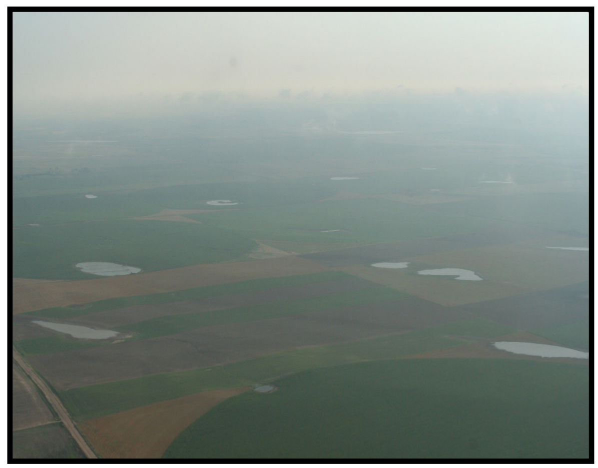
Biological Inventory and Evaluation of Conservation Strategies In Southwest Playa Wetlands

Final Report to the Nebraska Game and Parks Commission and the Playa Lakes Joint Venture



December 2007

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ROCKY MOUNTAIN BIRD OBSERVATORY

The mission of the Rocky Mountain Bird Observatory (RMBO) is to conserve birds of the Rocky Mountains, Great Plains, and Intermountain West and the habitats on which they depend through research, monitoring, education, and outreach. *RMBO practices a multi-faceted approach to bird conservation that integrates scientific research and monitoring studies with education and outreach programs to bring bird conservation issues to the public and other conservation partners. RMBO works closely with state and federal natural resource agencies, private landowners, schools, and other nonprofit organizations. RMBO accomplishes its mission by working in four areas:*

***Research**: RMBO studies avian responses to habitat conditions, ecological processes, and management actions to provide scientific information that guides bird conservation actions.*

***Monitoring**: RMBO monitors the distribution and abundance of birds through long-term, broad-scale monitoring programs that track population trends for birds of the region.*

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Playa in Southwest Nebraska: field shot, RMBO; overview, NGPC.

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Playa ringed with smartweed, in the study area, fall 2006.

EXECUTIVE SUMMARY

This is the Final Report for the Nebraska Game and Parks Commission State Wildlife Grant (SWG) entitled *Biological Inventory and Evaluation of Conservation Strategies in Southwest Playa Wetlands* (T-41 Segment 1). This is also the Final Report for a Playa Lakes Joint Venture (PLJV) Conoco-Phillips grant entitled *Biological Inventory and Buffer Evaluation of Nebraska's Southwest Playas,* which provided matching funds to the SWG.

This project investigated playa wetland hydroperiods, habitat availability, and use by frogs and toads and migrating birds in southwestern Nebraska. In the summer and fall of 2006, we combined radar rainfall data, aerial infrared photography, and 576 on-the-ground surveys of 43 playas to document habitat conditions and bird use following a heavy precipitation event. We also collected water depth information and vegetation cover data for twelve playas. This represents the most comprehensive dataset of vegetation and avian use for playas in this part of Nebraska.

We report findings in relation to our primary study objectives, as follows:

1. Correlate various Geographic Information System (GIS) data layers, including satellite imagery from PLJV, National Wetland Inventory (NWI), Soil Survey Geographic (SSURGO), and aerial photography from USFWS to create a comprehensive map of playas in the region (PLJV Objective 4, SWG Objective 6). Interpretation of the aerial photography also provides feedback on several biological planning assumptions of the PLJV as well as the accuracy of the GIS model of playas in the Bird Conservation Region 18 of Nebraska.

2. Quantify playa hydroperiod responses to precipitation events, playa size, watershed size and condition, buffers, dominant land use, and mapped soil types (PLJV Objective 1; SWG Objective 5).

3. Quantify the diversity and abundance of bird species using wet playas during migration, beginning with fall of 2006, with the addition of spring migration and/or breeding season surveys if funding levels are sufficient (PLJV Objective 2, SWG Objective 1).

4. Analyze the relationship between bird and amphibian use and habitat variables within the wetland and landscape attributes of the surrounding watershed (PLJV Objective 3; SWG Objective 3).

5. Coordinate with the Nebraska Natural Heritage Program to document other species of plants and animals using playas (SWG Objective 4).

6. Describe amphibian species composition and frequency of occurrence in playas, if seasonally appropriate (SWG Objective 2).

This document fully reports the data collected in the summer and fall of 2006. We report only results from the anuran surveys conducted in the spring of 2007, because the rest of the dataset is still undergoing quality assurance and analysis.

Key findings include:

- Revised GIS models estimate 15,389 potential playa locations in the Southwest Playa Complex of Nebraska. This represents a 9% increase in the number of playas and a 33% increase in acreage over the original model.
- Field visits confirmed playas at 56% of the predicted locations. Additional playas were also found during field visits and through interpretation of aerial photography.
- When receiving similar rainfall, playas surrounded by cropland or shortgrass prairie were more likely to become wet than playas surrounded by CRP.
- Playas in our study area remained wet throughout the migratory season and provided water depths appropriate for migratory waterfowl and shorebirds.
- 29,974 birds comprising 106 avian species used playas or adjacent uplands; waterfowl and shorebirds represented 63% and 9% of all birds, respectively.
- Twenty-three Tier 1 and Tier 2 avian species of interest to Nebraska Natural Legacy Project were observed.
- Waterfowl and shorebird numbers were higher on larger playas and playas with a greater percent of flooded habitat. Shorebird numbers were also related to the percent of playa covered in wet mud.
- Frogs and toads were found at 93% of playas surveyed, comprising four species. Night surveys were most effective for determining anuran presence.
- Playas within the study area provided seed-producing annual plants appropriate to the needs of foraging waterfowl and shorebirds in the migratory season. Average percent cover by exotic plants exceeded cover by native plants.

In addition to the research work outlined above, we conducted outreach as part of the project. We presented information about playas, conservation practices and opportunities, and our research at six venues, including the Nebraska Game and Parks Commission's Annual Wildlife Division Meeting, Natural Resource Conservation Service Leadership Meeting, Natural Resource Conservation Service Area Two Meeting, two Nebraska landowner workshops, and the 125th American Ornithologists' Union Meeting.

The study is ongoing, with Phase II support from NGPC and PLJV. Phase II will include analysis of all field data collected in spring, summer, and fall of 2007, including habitat models for both amphibians and birds. We also plan another aerial flight in 2008 (if rainfall is suitable) to collect information on the rate of inundation of playas in various buffer types and to provide additional data for refinement of the GIS model.

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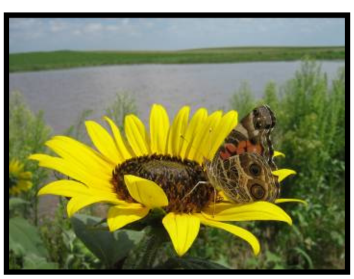
1 INTRODUCTION

Playas are shallow seasonal wetlands that are filled following heavy rainfall events in the short- and mid-grass regions of the Great Plains. Characteristic wet-dry cycles produce rich vegetative and insect resources that form critical migration habitat for waterfowl, shorebirds, and other wetland-dependent species (Skagen and Knopf 1993, Smith 2003). In the Southwest Playa Complex of Nebraska (Figure 1) there are estimated to be over 16,000 playas totaling 21,680 acres (LaGrange 2005). However, due to localized and unpredictable rainfall events, not all playas are wet during an average year (Bolen et al. 1989). Information relating rainfall history to wet playa conditions is lacking, thereby hampering efforts to estimate habitat availability for migratory species (Hands 2005).

An estimated 70% of playas have been degraded due to sedimentation from agricultural landscapes (Smith 2003). Buffers and conservation tillage practices may be effective in reducing sedimentation in playas but the effects of such practices on playa hydrology are unknown. Conservation programs have been made available for buffer implementation, pit removal, and other practices, but there has not yet been an opportunity to monitor the hydrological and wildlife responses to these programs. Understanding the relationship between local and landscape features of playas and habitat use by amphibians and birds will enable landowners, managers, conservation partners, and others to engage in biological and conservation planning and implementation to secure such habitats for wetland-dependent wildlife species of interest into the future.

Playa affected by agriculture

Playas provide many other important wetland functions, including flood mitigation, capturing and filtering surface runoff, recharging the Ogallala aquifer, and enhancing biodiversity on a landscape scale (Pezzolesi et al. 1998, Haukos and Smith 1994). Understanding the relationship between rainfall events, the capture of surface runoff, and the storage of surface water may assist other conservation partners in water resource planning, including evaluating the possibility of using playa restoration and conservation as an offset to water depletions in western Nebraska.



Painted lady butterfly in front of a playa

The *Nebraska Natural Legacy Project* specifically articulates the need to conserve and restore Southwest playas and further states that due to a lack of knowledge about these communities, “there is a need to conduct an analysis of these and other similar types of communities to identify priority sites for conservation action” (Nebraska

Game and Parks Commission 2005). This project addresses this information need by generating abundance and species lists for birds, amphibians, and other species using Playa Wetland and Wheatgrass Playa Grassland communities in the Shortgrass region of Nebraska.

Playas within the study area, August 2007

This project similarly contributes to several high priority research needs of the Playa Lakes Joint Venture, including increasing our understanding of the function of playa buffers, the highest priority research topic for the PLJV. The project also addresses other priority topics identified by the JV, including the monitoring of priority species during migration (high priority), the landscape-scale comparison of well-utilized and non well-utilized wetlands (high), documenting the duration of inundation of individual playas (medium), and comparing the rate of inundation and hydroperiod of playas in different land uses and landscape contexts (medium).

Our primary study objectives are as follows:

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2 METHODS

2.1 Study Approach

Our study region is the Southwest Playa Wetland Complex (LaGrange 2005), located mostly in the Shortgrass Prairie Ecoregion of Nebraska and encompassing the Kimball Grasslands, Sandsage North, and Sandsage South Biologically Unique Landscapes (Nebraska Game and Parks Commission 2005, Figure 1). This also corresponds to most of the Playa Lakes Joint Venture area within southwestern Nebraska (Figure 1). We studied playas within this region in specific study areas as delineated by heavy rainfall.

