Platte River Vegetation Mapping Project
2005 Land Cover
Methods Summary

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PLATTE RIVER
RECOVERY IMPLEMENTATION PROGRAM

Great Plains GIS Partnership

HABITAT AND POPULATION EVALUATION TEAM

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INTRODUCTION

The Big Bend reach of the central Platte River serves as a major staging area for migratory water birds (waterfowl, wading birds, shorebirds) during spring migration. Reduced spring flows and drought conditions within the Platte system have promoted encroachment by undesirable woody and herbaceous invasive species, which has caused the once-shallow braided channels of the Platte River to incise. This action has significantly reduced available habitat for roosting and loafing Sandhill Cranes, endangered Whooping Cranes, and millions of waterfowl that annually utilize the Platte River each spring. The change in river morphology has also reduced available nesting habitat for the federally listed Interior Least Tern and Piping Plover. In addition to the degradation of the open channel, wet meadows and lowland grasslands adjacent to the active channel have been invaded by Eastern Red Cedars, Russian Olives, and other undesirable woody species. Furthermore, important side channels, backwaters, and wetland sloughs have also been overgrown with Purple Loosestrife, hybrid Cattails, Phragmites, and Reed Canary Grass. This reduction in available habitat quality has galvanized a strong partnership between conservation agencies, non-government organizations, and private landowners to work together to protect, restore, and enhance habitat along the central Platte River valley. As the partnership matured it became evident there was a need to develop a baseline inventory of the current vegetation along the central Platte River in a Geographical Information System (GIS). This baseline vegetation dataset can now be used in a multitude of analyses and habitat models to better plan and implement conservation practices.

METHODS

Landcover development from aerial photography has been problematic in the past largely due to software and hardware limitations. In the last three years, monumental strides have been made in imagery acquisition, data development, processing, and image analysis to make this a cost-effective, efficient method for mapping and monitoring activities. The Rainwater Basin Joint Venture (RWBJV) office in Grand Island, NE has developed and refined a process for landcover mapping in prairie systems. Steps include data gathering/mask creation, vegetation classification system development, image acquisition/processing, sampling design, field work, image classification, accuracy assessment, and final landcover development.

Data Gathering/Mask Creation

The first step is the process of spatial data acquisition and compilation for the purpose of creating a base dataset. By using this base dataset as a habitat mask to represent "known" classes, one can reduce confusion between classes of important habitats thereby increasing the overall accuracy of the final dataset. This project was started with the Farm Service Agency Common Land Unit (CLU) layer. The CLU is the agriculture field boundary layer created to administer USDA programs. The data are created on a county basis. For this project, 17 counties were merged into a seamless dataset. Next, the data were attributed relative to the needs of this project. The basic classes included: Agriculture fields, Undisturbed Grassland, Trees, Grass, Water, Non-Agriculture, and Developed. These classes were created by heads up digitizing at a 1:5,000 scale, referencing 2004 color, 2004 color-infrared, and 2005 color-infrared imagery.

Vegetation Classification System

Federal Agencies are required to map vegetation according to the National Vegetation Classification System (NVCS). The NVCS is a hierarchical approach that provides a consistent framework for mapping by federal agencies. This project focused on mapping to the alliance/association level, which characterizes vegetation by the dominant species that represents a community. To enhance the value of the project, several additional classes were developed to map invasive/exotic species that are of management concern, as well as habitat features important to bird species of management concern. The following synopsis details vegetation communities that were mapped, as well as dominant species found in those communities.

Table 1: Example Species by Vegetation Community

Class	**Species**
Riparian Woodland	Eastern Cottonwood (Populus deltoides), American Elm (Ulmus americana), Eastern Red Cedar (Juniperus virginiana)
Xeric Wet-Meadow	Big Bluestem (Andropogon gerardii), Switchgrass (Panicum virgatum), Little Bluestem (Schizachyrium scoparium), Indiangrass (Sorghastrum nutans), Smooth Brome (Bromus inermis)
Mesic Wet-Meadow	Prairie Cordgrass (Spartina pectinata), Reed Canarygrass (Phalaris arundinacea), River Bulrush (Schoenoplectus fluviatilis), Emory’s Sedge (Carex emoryi), Woolly Sedge (Carex pellita), and Illinois Bundleflower (Desmanthus illinoensis)
River Early Successional	Barnyardgrass (Echinochloa crusgalli), Sprangletop (Leptochloa fusca), Smartweed (Polygonum amphibium), Bareground
Meadow Sand Ridge	Tall Dropseed (Sporobolus compositus), Sand Dropseed (Sporobolus cryptandrus), Prairie Sandreed (Calamovilfa longifolia), Needle-and-Thread (Hesperostipa comata)
Riparian Shrubland	Willow species (Salix spp), Dogwood species (Cornus spp), Desert False Indigo (Amorpha fruticosa)
River Shrubland	Same species as Riparian Shrubland class. Most often encompassing mid to late successional sandbars in-channel.
Phragmites	(Phragmites spp)
Purple Loosestrife	(Lythrum salicaria)

