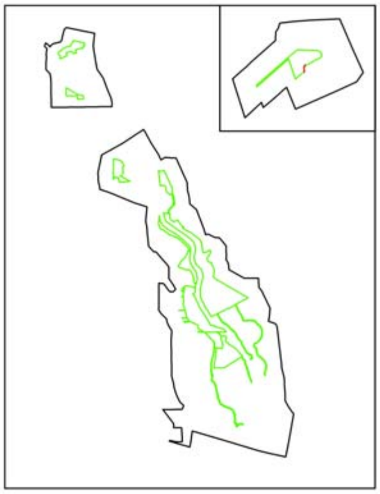
S-BLWL *Salix nigra* Temporarily Flooded Shrubland Alliance
Black Willow Temporarily Flooded Shrubland Alliance Stand

Associations and Alliances
Salix nigra Temporarily Flooded Shrubland Alliance

Common Species
Salix nigra
Ampelopsis arborea
Cynodon dactylon
Acer negundo

Description
Thickets of black willow were rare at SAAN only occurring in one mappable stand along the river at the Rancho Unit. This type was not sampled but was mapped based on observations in the field. This stand appeared to be young or frequently disturbed having few to no other species present. Black willow was also present as a minor associate in other riparian woodland map classes but was never dominant. On the color infrared imagery this type appeared as small brown to black spots contrasted with a mottled signature adjacent to the river.

Range and Distribution



Representative Ground Photo

Photo Signature Example

Herbaceous Vegetation

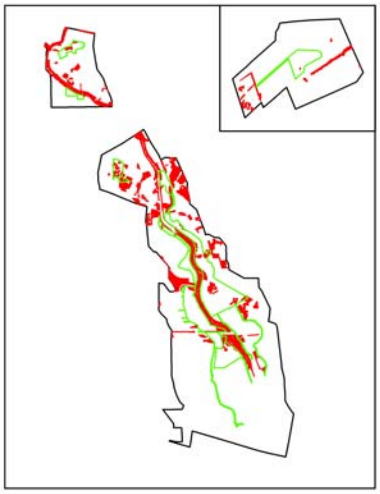
H-BERM *Cynodon dactylon* Herbaceous Vegetation
Bermuda Grass Herbaceous Alliance

Associations and Alliances
Cynodon dactylon Herbaceous Vegetation

Common Species
Cynodon dactylon
Eragrostis intermedia
Nassella leucotricha
Sorghum halepense
Prosopis glandulosa

Description
This type occurs on undulating uplands and high bottomland terraces along and paralleling the San Antonio River. The presence of this type is likely a result of past management where Bermuda grass was either planted or cultivated for pasture or escaped from these areas. This class is found on the Rancho Unit where it occurs on cultivated pastures along the entry easement and on cleared bottomlands. In addition, on the Missions Unit, this type was used to map large grasslands that were likely mowed and maintained. The vegetation is dominated by the exotic short grass, *Cynodon dactylon*. Native midgrasses (*Eragrostis intermedia, Nassella leucotricha*) and the exotic tall grasses, *Sorghum halepense*, are common associates. The remaining associates are a variable and diverse mix of low frequency forbs, especially weedy native species. This type ranged on the color infrared imagery from a pale, smooth grey/blue where it was dormant to a smooth red and pink were it was growing.

Range and Distribution



Representative Ground Photo

Photo Signature Example

H-SVJN *Bothriochloa laguroides – Sorghum halepense* Herbaceous Vegetation
Silver Beardgrass - Johnsongrass Herbaceous Vegetation

Associations and Alliances
Bothriochloa laguroides – Sorghum halepense
Herbaceous Vegetation

Common Species
Sorghum halepense
Bothriochloa ischaemum
Nassella leucotricha
Schizachyrium scoparium
Clematis drummondii
Merremia dissecta
Lactuca serriola
Torilis arvensis

Description
This map class occurs at the Missions Unit on rather large fields that are maintained by mowing. It was not found on the Rancho Unit but a few small areas were mapped in the environs. This type is largely dependent on past management including planting, fire suppression, and dispersal. The vegetation is dominated by exotic mid- and tall grasses, particularly *Sorghum halepense* and *Bothriochloa ischaemum.* Native prairie grasses (*Nassella leucotricha* and *Schizachyrium scoparium*) commonly persist as important associates. Weedy forbs (*Lactuca serriola*, *Torilis arvensis*) and herbaceous vines (*Clematis drummondii, Merremia dissecta*) are frequent and often form large patches. On the 2003 color infrared imagery this type appeared light blue to gray with patches of red likely due to the presence of other grasses or forbs.