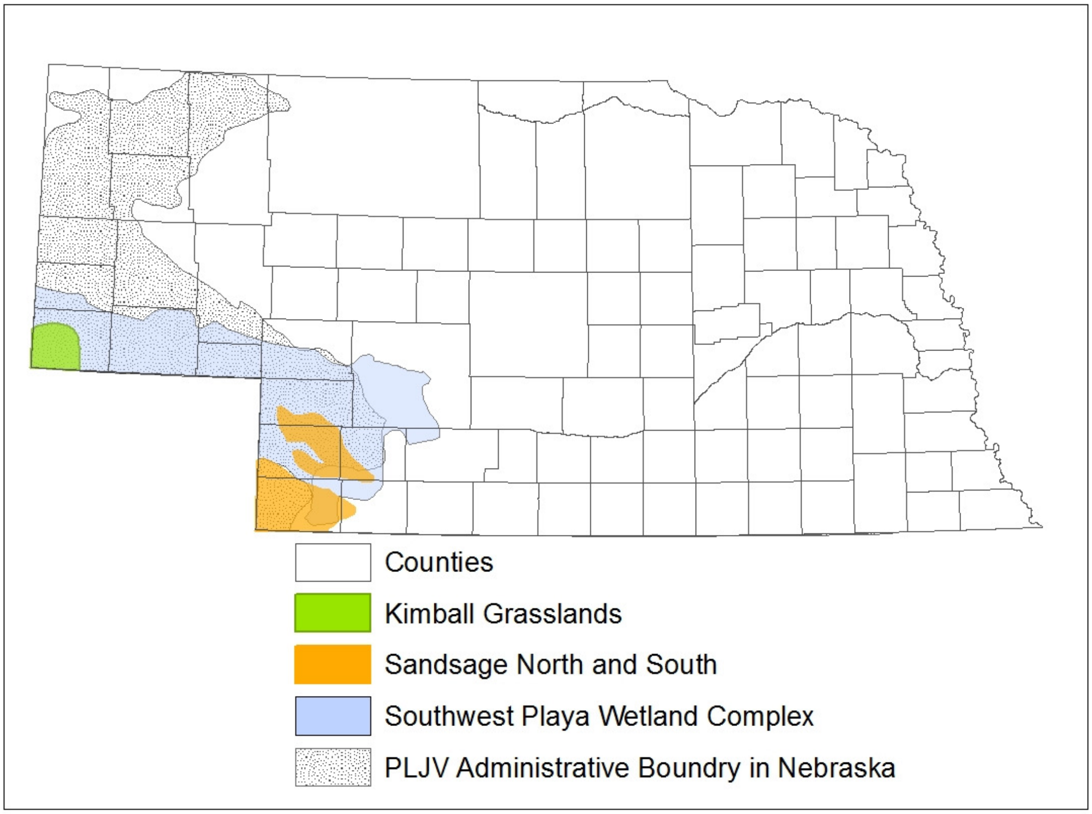

Figure 1. Map showing the Southwest Playa Wetland Complex, PLJV boundary, and Biologically Unique Landscapes in our study area.

In July of 2006, we began monitoring rainfall data within the study region daily at http://www.srh.noaa.gov/rfcshare/precip_download.php, a National Weather Service website that integrates radar and rain gauge data. The first rain event that met our criteria of encompassing at least 40 playas (based on our GIS model) with at least 2 inches of rain (what we estimated as necessary to pond water for several weeks) occurred on August 8. This rain event of up to 4 inches covered approximately 390 square miles in Chase and Perkins counties (Figure 2). A cursory ground survey accomplished by cooperators from Nebraska Game and Parks Commission confirmed the abundance of playas with ponded water in the area. Because of the prohibitive cost of flying the entire area, four smaller units totaling 83 square miles within the rain area were selected for an aerial flight. Flight units were selected to reflect a gradient from 1.5 inches to 4 inches of rainfall and contain cropland, grassland, and CRP landcover types (according to USFWS and PLJV landcover data). On August 14, with the cooperation of the U.S. Fish and Wildlife Service, the area was flown to collect infrared imagery of playa basins.

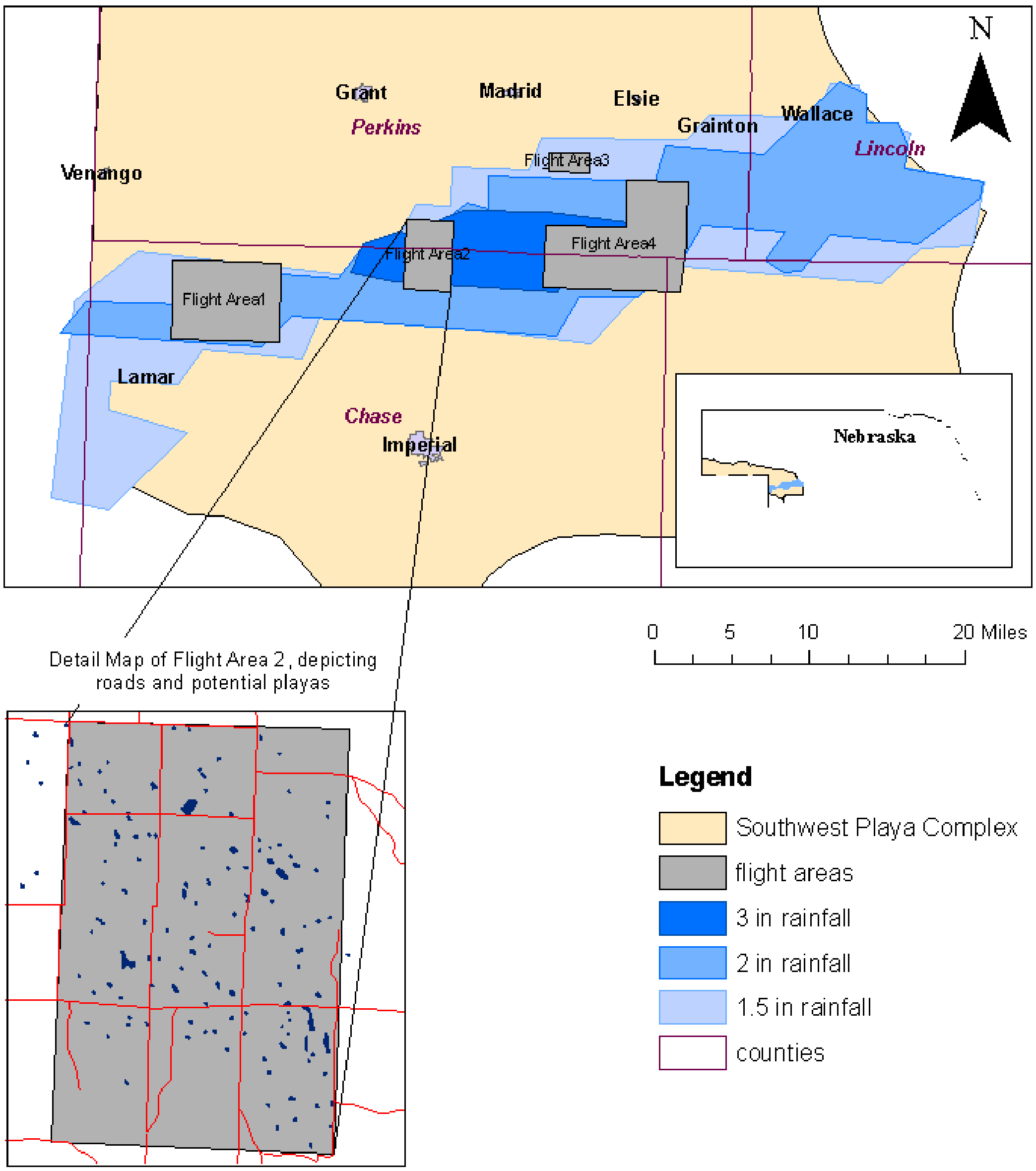

Figure 2. The fall 2006 focus area, showing levels of rainfall received August 8, 2006 and the areas flown August 14, 2006.

2.2 GIS Model

At the initiation of this project, the best model ("original model") of playa occurrence in Nebraska was created by PLJV based upon National Wetlands Inventory data (imagery dates 1981-1982; K. Callahan, PLJV, personal communication). This contained palustrine emergent wetlands with seasonal or temporary water status, with some waterbodies removed, such as those that were associated with riverine systems or those that were "h-modified." The original model contained 16,608 potential playas accounting for 19,157 acres throughout the PLJV in NE. Within the Southwest Playa Complex boundaries (our study area), 14,078 potential playas indicated 16,440 acres of habitat.

In 2006, we compiled a model "Model 2" of potential playas in the study area that added together potential playa polygons from the National Wetlands Inventory (NWI; n=14,078), Soil Survey Geographic (SSURGO; n=2,124), and satellite imagery as interpreted by the Playa Lakes Joint Venture (Landsat; n=1,297). When potential playas were found both in NWI and SSURGO, NWI and Landsat, or all three data sources, the perimeter of the potential playa was represented by the polygon from NWI; when found in SSURGO and Landsat, the SSURGO polygon was used. This was the model we used for selecting playas for field investigation in 2006 and 2007.

In 2007, a third model of playa occurrence ("Model 3") was constructed, based on the acquisition of additional data for the region. Additional potential playa locations (XX representing XX acres) were identified through photo-interpretation conducted by our collaborators at USFWS during a landcover update for the region using National Agriculture Imagery Program (NAIP, 2003-2006). Also during this process, some potential playas from the earlier models were determined not to be playas. In addition, they re-integrated the datasets from NWI, SSURGO, and PLJV Landsat imagery to ensure that playas were not represented more than one time in the dataset. When combining data from the multiple data sources, the perimeter of the potential playa was created by combining all of the polygons to create a new outer boundary. Finally, additional playa basins were identified by photo-interpretation of the Color Infrared Imagery in the flight area. All of this work updated the estimated number of potential polygons in the Southwest Playa Complex and also associated them with landcover types.