Upland trees, shrubs, and grass were separated after the classification using a layer that delineated the Platte Valley. Species in these upland classes are similar to their lowland counterparts, but can contribute to different habitat needs due to their position on the landscape. Agricultural features mapped include: Undisturbed Grasslands and Agricultural fields. Water features mapped include: River Channel, Warmwater Sloughs, Floodplain Marshes, Sand Pits, Stock Ponds, Reservoirs, Irrigation Reuse Pits, Canals, and Lagoons. The Bareground class was divided to separate bare sand in-channel (Unvegetated Sandbar) and all other bareground (Bareground/Sparse Veg). The last class mapped was Developed land. Developed was then broken into several classes including: Rural Developed, Urban/Suburban Developed, and Roads. All of the above mapping classes were developed based on management concerns, as well as cross-walking to the Hierarchical All-Bird Strategy (HABS) Landcover classes for use later in assessing bird conservation potential for the Platte River Corridor.

Image Acquisition/Processing

Imagery was acquired for the Platte River Corridor between August 15 – September 5, 2004 as well as August 25 – September 1, 2005. The 2005 imagery was acquired from Chapman to Gothenburg, five miles on either side of the channel. The 2004 imagery was acquired from Ogallala to Columbus within 5 miles of the outermost channel. These image sets were color balanced across the range of the acquisition. Color balancing removes streaking and variation between image acquisition dates and helps to maintain consistent color and hue for the entire image dataset. The images were then ortho-rectified and stitched together into a seamless mosaic from Columbus to Ogallala. For this project, the 2005 imagery was used where available. The 2004 imagery was employed from the Dawson county line west to Ogallala.

Sampling and Database Design

To develop the sampling framework, eCognition – an object-oriented image classification software – was used to complete a multi-resolution image object segmentation. This process created image objects containing similar spectral and textural characteristics. For example, a stand of trees would be isolated and a polygon would be created around the object. A database was created with pre-determined input fields of the predominant vegetation communities, as well as a large number of specific vegetation species common to the region. This database was used by a technician to attribute the sample polygons in the field. The database contained a field to identify the overall vegetation community, and three fields to identify dominant vegetation species present in the sample polygons .

A vast majority of the land in the central Platte corridor is under private ownership, therefore training data collection focused almost entirely on public and non-governmental organization (NGO) lands (Nebraska Game & Parks Commission, U.S. Fish & Wildlife Service, The Nature Conservancy, Platte River Whooping Crane Maintenance Trust, National Audubon Society, Public Power Districts).

Field Work

Field technicians used Trimble GeoExplorer XT GPS units (GeoXT) equipped with the ArcPad software to check out polygon data for training data collection. The check-in check-out feature of ArcGIS allows the organization of the training data in one master project, ensuring that all sampling areas were visited and data were not double-edited. Once the data were checked out to the GeoXT, the technician used the GPS functionality to navigate to the polygons in the field and class the vegetation. When the technician arrived at a sample polygon, the overall vegetation community type was assessed and attributed in the GeoXT. Up to three dominant plant species were also attributed, along with their approximate relative coverage in the polygon. Once the checked-out data were attributed, they were checked back in to the master project. Over the course of two summers, nearly all public and NGO lands along the river from Lexington to Highway 281 at Grand Island were visited.

Image Classification

Utilizing the training data collected by the technicians, a training and test area mask (TTA mask) was created. This TTA mask was then integrated into eCognition to complete a supervised classification of the entire project area. The TTA mask provided samples used to "train" eCognition with a known vegetation community's spectral signature. This information was then extrapolated by eCognition via a nearest neighbor classification strategy across the entire image. The result was the fully classified landcover for the image.

In areas west of the Dawson County image segment, the classification was not completed to as detailed a level as the rest of the landcover. This was due to limited availability of training data in these areas, combined with the difference in imagery upstream and downstream of Gothenburg.

After the nearest neighbor supervised classification was completed in eCognition, the landcover went through a full photo interpretation process. During this photo interpretation process, obvious misclassifications were reclassified. The photo interpretation was completed by the field technician, so as much field knowledge as possible was used in correcting error. As an additional step, features were separated into finer mapping units that could not be remotely sensed using eCognition. For example, water was separated into sand pits, stock dams, canals, etc. Ancillary data were employed to separate similar habitat types based on their position on the landscape. For example, digital elevation model (DEM) data were used to delineate the Platte River valley from the surrounding uplands. This delineation was used to separate wet meadow grasslands from upland mixed-grass prairie and riparian shrublands from upland shrublands. As another example, a riparian zone was delineated and used to separate Riparian Woodlands from Upland Trees. Bare sand in the river channel is an important habitat type for migrating waterfowl and shorebirds, so an active channel layer was created and used to separate unvegetated sandbars from other bareground areas of the map.