Range and Distribution

Representative Ground Photo

Photo Signature Example

H-OFLD Old Field Weedy Herbaceous Vegetation

Associations and Alliances
Local Stand (no NVC Alliance at this time)

Common Species
Celtis laevigata
Sapindus saponaria
Prosopis glandulosa
Clematis drummondii
Torilis arvensis
Viguiera dentata
Nassella leucotricha
Sorghum halepense

Description
This type was used to map the variable early succession vegetation occurring on old fields. Old fields are located on the natural terraces and artificial levees bordering the San Antonio River in the Missions unit and in some of the fallow fields surrounding the Rancho unit. At the Missions Unit, this type occurs on both raised artificial and natural terraces along the San Antonio River. Species composition is variable depending on past management, fire suppression, and introduction of exotic species. The vegetation in this type is mainly comprised of grasses and weedy forbs that were typically less than 5 meters high. In some sites, succession was replacing the grasses with saplings of *Celtis laevigata, Acacia farnesiana, Diospyros texana, Ligustrum japonicum, Melia azedarach, Prosopis glandulosa,* and *Sapindus saponaria.* On the color infrared imagery this type had a mottled signature characteristic of the variable species composition. Colors ranged from bright red (actively growing species) to dark gray (dormant species)

Range and Distribution

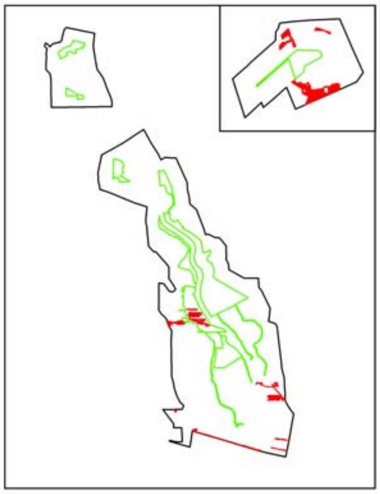
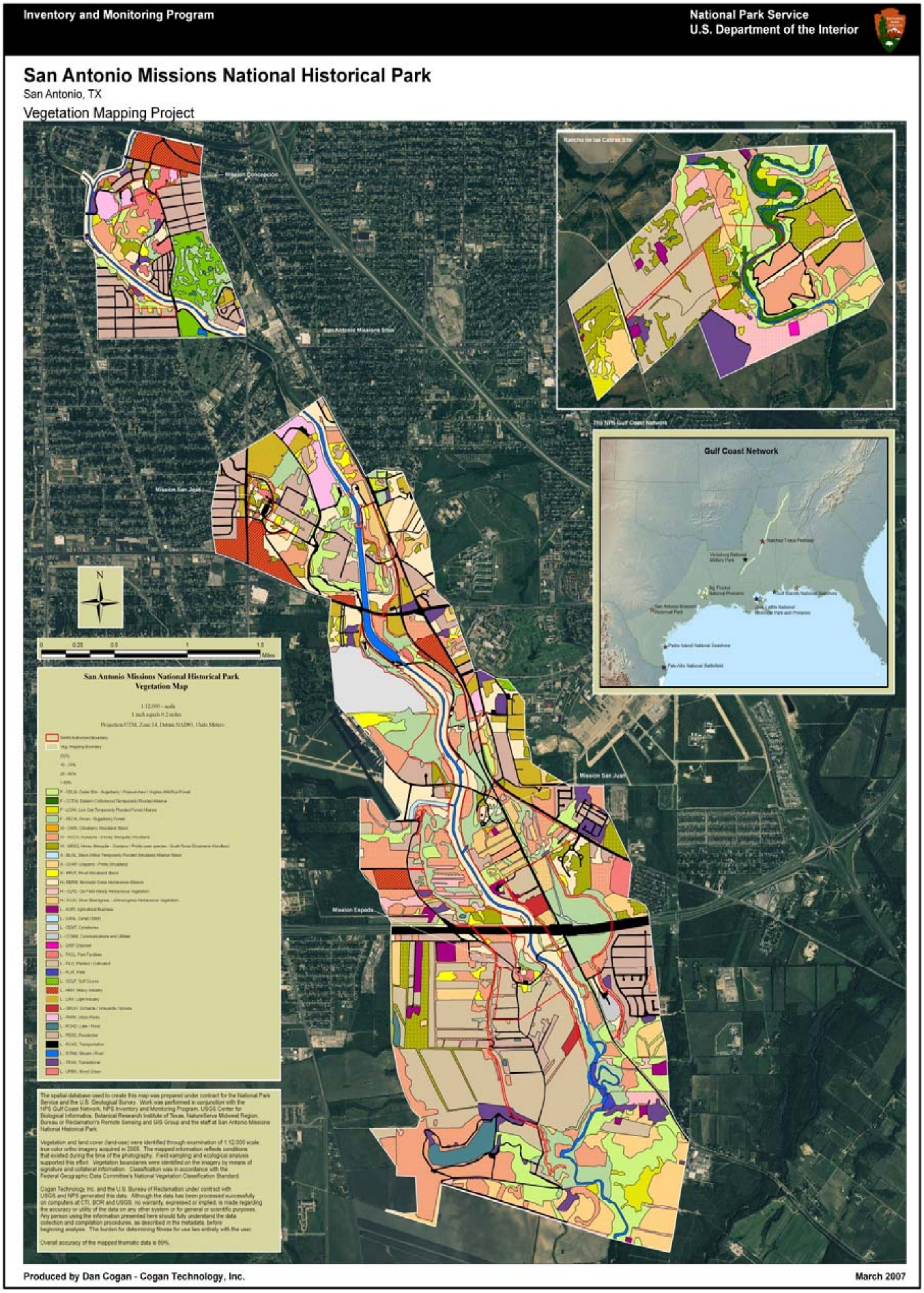


Photo Signature Example

Representative Ground Photo

APPENDIX G: Final SAAN Vegetation Map



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NPS D-68, May 2007

National Park Service
U.S. Department of the Interior

Gulf Coast Inventory and Monitoring Network
Gulf Coast Network
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