2.3 Hydroperiod and Buffer Assessment

To model the proportion of playas that filled from the August 8 2006 rain event, we delineated the amount of ponded water visible in the aerial photography (color infrared, 1 m resolution). Delineated water was then associated with potential playas as mapped in GIS Model 3. To minimize errors derived from a spatial offset among the various source data layers, water polygons that intersected a potential playa polygon were associated with that playa, regardless of whether all of the water was contained within the potential playa polygon. Pits or excavations in playas were delineated separately, so that the acreage of pits could be compared to the acres in unexcavated playas. Some water within playas was delineated as sheetwater, when the GIS analyst was unsure if the water represented a playa basin. We summed pitted, sheetwater, and unexcavated playa acres together to represent the flooded area for each playa. Percent full was calculated by dividing the flooded acreage by the acreage of the potential playa as represented in GIS

Model 3. Ponded water polygons that appeared to be playas but did not intersect a potential playa polygon from Model 3 were considered new playas to the dataset.

To determine hydroperiod length of playas during fall of 2006, for all playas that had any standing water during the initial survey, we conducted weekly or biweekly visits, noting on each visit a visual estimate of the percent standing water. Playas were visited until the end of the migration season (October 31) or until no water remained standing in the playa, whichever came first.

Buffers surrounding playas were extracted from the enhanced PLJV landcover (USFWS 2007) for all playas in the Southwest Playa Complex. In addition, buffers (adjacent land uses surrounding the wetland) were described during field surveys. Buffer types were verified by visually inspecting the aerial photography for a subsample of playas that were also field visited. The amount of area covered by cropland, CRP, or grassland in buffers of 100, 400, 800, and 1600 meters from all playas in the flight areas was determined.

We were not able to estimate watershed sizes for the playas we studied because United States Geological Survey quad maps and 10-meter digital elevation models provided insufficient detail to delineate watersheds in this relatively flat environment. However, the Natural Resources Conservation Service volunteered to delineate watersheds for a number of the playas studied in fall of 2006 in Chase and Perkins counties, using a combination of GIS and fieldwork. When these data become available, we will incorporate them into our understanding of landscape effects on hydroperiod and wildlife use. In addition, once the watershed is delineated we can relate playa hydroperiods to mapped SSURGO soil types within the watersheds. We provide a summary table of the soils associated with playas throughout the study area, but it is the soil of the watershed surrounding the playas that is most important in determining rates of sedimentation. Thus, having watersheds delineated will allow us to better evaluate the effect of soil type on playa hydrology.

2.4 Field Surveys

Our field survey sampling design focused on the area flown to maximize integration of the imagery and field data. An initial examination of the GIS database indicated that 70% of the 460 potential playas within the flight area were less than one acre in size. Because we expected small playas to have shorter hydroperiods than larger playas, we stratified our sampling based on size to maximize the number of repeat surveys per playa. We attempted to survey all potential playas in our GIS model whose boundaries intersected a buffer of 100 m from the road and greater than one acre in size (n=48). We also randomly selected half of the 88 potential playas less than one acre in size and within 100 m of the road for sampling (n=44), for a total of 92 potential playa locations for roadside sampling. Because our initial selection did not yield many playas in non-cropland cover, we also added several potential playas that appeared to be associated with grassland or CRP cover that were within 250 m of roads.

To complement the roadside surveys, we also selected a set of playas that would represent conditions distant from roads; these were within a flight unit, at least 300 m from a road, greater than 1 acre, and had received at least 3 inches of rain. We imposed the latter two conditions to increase the probability that these playas would maintain standing water long enough to provide a rigorous comparison of bird use with playas near the road throughout the fall migration season. This process generated a list of 23 potential playas for contacting landowners for access. We gained access to eight of these playas that were suitable for surveys (contained standing water that was not obscured by standing corn). We opportunistically added to the sample 5 playas that were wet, not obscured by corn, at least 1 acre, and at least 200 m from the road. These 13 playas were surveyed weekly for water depths, vegetation frequency and height class, and bird use, for a total of 5 repeat surveys per playa.

In the spring of 2007, we tracked over-winter precipitation (National Weather Service daily data combined for November and December 2006 and January and February 2007) to target areas for playa sampling in March, where wet playas might provide migratory habitat for waterfowl. We selected several locations within the study area that represented a precipitation gradient and visited potential playas in those areas (Figure 3).

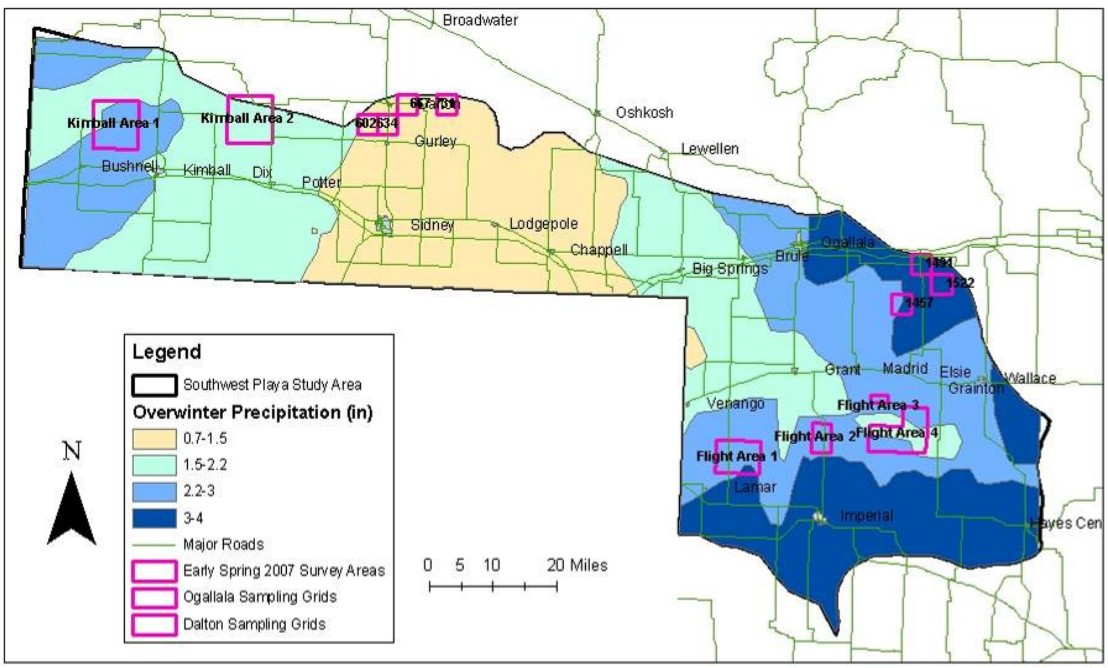

Figure 3. Spring 2007 playa survey locations in relation to total overwinter precipitation.

2.4.1. Initial Visits to Potential Playa Locations

On initial visits to potential playa locations, we assigned each potential playa a status: playa, possible playa, other waterbody, no access, or no visible playa. For this study, we define a playa as a depressional wetland fed by rainfall and runoff that is hydrologically isolated from other natural water bodies in the landscape, particularly stream beds and creeks. Possible playas could not be confirmed at the time of visit, usually due to heavy anthropogenic modification or a tall standing crop. Other waterbodies included reservoirs, feedlot ponds, or stock dams within creek drainages. No access indicated that the road was not passable, was private, or for some other reasons the surveyor was not able to view the potential playa location. No visible playa was reserved for cases when the surveyor was able to view the appropriate location and determined that a playa was not present. Potential playas with unconfirmed status may be investigated further in subsequent seasons and/or by examining aerial photography to attempt to classify these into one of the other categories (i.e., other waterbody, playa, no visible playa).

Photo taken from the roadside on initial visit

For each playa or possible playa, we collected the following information using a standardized field form:

- We marked the location with a handheld Garmin eTrex® Global Positioning System (GPS) unit and recorded the Universal Transverse Mercator (UTM) coordinates;
- We estimated the distance and bearing from the observer to the center of the playa, using a Bushnell Yardage Pro 500 laser rangefinder;
- We took at least one photograph and recorded the location, direction, and a written description for each photograph;
- We estimated playa size by using the rangefinder to measure distance from the observer to the near and far edges of the playa and converting diameter (<100 m, 100-250 m, and >250 m) to area (assuming playas were circular) to classify playas into one of three size classes (<2 ac, 2-12 ac, or >12 ac);
- We documented the relative wetness of playas by classifying the extent of standing water within the playa basin based on visual inspection in the field (> 100% full, e.g., water substantially in roadways; 50-100% areal extent covered by standing water, 1-50% areal extent covered by standing water), documenting indicators of past wetness (dry with hydrophytes present, dry with cracks visible), or noting if the playa was dry (no hydrophytes or cracks visible);
- We recorded the surrounding land use as dryland agriculture (cropland), irrigated cropland, USDA Conservation Reserve Program (CRP), grassland, or other;
- We noted the following agricultural uses in the playa: farmed, grazed, or hayed;
- We noted hydrologic modifications to the playa: pit/excavation, constructed inlet or outlet, impoundment/berm/terrace, and whether a well was present;
- We noted if the playa basin was bisected by a road;
- We estimated the average height of vegetation within the playa (<0.1 m, 0.1- <0.5 m, 0.5 – 1.0 m, and >1.0 m);
- For both the playa and the surrounding upland, we documented the percent cover to the nearest 5% in each of the following categories: bare ground, open water, grass, forb, shrub, cactus, and yucca;
- We documented wildlife use of the playa and the surrounding quarter section. We recorded the number of individuals of each bird species detected by sight and

sound during the survey period. We also recorded the number and species of other wildlife, observed by sight or sign.

2.4.2 Repeat Visits to Wet Playas

We visited the 30 playas verified as wet playas in the initial surveys twice a week from the road August 18 through October 15, 2006 or until they no longer provided standing water. Due in part to a number of smaller subsequent rainfall events in the study area, most playas remained wet throughout the study period. Most playas received 14 repeat surveys each, for a total of over 350 surveys.

Playa in cropland, fall 2006.

At each visit, we conducted a vantage count bird survey (see below). To describe habitat availability, we estimated the percent of the playa basin covered by the following categories: dry ground, dry ground vegetated, dry mud, dry mud vegetated, wet mud (saturated), wet mud vegetated, standing water (inundated), and standing water, vegetated. We also recorded the interspersion pattern of the vegetation.