When the remotely sensed landcover was completed, the training data polygons were reintegrated into the landcover. This provides polygons classified with extremely high confidence for areas that were physically visited by the technicians.

After review of the classification, some classes were removed from the remotely sensed areas of the landcover. These classes include Coniferous Woodland and Hydrophytes. These classes were not effectively attributed by the nearest neighbor classification, primarily due to the lack of available training data. Among the training data collection areas, these communities were primarily a component of another dominant community, as opposed to an exclusive homogeneous community themselves. Coniferous Woodlands were almost always found as an understory to a larger deciduous canopy, and therefore not effectively seen through aerial photography. Hydrophytes were most often a component of a riparian shrubland community, but could also be found in some wetter mesic wet meadows. Due to the spectral confusion introduced by these mixed communities, they were removed as an independent class and incorporated into a related habitat type. Coniferous and Deciduous Woodland were combined to become Riparian Woodland, and Hydrophytes was incorporated into various shrubland and slough classes, depending on location.

Accuracy Assessment

The accuracy assessment process was completed after a final photo interpretation of the nearest neighbor classification. It was completed before the training data were reintegrated and before the use of landscape features to separate habitat types. The assessment was completed by selecting 30 features of each of the vegetation classes from the set of collected field data. These features were intersected with the nearest neighbor classification and the total acres were summarized. The result is an error matrix that displays errors of omission and commission, as well as overall accuracy.

Final Landcover

Once the accuracy assessment process was completed, the dataset was prepared for distribution. The data were prepared in both hard-copy format and digital format. This includes both vector and raster datasets. The raster data will be integrated into the HABS landcover and used to assess current habitat provided by the corridor and also to develop estimated carrying capacity for species of concern. The summary of the final landcover composition is found in Table 2.

Table 2: Total Acres by Class

LCLU Class	Total Acres	Percent of Total
Ag	979,593.14	49.68%
Upland Grassland	477,456.82	24.22%
Xeric Wet Meadow	147,959.17	7.50%
Rural Developed	71,291.10	3.62%
Riparian Woodland	68,905.08	3.49%
Urban/Suburban	43,297.75	2.20%
Upland Woodland	35,787.17	1.82%
Roads	35,386.40	1.79%
Reservoir	21,545.52	1.09%
Riparian Shrubland	18,976.43	0.96%
Mesic Wet Meadow	15,521.81	0.79%
River Channel	7,866.72	0.40%
Undisturbed Grassland	7,257.03	0.37%
River Shrubland	6,554.51	0.33%
Unvegetated Sandbar	5,534.20	0.28%
Sand Pit	5,360.00	0.27%
Phragmites	4,213.30	0.21%
Bareground/Sparse Veg	4,181.85	0.21%
Canal/Drainage	3,631.97	0.18%
Upland Shrubland	3,570.55	0.18%
River Early Successional	2,533.43	0.13%
Meadow Sand Ridge	2,497.54	0.13%
Stock Pond	1,430.35	0.07%
Lagoon	528.03	0.03%
Irrigation Reuse Pit	345.49	0.02%
Purple Loosestrife	222.49	0.01%
Warmwater Slough	190.76	0.01%
Floodplain Marsh	21.50	0.00%
TOTALS	1,971,660.11	100.00%

ACCURACY ASSESSMENT

An accuracy assessment was completed for the remotely sensed classified vegetation map. As stated earlier, this assessment was completed after the remote sensing classification and photo-interpretation, before the re-integration of the training data and separation of classes based on ancillary landscape data. The accuracy assessment was completed by selecting 30 features from each of the vegetation classes out of the collected field data. These accuracy features were intersected with the remotely sensed nearest neighbor classified vegetation map. The resulting intersected acres were summarized by class, allowing an error matrix and report to be generated (Table 4).

As a whole, the landcover has an accuracy of 98.9%. Because this error matrix is created using acres of samples, it is heavily weighted by the large area of the agriculture class compared to any other class in the study area. Since classification of agriculture was not the focus of this landcover, an overall accuracy of the various other habitat types may also be useful. The overall accuracy of the landcover considered without Ag, Developed, and Water is 82.7%. What follows is a breakdown of individual accuracies by class. These accuracies are also summarized in Table 3.

Agriculture had an overall accuracy of 100%. This high level of accuracy is a result of using the CLU in developing the landcover mask.