2.4.3. Bird Surveys

For playas surveyed from the road, observers used binoculars and spotting scopes to survey all of the birds seen or heard from their vantage point. All birds detected during the duration of the survey were recorded.

For all surveys, we noted if bird numbers were estimated. When possible, we recorded the habitat association of each bird, using the categories described above (e.g. dry vegetated, wet mud not vegetated, open water, upland). We also recorded the activity of the birds, including bathing, drinking, flushing, foraging, resting, preening, flyby (low flight near playa), flyover (high flight probably unassociated with playa), and other. If individuals of some species could not be identified, they were classed into groups (e.g., Greater and Lesser Scaup [*Aythya marila* and *A. affinis*], Greater and Lesser Yellowlegs [*Tringa melanoleuca* and *T. flavipes*], small sandpipers in the genus *Calidris*).

For each bird survey, the beginning and end times and weather conditions including temperature, wind speed using the Beaufort scale, and cloud cover were recorded.

For the playas we surveyed >200m from roads, we employed a form of double sampling adapted from Farmer and Durbian (2006), who applied similar methods for surveying shorebirds on wetlands in Missouri. Field crews of one or two observers conducted a vantage survey followed directly by a flush survey to compare data collected by each technique. Observers minimized the time elapsed between vantage surveys and flush surveys in order to minimize entrances and exits of birds from the site during the surveys. Protocols for the survey methods were as follows:

Vantage survey: Monitor used spotting scope from remote vantage point to survey birds, attempting not to flush any birds. The spotting scope was positioned such that as many birds as possible (preferably all) could be surveyed from the vantage point location. The observer panned from one side of the wetland basin to the other, counting individuals of a given species. The observer repeated this action for each species, until the impoundment was fully surveyed. If few birds were present (e.g., < 50) in the wetland, the panning method was still used, but tallying was done all at once rather than with repeated pans for each species.

Flush survey: Following the vantage survey, surveyor(s) walked through or around the wetland flushing any birds, using binoculars or direct observation to identify and do a full re-count of all birds.

We noted if birds arrived, were present throughout, or exited during the survey period, to facilitate comparison of the two survey methods. We also tallied all birds seen by both methods into a "best count" for the day.

2.4.4. Hydrologic Profiles

For playas for which we gained access, we conducted surface hydrologic surveys to measure water depths for six weeks from September 7 through October 15, 2006. We visited each playa six times, except for two playas that dried during the season and therefore were only sampled three and four times, respectively, and two playas that were only sampled five times. One playa was surveyed twice in one week, for which we present the mean of the two surveys. In total, we report on 73 surveys. A mean of 46.57 ± 1.71 points were recorded for each survey.

We measured water depths while walking four transects across each basin. The transects were placed by pacing a baseline across one edge of the playa, dividing the distance by five, and then walking across the playa in four equally-spaced transects perpendicular to the baseline.

Hydrological monitoring along a transect.

Measurements of water presence and depth and vegetation presence and height were taken at the playa edge and every 10 m (by pacing) thereafter along each transect. Each point was classified as dry, saturated (damp to the touch but no standing water), or wet. For wet points, the depth of standing water was measured to the nearest 0.5 cm. by reading a meter stick at arm's length. Each point was also classified as vegetated if a 0.5 m radius around the observer was at least 25% covered by vegetation (an amount of vegetation we estimated to correspond to providing cover and visual obstruction for birds). We also recorded vegetation heights in categories as follows: A (0-20cm), B (20-50cm), C (50-100cm), and D (>100cm).

2.4.5. Vegetation Sampling

We characterized plant species composition using a 1 m^2 frame. Ten to fifteen plots per playa were used to characterize the vegetation within the playa basin. Ten plots were placed around the perimeter. If upon visual inspection plant composition differed between the basin and the perimeter, five additional plots were sampled in the center of the playa. Several plots were photographed, including those representing dominant plant species.

Once the frames were in place, each cover type was categorized into one of six cover classes: 1=0-5%, 2=5-25%, 3=25-50%, 4=50-75, 5=75-95% and 6=95-100%. Total percent cover could exceed 100% in some cases due to layering.

1 m^2 plot for estimating canopy cover.

In addition to percent canopy cover for each plant species, we estimated cover for litter, bare ground, open water and unknown residual. Plants were identified to species when possible. Any unknown plants were collected, labeled, pressed, and identified by local botanical expert Don Hazlett (of New World Plants and People). Plants in the genus *Carex*, *Juncus,* and *Eleocharis*, were generally not identified to species. Before leaving the area, observers scanned the entire wetland to see if there were additional plant species not found on the sampled plots. These species were recorded on the form and if unknown, they were collected for later identification.

2.4.6. Other Species Surveys

We were given the names of the following at-risk species of plants to look for by Gerry Steinauer of NGPC: Eared redstem *(Ammannia auriculata),* Texas Bergia *(Bergia texana),* Shortseed waterwort *(Elatine brachysperma),* Purple spikerush *(Eleocharis atropurpurea),* Blackfoot quillwort *(Isoetes melanopoda),* Lowland rotala *(Rotala ramosior), Schoenoplectus saximontana,* and Poison suckleya *(Suckleya suckleyana).* No faunal species were recommended to us for special survey effort.

2.4.7. Anuran Surveys

In the spring of 2007, both nocturnal and diurnal surveys were used for frogs and toads. The protocol used for nocturnal calling surveys was shared with us by Mike Fritz of NPGC and was utilized to collect data in previous anuran surveys in Nebraska. Nocturnal surveys were to take place during three windows of time: April 1-May 4, May 7-June 4, and June 13-July 10. During each of these periods, directly following a rain event, we surveyed all wet playas in our roadside study group in Chase, Perkins, and Keith counties. We conducted surveys of 87 playas on April 26-30, 65 playas May 20-24, and 75 playas June 18-23. Surveys began thirty minutes after sunset, with temperatures above 40 degrees Fahrenheit and wind speeds <15mph. The average temperatures during the three survey periods were 16 ºC, 21 ºC, and 24 ºC, respectively.

Woodhouse's Toad found on a playa

Our staff noted the weather conditions in the prior 48 hours, playa location, playa identification number, distance and direction to the playa from the survey point, distance from the last playa surveyed, current air temperature, wind speed, sky conditions and start time. We also recorded a noise index as a measure of background noise, noted using a scale of 0-4, ranging from no appreciable effect to profoundly affecting sampling ability. Observers waited two minutes after arriving to record detections. Species were recorded with their call frequency ranging from 1 (individuals can be counted, no overlap) to 3 (full chorus). After three minutes a line was drawn across the data sheet and all species heard for the next two minutes were recorded to provide datasets comparable to other studies. All data were recorded on the data sheet and with a digital recorder. To ensure data quality, digital recordings were sent to Mike Fritz at NGPC for species verification.

We conducted daytime anuran surveys at all playas visited for bird surveys (March – June, n = 121). All species heard calling during the survey period were recorded.

2.5 Data Processing and Analysis

We entered all of the field data digitally into a *MS Access* database specifically designed for this project. Data management included standardizing nomenclature for birds and plants, searching for missing data records, and proofing the data in multiple queries. Ten percent of all of the datasheets were re-examined for accuracy in data entry. At least 90% of that sample was required to be correct. Failure to meet this criterion triggered a 100% proofing of all datasheets containing similar data. Data analyses were conducted using *MS Access*, *MS Excel*, *Program R*, and *Jump®In 4.0.4* (SAS Institute Inc. 2001).

2.5.1. Hydroperiod and Buffer Assessment

We developed a regression model to understand what variables influence playa hydrology. Because of difficulty in matching up the basins delineated by the GIS model with the wet basins in the photography, and because of the prevalence of dry playas (i.e., 0% wet; n = 287 of 707) we decided to use as a response variable whether the playa was wet or dry (rather than the percent wet) following the August 8 2006 rainfall event. All playas with percent wet greater than zero, according to photo-interpretation, were classified as wet. We ran a nominal logistic regression with the predictive variables as amount of precipitation, surrounding landcover type, and playa size. The amount of precipitation was calculated by smoothing the National Weather Service data (from a 4 km grid) and associating the smoothed value with each from playa in the analysis n = 707). The landcover type had three levels: cropland, shortgrass, and cultivated cropland (CRP); grassland was the reference level to which the other two levels were compared. Playa sizes ranged from 0.08 to 25.20 acres, but 63% were less than one acre in size (median = 0.59 ac). Therefore, we used log-transformed acres in the model.

2.5.2. Avian Use

At-risk species were Tier 1 and Tier 2 species, as reported in the Nebraska Natural Legacy Project: A Comprehensive Wildlife Conservation Strategy (Schneider et al. 2005).

We estimated avian abundance and species richness from 490 bird surveys at 55 playas. For playas surveyed by both a vantage count and a flush count on a particular date, we used the “best count” which combined data from both surveys.

If bird surveys were completed on a playa on more than one day within a week, we averaged the data for analysis. We then divided bird abundance estimates by acreages from GIS Model 3 to calculate bird density estimates for each survey week. To observe differences in bird use between playas in the interior part of the landscape versus playas along the road we compared vantage counts using a Wilcoxon Rank Sum Test.

Roadside vantage count using binoculars and spotting scope

To describe the response of shorebirds and waterfowl to wetland conditions on our study playas throughout fall migration in 2006, we developed a series of non-linear regression models. We predicted that playa size, percent of open water in the playa, and percent wet mud in the playa would affect bird use. A likelihood ratio test for over-dispersion indicated that we should use a negative binomial distribution to adjust the error structure of our models. We used an information theoretical approach to select the best model from a set of candidate models. Due to small sample sizes, an adjusted Akaike's information criterion (AIC_c) was used. Relative variable importance was assessed using Akaike weights over the subset of models that included a given variable (Burnham and Anderson, 1998).

2.5.3. Hydrologic Profiles

For every week during which hydrology transect data were taken, we provide the mean percent of each playa in each cover type class. Secondly, we report the mean water depths for areas that were flooded (i.e., excluding water depths of zero). Third, we summed all of the plots per wetland and generated a proportion in each water depth class. We also calculated proportions of sites that were classified as vegetated and unvegetated within each of the water depth classes.

We combine water depths and vegetated to describe habitat conditions for shorebirds and waterfowl, based on previous research on migrating shorebirds and waterfowl that we conducted on the South Platte River in Colorado (Cariveau and Risk 2007). Our work suggested that shorebirds preferred habitat that was unvegetated (vegetation cover less than 25%), saturated soil (mud), or with water 0-4 cm deep, with a lesser preference for water depths 10-20 cm deep. Waterfowl preferred water less than 40 cm deep, without a preference for unvegetated areas.

2.5.4. Vegetation

Plants were classed as annual or perennial, native or exotic, and according to their wetland indicator status as defined in the United States Department of Agriculture national PLANTS database http://plants.usda.gov/ (USDA, NRCS, 2007). We categorized each plant species into one of five wetland groups according to wetland indicator status (1=obligate wetland, 2=facultative wetland, 3=facultative, 4=facultative upland, 5=obligate upland) as defined in the 1987 *Wetland Delineation Manual* (Environmental Laboratory 1987) and listed in the *National List of Vascular Plant Species that Occur in Wetlands* (Reed 1988). If available, we used the USDA Region 5 indicator status rather than the national status. We also used the USDA PLANTS Database to categorize the status of plants as annual or perennial, native or introduced, and noted if they were invasive or noxious weeds. Because some plants were identified only to genus, not all plants were categorized. We calculated mean percent cover for each species within each playa using cover class midpoints.

Seeds from alfalfa and curly dock, good seed sources for waterfowl.

3 RESULTS

3.1 GIS Model

When combining data to create Model 2, we added 529 playas (3,872 ac) from SSURGO data and 299 playas (650 ac) from the potential playas delineated in Landsat imagery. Model 2 included a total of 14,906 potential playas available for ground-truthing, a 6% increase over the number of playas predicted by NWI alone (original model). Model 2 contained 20,963 acres of potential playas, a 28% increase over the original model.

In Model 3, 279 potential playas were removed due to overlaps or lack of playa characteristics and 762 new potential playas were added from landcover photo-interpretation (Table 1). This yielded a new estimate of 15,389 playas in the Southwest Playa Complex, a 9% increase over the number of playas and 33% increase in acreage over the original model. Playa sizes are depicted in Table 1; playas delineated by SSURGO averaged larger than the other datasets.

Table 1. Numbers and acreages of potential playas in GIS Model 3, by data source.

Data Source	Number	Total Acres	Mean (SE) Acres
NWI	14,078	16,440	1.17 (0.02)
SSURGO	529	3,872	7.32 (0.31)
Landsat	299	650	2.17 (0.17)
NAIP	762	613	0.81 (0.03)
Model 3 Combined	**15,389***	**21,830**	**1.42 (0.02)**

*Total of the four data sources above minus the 279 polygons that were removed

If we apply a 56-67% confirmation rate (see section 3.2 below) to the number of potential playas in Model 3 and assume that the model is not missing any real playas, this would equal an estimated 8,618 -10,311 playas (12,225-14,626 ac) in the Southwest Playa Complex. However, we know that some additional playa exist in the landscape that are not included in the GIS model. For example, an additional 215 playas were identified in the examination of the aerial photography, and four during field visits in fall of 2006.

We delineated 70 playa pits in the aerial photography, which totaled 23 acres. We also delineated 364 playa ac (n = 462) and 11 ac of sheet-water (n = 36). Wet playa acres totaled 398 acres, 38% of the 1,039 ac of playas mapped by GIS Model 3 within the flight area. Pitted acres accounted for 6% of the wet playa acres identified, and 2% of all acres.

3.2 Playa Hydroperiods and Buffer Evaluation

To compare our field descriptions of playa hydrology with the attributes observed in the aerial photography, we compared playas visited within 10 days of the flight (n=36 with data from both sources; Table 2). Overall, our field hydrologic categories matched the photo classifications 69% of the time. When we simplified it to whether or not playas were wet, two playas classified in the field as wet were indicated as dry in the photography, and one playa that we thought was dry in the field was indicated as wet in the photography, for a 92% concurrence of whether or not a playa had become wet.

Table 2. Hydrologic characterization of playas by field surveys compared to classification of percent wet of playas by interpretation of the aerial photography.

	Aerial Photography Classification		
Field Characterization	> 50% full	1-50% full	dry
> 50% full	16	7	1
1-50% full	1	1	1
dry	8	1	0

Based on the aerial photography, a lower proportion of playas in CRP became wet (16%) in response to the rain event than did playas in grassland (39%) or cropland (42%) (Pearson chi-square = 9.80, p = 0.007; Figure 4).

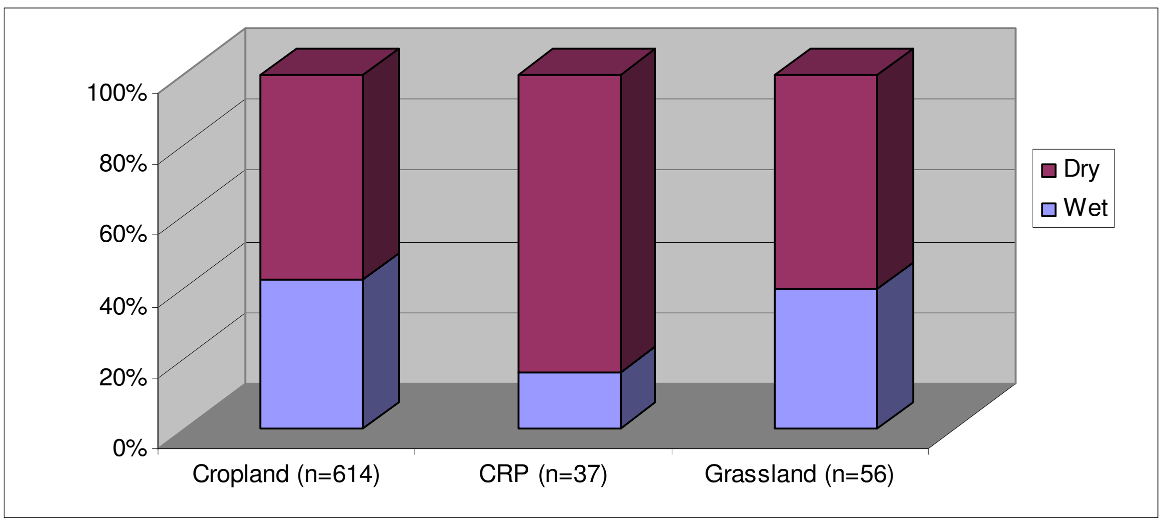

Figure 4. The percent of playas that became wet following the August 8, 2006 rain event, for playas in different buffer types in Chase and Perkins counties, NE.

Larger playas were more likely to become wet following the rain event (Pearson chi-square = 78.49, p < 0.001; comparing three size classes: small, 0.08 - 0.38 ac, n=235; medium, 0.38 – 1.14 ac, n=236; and large, 1.14 - 25.2 ac, n=236; Figure 5). Playas that received more rainfall also were more wet ($R^2 = 0.02$; $F_{1, 705} = 13.33$, p = 0.003).

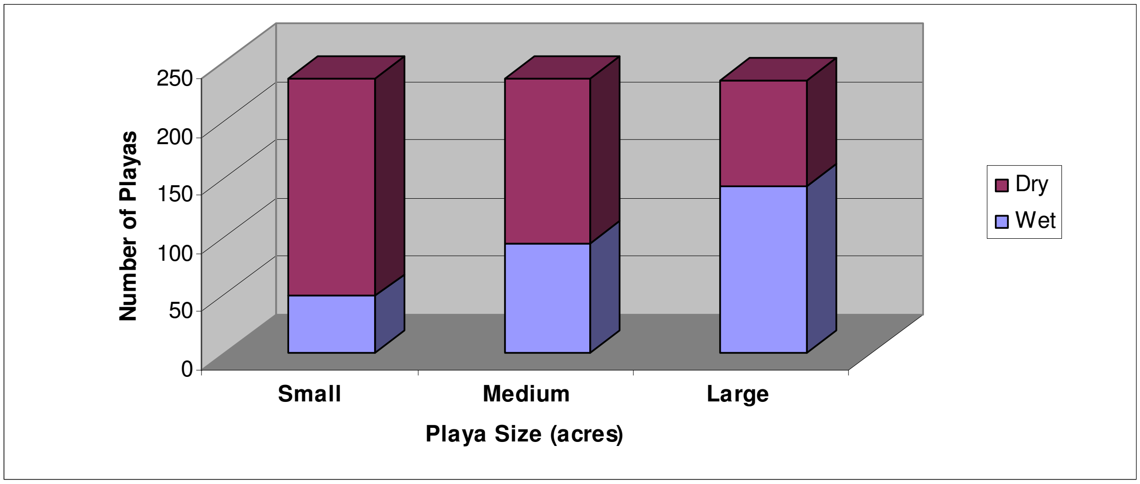

Figure 5. Number of playas in three size classes that became wet or stayed dry following the August 8, 2006 rain event in Chase and Perkins counties, NE.

The multiple logistic regression model was significant ($R^2 = 0.11$; chi-square = 108, $p < 0.001$) with acres, rainfall, and buffer type all significant in the model. Larger playas with more rainfall were more likely to be wet, while playas in CRP were less likely to be wet (Table 2).

Table 3. Parameter estimates for logistic regression model, where Intercept represents LOCATION [Grassland].

Term	Estimate	Std Error	Chi-Square	Prob>ChiSq	Odds Ratio
Intercept	-1.61	0.35	20.97	<.0001	.
Log_Acres	1.67	0.19	75.86	<.0001	65.81
aug08rainfall	0.42	0.12	12.61	0.0004	4.27
LOCATION[Ag]	0.42	0.19	4.79	0.0286	2.34
LOCATION[CRP]	-1.15	0.33	11.78	0.0006	0.10

We documented hydroperiod length for twenty-nine playas that were tracked from the beginning of the study season and received at least seven repeat visits. Eighteen playas (62%) remained wet from August 14 through October 31, representing a hydroperiod length of at least 77 days. Eleven playas (38%) were dry on the final visit; however, all were still wet on the penultimate visit (~October 24). When we averaged the last date with wet conditions with the final date with dry conditions, the average hydroperiod length = 62 ± 2 days. Study playas received additional rainfall throughout the study season, and throughout the Southwest Playa Complex over forty percent of playas received at least 1 inch of precipitation each month (Figure 6). Only one playa in this set was classified as within shortgrass, so the data were insufficient for determining if surrounding land use affected hydroperiod length.