Bareground had an overall accuracy of 92.6%. The main contributor to error for Bareground was the Early Successional class. A likely factor in the error is the changing of river channel composition from year to year and a difference of 1-2 years between the collection of the training data and the acquisition of the imagery.

Deciduous Woodland had an overall accuracy of 93.2%. The main contributors to error for Deciduous Woodland are Shrub/Herbaceous and Phragmites. Shrub/Herbaceous is often found mixed within, or bordering, Deciduous Woodlands. Phragmites can often be found on the river side of riparian tree canopies. For these reasons, some of this error can be expected.

Developed had an overall accuracy of 99.9%. Developed areas were derived from the CLU and were photo-interpreted as a part of the creation of the landcover mask and therefore had a high level of accuracy.

Early Successional had an overall accuracy of 74.6%. As explained above, areas of Early Successional change from year to year based on river conditions; therefore the gap in time between training data collection and imagery acquisition is a likely cause of this error. Considered together, Early Successional with Bareground results in an accuracy of 89.2%

Meadow Sand Ridge had an overall accuracy of 79.4%. The largest source of error for the Meadow Sand Ridge was Xeric and Mesic Wet Meadows, which accounted for 20.4% of the error. Meadow Sand Ridges are almost always found as a feature within a Xeric or Mesic Wet Meadow area, so this error is not unexpected. Meadow Sand Ridge was a community seen mostly along the stretch of river from Kearney to Grand Island, and did not result in a large amount of training data. The lack of training data and the relative rarity of the community in the landscape are likely the biggest contributing factors to the lower accuracy.

Table 3: Summary of Accuracy Results by Class

Class	Producer's Accuracy	User's Accuracy	Overall Accuracy
Ag	100.0%	100.0%	100.0%
Bareground	100.0%	85.3%	92.6%
Deciduous Woodland	91.8%	94.5%	93.2%
Developed	100.0%	99.7%	99.9%
Early Successional	61.3%	88.0%	74.6%
Meadow Sand Ridge	59.6%	99.3%	79.4%
Mesic Wet Meadow	56.7%	83.2%	69.9%
Phragmites	62.5%	98.8%	80.6%
Shrub/Herbaceous	96.3%	76.0%	86.1%
Water	100.0%	99.4%	99.7%
Xeric Wet Meadow	97.0%	76.2%	86.6%

Mesic Wet Meadow had an overall accuracy of 69.9%. The largest source of error for Mesic Wet Meadow is Xeric Wet Meadow, which accounted for 24.2%. Mesic Wet Meadow communities are often found within a larger Xeric Wet Meadow community. The boundary between these communities is not discrete, changing or overlapping based on a number of factors (precipitation, soil type, etc). As a result, vegetation species often co-occur and the "boundary" between the two communities can change from year to year.

Phragmites had an overall accuracy of 80.6%. Phragmites had three main contributors to error: Bareground, Early Successional, and Shrub/Herbaceous. Since Phragmites is almost exclusively found in the river channel, it is subject to the yearly change in flows. What is Phragmites one year may be treated or just washed out by high flows the next year and become Bareground or Early Successional. In addition, Phragmites is found in some riparian shrub communities, and this may influence their spectral signatures. The largest factor in this error is likely the gap in time between training data collection and imagery acquisition.

Shrub/Herbaceous had an overall accuracy of 86.1%. The largest source of error for Shrub/Herbaceous was Deciduous Woodland. These two communities often co-occur, with an over-story of Deciduous Woodland species and an understory of Shrub/Herbaceous species. In addition, shrubland communities are often found on the river side of riparian tree canopies. For these reasons, some amount of spectral confusion is likely to have occurred.

Water had an overall accuracy of 99.7%. The high level of accuracy for Water was due to the extensive photo-interpreting done in the creation of the initial mask.

Xeric Wet Meadow had an overall accuracy of 86.6%. The largest source of error for Xeric Wet Meadow is Mesic Wet Meadow. As explained for Mesic Wet Meadow, these two communities often co-occur and some error arises with the fluidity of their boundaries year to year.

Table 4: Error Matrix

Sum of Acres	Field Veg			
Classified Veg	Ag	Bareground	Deciduous Woodland	Developed
Ag	13,197.0120			
Bareground		161.7789	0.0209	
Deciduous Woodland			76.4807	
Developed	1.2241		0.0500	510.4209
Early Successional			0.0415	
Meadow Sand Ridge			0.0024	
Mesic Wet Meadow			0.1024	
Phragmites			0.0455	
Shrub/ Herbaceous			6.2525	
Water			0.0298	
Xeric Wet Meadow			0.2690	0.0046
Grand Total	13,198.2361	161.7789	83.2947	510.4255
Omission Error	100.0%	100.0%	91.8%	100.0%