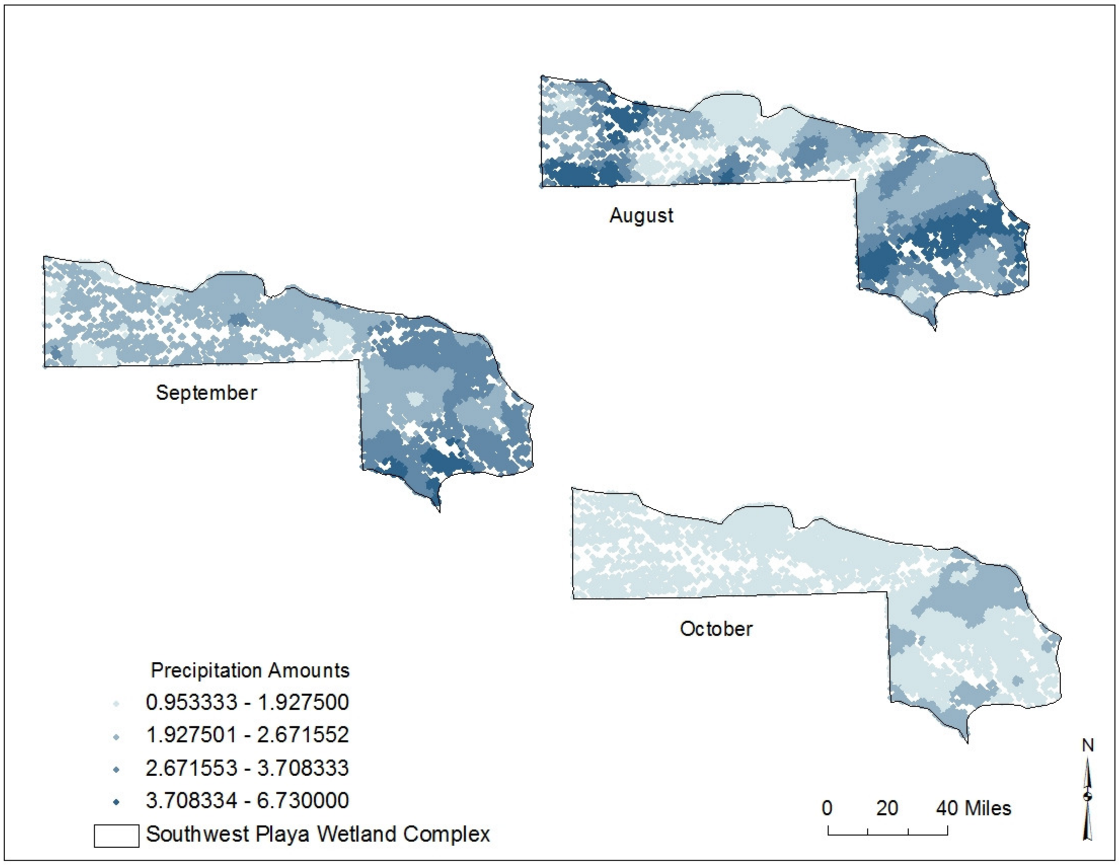

Figure 6. Amount of rainfall in Southwest Playa Complex, fall 2006.

3.3 Playa Field Attributes

In the fall of 2006, we attempted to visit 119 potential playa locations predicted by our GIS model. We were unable to access 20 of these because roads were not present or were private (see Figure 7). Of the 99 we accessed, we verified 55 (56%) as playas in the field. We classified eleven locations as "possible playas." If we also include those locations as playas, the confirmation rate would be 67%. We found no visible playa at 31 locations and other waterbodies at two locations. One location classified as "no visible playa" in fall 2006 was re-classified as a playa when we re-visited in spring of 2007. Thus, some of the "no visible playa" locations may also be found to be playas if visited again in the future. In fall of 2006, we also found six additional playas in the field that were not in GIS Model 2.

Of the 55 playas visited in 2006, we found that 44 were tilled, two were pitted or excavated (one of which was also impounded) and none were apparently grazed, hayed, contained a well, or a constructed inlet or outlet. Of the 11 potential playa locations given the status of possible playa, four were tilled, one was grazed, and one had a constructed inlet or outlet and was impounded. The mean size of wet playas that we sampled in the field in fall of 2006 was 1.81 ± 0.29 acres (n=47).

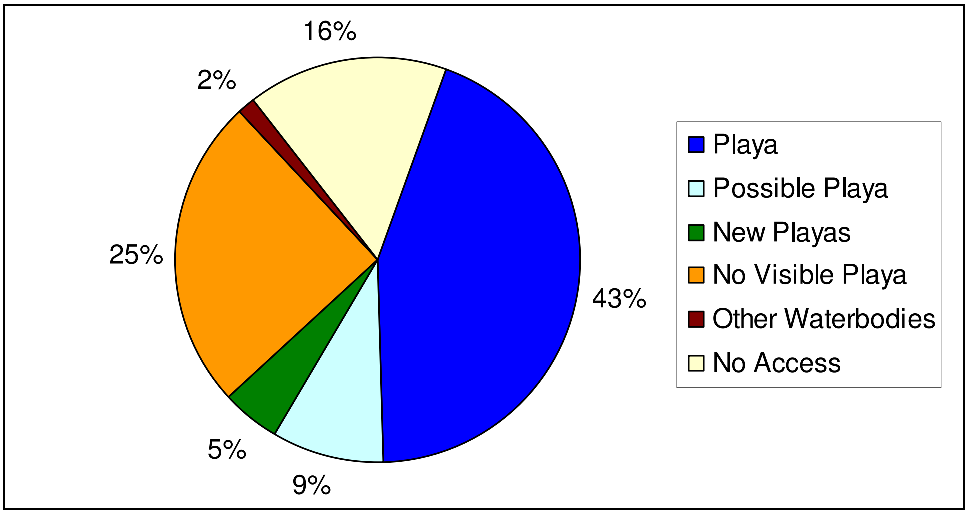

Figure 7. The status of potential playa locations visited in fall of 2006.

3.4 Avian Use

Abundance and Guild Composition

In the fall of 2006, we documented 29,974 birds comprising 106 avian species using playas or adjacent uplands (Appendix A). Waterfowl were most abundant, with twelve species representing 63% of all birds surveyed. Sixty-three species of landbirds were observed, comprising 27% of all birds detected. Twenty-two species of shorebirds represented 9% of birds surveyed. Nine species of waterbirds, including secretive marsh birds and wading birds, comprised 1% of all detections. The five most abundant species within each major guild are listed in Table 3.

Table 4. The five most commonly observed species within four bird guilds, fall of 2006.

Guild	Species	Number
Waterfowl*	Mallard	5,818
	Northern Pintail	2,491
	Green-winged Teal	917
	Blue-winged Teal	523
	Northern Shoveler	325
Shorebirds	Killdeer	1,596
	Lesser Yellowlegs	234
	Baird's Sandpiper	214
	Wilson's Snipe	166
	Least Sandpiper	158
Landbirds*	Horned Lark	1,169
	Yellow-headed Blackbird	778
	Red-winged Blackbird	777
	Barn Swallow	662
	Brown-headed Cowbird	497

Waterbirds	Sandhill Crane	148
	Black Tern	51
	Pied-billed Grebe	40
	American Coot	25
	Great Blue Heron	9

*We also recorded 7,591 undifferentiated teal species, 1,008 unidentified ducks, and 1,200 undifferentiated blackbirds.

Species of Interest

In the fall of 2006, we detected three Tier I and nineteen Tier II avian species of interest to the Nebraska Natural Legacy Project (Table 4). In addition, our field surveyors observed Canvasback, Mountain Plover, Short-eared Owl, and Western Grebe incidentally in the study area. We also documented several species rare for the area, including American Golden-plover (*Pluvialis dominica*) and Yellow-crowned Night-heron (*Nyctanassa violacea*) using playas, as well as Buff-breasted Sandpiper (*Tryngites subruficollis*) incidentally.

Table 5. At-risk bird species documented on playa surveys, fall of 2006.

Tier	Common Name	Scientific Name	Number Observed
I	Brewer's Sparrow	*Spizella breweri*	1
	Burrowing Owl	*Athene cunicularia*	24
	McCown's Longspur	*Calcarius mccownii*	16
II	American Avocet	*Recurvirostra americana*	1
	American Wigeon	*Anas americana*	105
	Black Tern	*Chlidonias niger*	51
	Brewer's Blackbird	*Euphagus cyanocephalus*	133
	Chestnut-collared Longspur	*Calcarius ornatus*	469
	Cinnamon Teal	*Anas cyanoptera*	6
	Cooper's Hawk	*Accipiter cooperii*	6
	Dark-eyed Junco	*Junco hyemalis*	8
	Lesser Scaup	*Aythya affinis*	1
	Merlin	*Falco columbarius*	2
	Northern Harrier	*Circus cyaneus*	38
	Peregrine Falcon	*Falco peregrinus*	2
	Prairie Falcon	*Falco mexicanus*	1
	Sandhill Crane	*Grus canadensis*	148
	Savannah Sparrow	*Passerculus sandwichensis*	272
	Swainson's Hawk	*Buteo swainsoni*	5
	White-faced Ibis	*Plegadis chihi*	1
	Willet	*Tringa semipalmata*	3
	Wilson's Snipe	*Gallinago delicata*	166

Densities and Species Richness

Waterfowl were found at an average density of 40.99 birds per acre, per survey, across the entire season (SE = 7.56; range = 0.14 – 503 birds/ac). Shorebirds averaged 3.43 birds/ac (SE = 0.67; range = 0.08 – 59 birds/ac). The average densities of shorebirds and waterfowl were not significantly different between roadside and interior playas (W = 175, p = 0.11).

Waterfowl and shorebird densities and species richnesses varied throughout the migration season. Waterfowl counts were highest during weeks 34 and 36 (August 22-25 and September 4-8), with very low numbers of waterfowl from the end of September on (Figure 8). Species richness of waterfowl was highest in week 37 (September 10-15; Figure 9). Shorebird numbers were highest in late August and dropped to fewer than one bird per acre after mid-September (Figure 10). Average species richness of shorebirds declined throughout the study period (Figure 11).

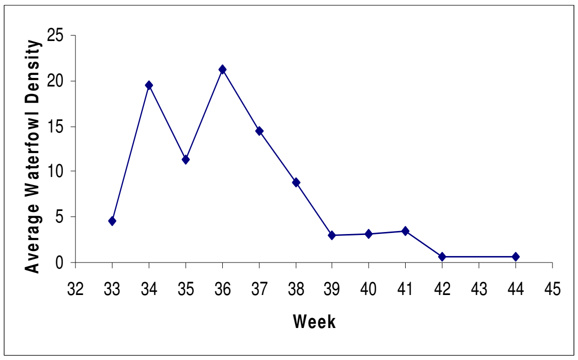

Figure 8. Waterfowl densities throughout fall migration.

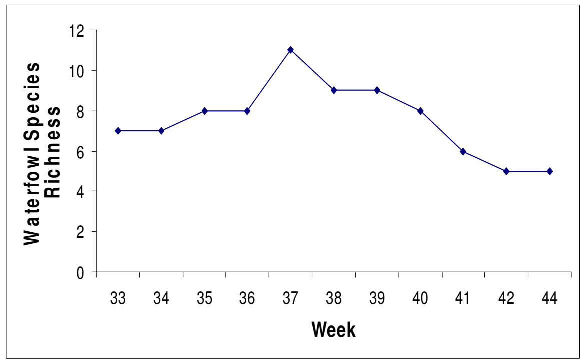

Figure 9. Waterfowl species richness during fall migration.

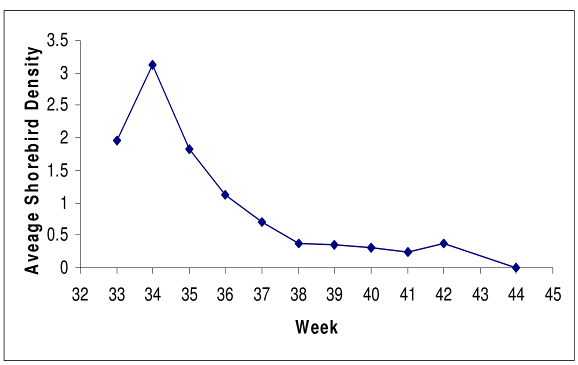

Figure 10. Shorebird densities throughout fall migration.

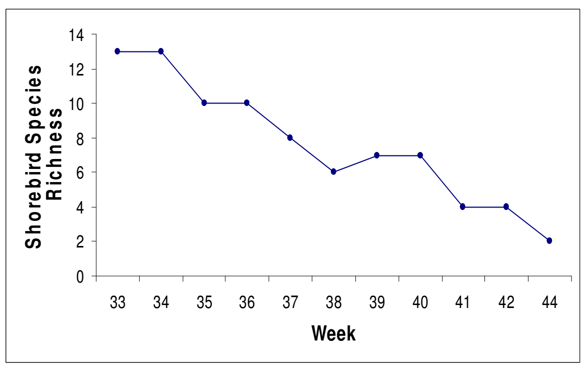

Figure 11. Shorebird species richness during fall migration

3.5 Habitat Use Models

Fall avian use models were developed for shorebirds and waterfowl using roadside playas (n=29). Model 1 for shorebirds was determined best among the seven candidate models (Table 6).

Table 6. Regression models of shorebird use of playas, Southwest Playa Complex, fall 2006.

Model No.	Model	K	AICc	Δ AICc	W_i
1	Count~Area+Wet+Wet Mud	4	231.34	0.00	0.35
2	Count~Area+Wet Mud	3	231.83	0.49	0.27
3	Count~Area+Wet	3	232.83	1.48	0.17
4	Count~Area	2	234.62	3.27	0.07
5	Count~Wet+Wet Mud	3	234.06	2.71	0.09
6	Count~Wet Mud	2	235.27	3.93	0.05
7	Count~Wet	2	237.04	11.88	0

K=number of parameters, AIC_c=Akaike's Information Criterion, Δ AIC_c= delta AIC, W_i = Akaike Weights.

Akaike weights (W+) were used to obtain the relative importance of variables for the bird use models. In the shorebird models playa area (W+ = 0.86) was ranked the highest followed by percent wet mud (W+ = 0.76) and percent of open water (W+ = 0.61).

Model 1 indicates that playa area has the highest mean response compared to percent wet mud and percent open water (Table 7).

Table 7. Coefficient estimates for factors in the model of shorebird use of playas.

Variables	Estimate	Standard Error	*p*
Intercept	1.47	0.46	0.00
Area	0.20	0.09	0.03
Percent Standing Water	0.02	0.01	0.16
Percent Wet Mud	0.04	0.02	0.05

Fall waterfowl abundance appeared to be related to playa size (area), percent open water, and to a lesser extent, wet mud (Table 8). We selected Model 1 that contained playa area and percent open water (Wet) as the best model.

Table 8. Regression model of waterfowl use of playas, Southwest Playa Complex, fall 2006.

Model No.	Model	K	AICc	Δ AICc	Wi
1	Count~Area+Wet	3	196.61	0.00	0.30
2	Count~Area	2	197.27	0.66	0.22
3	Count~Area+Wet Mud	3	196.79	0.18	0.28
4	Count~Area+Wet+Wet Mud	4	197.67	1.06	0.18
5	Count~Wet	2	202.93	6.32	0.01
6	Count~Wet+Wet Mud	3	204.16	7.55	0.01
7	Count~Wet Mud	2	205.71	9.09	0.00

K=number of parameters, AIC**c**=Akaike's Information Criterion, Δ AIC**c**= delta AIC, W_i = Akaike Weights.

Akaike weights (W+) indicate that Area was the most important variable in the waterfowl model, followed by percent open water (Wet) and wet mud (Area W+ = 0.98, Wet W+ = 0.50, Wet Mud W+ = 0.47).

Table 9. Coefficient estimates for factors in the model of waterfowl use of playas.

Variables	Estimate	Std. Error	p
Intercept	-0.41	0.66	0.53
Area	0.75	0.14	0.00
Wet	0.03	0.02	0.07

3.6 Anurans

We detected anurans at 88 (93%) of the 95 playas surveyed nocturnally during the season. Of the same 95 playas, we detected anurans at only 57 (60%) using daytime surveys. Nocturnal surveys detected more than twice the percentage of playas containing Western Striped Chorus Frogs, Woodhouse's Toad, Great Plains Toad, and Plains Spadefoot Toad in comparison to diurnal surveys (Table 10). Forty percent of playas surveyed using both techniques showed no anurans present during the day but did have anurans present during nighttime surveys, while at only two playas did daytime surveys detect anurans when nighttime surveys did not. In playas surveyed using both techniques, nocturnal surveys detected all species known to be present 90% of the time while diurnal surveys detected all species known 15% of the time. Daytime surveys most often detected Western Striped Chorus Frogs and Great Plains Toads (Table 10).

Table 10. Percent of playas occupied by each species throughout sampling period.

Common Name	Scientific Name	Nocturnal	Daytime
Western Striped Chorus Frog	*Pseudacris triseriata*	73	36
Woodhouse's Toad	*Bufo woodhousei*	48	2
Great Plains Toad	*Bufo cognatus*	77	14
Plains Spadefoot Toad	*Scaphiopus bombifrons*	51	9

Great Plains Toad and Western Striped Chorus Frog appeared to be most abundant in the study area, followed by Plains Spadefoot Toad and Woodhouse's Toad (Table 10). Three other species (Northern Cricket Frog *Acris crepitans;* Western Gray Tree Frog, *Hyla chrysocilis*; and Bullfrog, *Rana catesbeiana*) were reported once each, but none were confirmed by recordings and we are assuming these were misidentifications.

Anurans were detected in the greatest percentage of playas during the first and third survey periods (Table 11).

Table 11. Percent occupancy of playas by anurans according to survey period.

	Percent of Playas with Anurans	
Survey Period	**Nocturnal**	**Diurnal**
March (pre-)	N/A	11
1. April 1-April 30	86	31
2. May 7-June 4	59	24
3. June 13-July 10	85	32
Entire Season	**94**	**45**

We analyzed call frequencies across the season as an index to the relative abundance of each species (Figure 12). Data on Western Gray Tree Frog, Bullfrog, Northern Cricket Frog and Plains Leopard Frog were not analyzed because two or fewer records existed for each of these species. Both the Great Plains Toad and Plains Spadefoot Toad peaked in April and decreased in abundance as the season advanced, with the Plains Spadefoot Toad undetected during the June 13-July 10 window of observation. Western Striped Chorus Frog abundance peaked during May with an average call frequency only slightly above 1 during April and June. Woodhouse's Toad abundance declined slightly in May but increased in June.

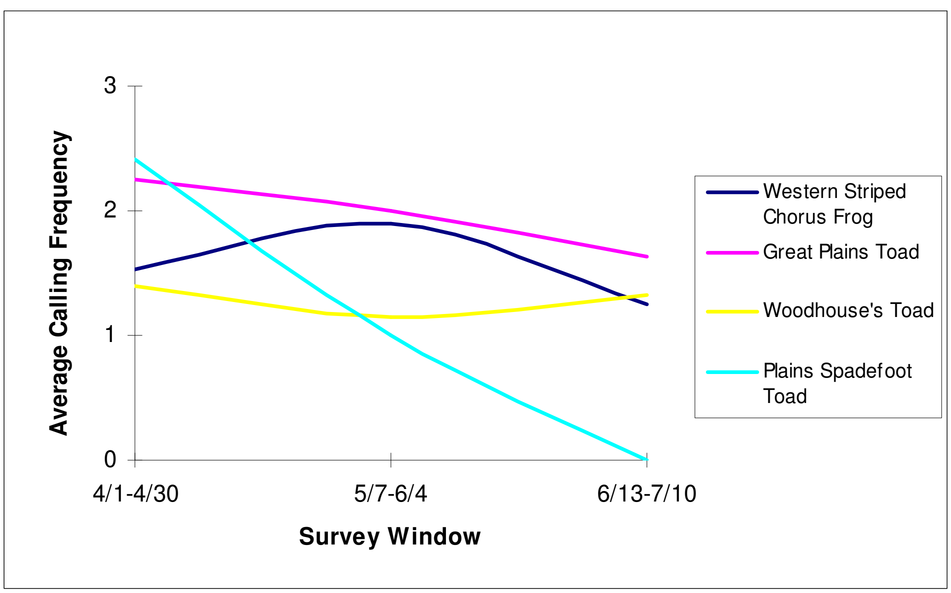

Figure 12. Anuran species composition throughout season based on average call frequency.

3.7 Other Species

We recorded two at-risk (Tier II) plant species in the field. Slender toothcup (or eared redstem, *Ammannia auriculata)* occurred as 1% cover or less in five of the twelve playas surveyed for vegetation. Dwarf spikerush (*Eleocharis coloradoensis or E. parvula)* was recorded in three playas, also accounting for less than 1% cover. Although we did collect some vegetation that we could not identify in the field, these two species were not collected. Therefore, we cannot verify the field identification.

3.8 Vegetation

Field technicians identifying vegetation on a playa.

A total of 115 vegetation plots were read across all sites, with an average of 10.4 plots per site (range=10-15). We documented the occurrence of 49 non-cultivated plant species within 12 playa basins. A list of all plant species documented during surveys is presented in Appendix B. In addition, we also collected cover, frequency, and height data.

Five of the twelve playas were dominated by cultivated species. Two playas were dominated by *Carex* species, three by barnyardgrass, and one by disk water-hyssop. Facultative or obligate wetland plant species were observed in all playas, and four playas were dominated by wetland species. In addition, average percent cover was higher for wetland plants than for non-wetland plants. Cover by annual plants was higher than cover by perennial species. Average percent cover by exotics (6.8%) exceeded cover by native plants (4.5%), although half of the playas surveyed contained a higher percent cover of native plants than exotics. Bare ground accounted for the highest average percent cover for all playas sampled (range 22 – 97, Table 12).

Table 12. Percent cover of playas surveyed for vegetation.

Playa	Crop	Annual	Perennial	Native	Exotic	Bare Ground	Duff	*Wetland Plants	*Upland Plants
1	28.75	0.25	0	0	0.25	73.25	14.5	0.25	0
2	9.5	2.5	0	2.5	0	26.5	20.5	2.5	0
3	3.75	1.25	1.75	0.75	2.25	75.75	21.25	2.75	0.25
4	0.5	23.5	0	1.75	21.75	47.5	27.5	2.25	21
5	0	1.25	6.5	7.5	0.25	78	12	7.25	2.5
6	5.75	44.5	0	4.25	40.25	40.5	4.25	24.5	19.25
7	0.25	9.5	0.25	0.5	9.25	75	6.5	5.25	4.5
8	0	2	0.25	2	0.25	97.5	6.5	2	0.25
9	0	5.75	0	1.25	4.5	96.25	3.25	4.25	2.75
10	3	7	13.25	19.5	0.75	35.5	34.75	5	16.25
11	12	12.25	1.75	12.25	1.75	23.75	50.75	19.5	1
12	28.5	1	0	1.75	0	22	19	14.5	0
Mean	**7.67**	**9.23**	**1.98**	**4.5**	**6.77**	**57.63**	**18.4**	**7.5**	**5.65**

* Wetland indicator status = obligate or facultative wetland; Upland = facultative or facultative upland

3.9 Hydrologic Profiles

The average hydrologic characteristics on all playas throughout the season was 27% wet unvegetated, 22% wet vegetated, 19% saturated vegetated, 12% dry unvegetated, 11% dry vegetated, and 9% saturated unvegetated. The proportion of habitat classified as saturated or wet varied from week to week but did not decline incrementally (Table 13).

Table 13. Proportion of playas that were saturated or wet, from mid-September through mid-October 2006, according to hydrologic transects.

	Week					
Playa	**36**	**37**	**38**	**39**	**40**	**41**
1	*	1	0.75	0.81	0.7	0.95
2	1	0.92	1	0.83	0.81	1
3	1	0.82	0.59	0.79	0.78	1
4	0.88	0.98	0.84	1	0.9	1
5	0.83	0.91	0.67	0.71	0.54	0.91
6	0.65	0.77	*	0	*	*
7	0.89	0.92	0.72	0.72	0.71	0.95
8	1	0.59	0.43	0.47	0.46	0.84
9	0.85	0.95	0.36	0.41	*	*
10	0.88	0.42	0.22	0.48	0.36	0.29
11	0.6	0.77	0.87	0.91	0.84	0.85
12	1	0.89	0.52	0.93	0.63	1
13	0.99	0.84	0.85	0.82	0.75	1
Mean	**0.88**	**0.83**	**0.65**	**0.68**	**0.68**	**0.89**

* indicates not sampled

Water depths on sampled playas were shallow (all dates averaged < 30 cm deep) and decreasing through the study period (Table 14). The maximum water depth recorded on any playa was 43 cm (16.9 in). Averages across all samples were < 16.5 cm (6.5 in).

Table 14. Average water depths (cm) for playas sampled September 7 – October 15, 2006.

Playa	**Weeks: 36**	**37**	**38**	**39**	**40**	**41**
1	*	31.3	20.57	17.45	13.57	7.48
2	23.31	21.92	19.91	18.63	16.34	14.4
3	15.39	16.91	14.29	13.85	10.27	8
4	29.28	32.3	25.89	25.83	22.97	19.36
5	18.8	15.27	13	12.7	11.38	8.06
6	3.89	2.6	0	*	*	*
7	20.85	19.8	16.59	15.91	12.11	11.06
8	16.17	15.05	10.5	12.12	9.07	8.5
9	4.84	4.53	3	0	*	*
10	7.73	8.63	7.25	13.62	7.91	4
11	22.88	26	20.81	22.67	17.57	14.45
12	2.67	4.61	5.33	*	3	3
13	11.24	14.93	11.09	11.78	11	7.62
Mean ± SE	**14.75 ± 2.4**	**16.45 ± 2.7**	**12.94 ± 2.2**	**14.96 ± 2.1**	**12.29 ± 1.6**	**9.63 ± 1.5**

* indicates not sampled

Combining all surveys to all playas for the entire season, we found that 11% of the playa habitat we profiled was unvegetated and saturated or less than 4 cm deep. Seventeen percent of the habitat was less than 5 in deep (12.7 cm; criteria used in the PLJV shorebird planning process; Brian Sullivan, personal communication), and 23% of the habitat met these criteria up to 20 cm deep. Fifty-one percent of the habitat we sampled met our criteria for waterfowl of flooded up to 40 cm deep. If saturated ground is also included, the percent of habitat suitable for waterfowl increases to 78%. Our calculations take into account that each playa was not entirely full on each visit. If one wanted to classify playas as either wet or dry, then the percent of wet habitat that was suitable was 22% (5 in depth) and 100% for waterfowl.

3.10 Outreach Activities

In addition to the research work outlined above, we conducted outreach as part of the project. We presented information about playas, conservation practices and opportunities, and our research through oral presentations for conservation partners, including the Nebraska Game and Parks Commission's Wildlife Division Meeting, the Natural Resource Conservation Service Leadership Meeting, and the Natural Resource Conservation Service Area Two Meeting. We also spoke and interacted with private landowners interested in playa conservation at two landowner workshops hosted by RMBO in 2007. In addition, we gave an oral presentation at the national 125th American Ornithologists' Union Meeting.

Public outreach event

Written outreach from this project included a one-page fact sheet about the playa that we gave to all landowners contacted in the field for access to playas. These landowners were also given a copy of the *The Playas: Reflections of Life on the Plains* videos or DVD's. For all participating landowners, we sent follow-up letters including lists of the birds and plants observed on their properties. This project was featured in the RMBO newsletter in August 2007. In addition, we helped to write a press release with NGPC in April 2007, which was sent to local and regional newspapers.

4 DISCUSSION

4.1 Playa Distribution


Aerial view of wet playas

The PLJV estimates over 60,000 playas within the Joint Venture boundaries (http://www.pljv.org); however, estimates for states north of the Southern Great Plains, including Nebraska, have been uncertain (Smith 2003). Our work has built upon and field-truthed the GIS models of playas created by PLJV. Our revised GIS model estimates 15,389 potential playa locations in the Southwest Playa Complex, a 9% increase in the number of playas and 33% increase in acreage over the original model. The large increase in acreage is due to the inclusion of potential playa locations predicted by SSURGO, which are on average larger than those from other data sources.

Our field confirmation rates of playas predicted in the GIS were only 56-67% (the higher number corresponds to inclusion of "possible playas"), which would adjust the estimated number of playas in the Southwest Playa Complex to 8,618 -10,311 (12,225-14,626 ac). Potential playa locations that were not confirmed in the field could indicate one of three things: that a playa was never in that location (i.e., error in the GIS model), that there is a playa but we cannot see it (e.g., there is a tall corn crop), or there has been a loss of a playa from that location (e.g., it has filled due to sedimentation). Confirming playas that still exist can be difficult, in part because of the cryptic nature of playas. Field experience indicates that playas may be evident in one month and not another, due to factors such as prolonged lack of rain, time of year, or obstructions such as dense crop cover. Thus, it is likely that we failed to confirm some playas that are truly present. However, we believe there are also instances when the model predicted a playa where it was actually absent (e.g., the location was covered in bare soil, the location was close to the road, and aerial photography also shows no basin).

In addition to uncertainty about the proper confirmation rates of playas, we also do not know how many playas exist on the landscape but are not included in the GIS model. We discovered a number of these during our fieldwork and interpretation of the aerial photography. The above estimates are biased low because they do not account for these playas missing from the GIS model.

Thus, we have large uncertainties regarding the number of playas in the region, and cannot currently recommend any amendments to the acreage used by PLJV for their biological planning. A large-scale effort is required to 1) ascertain if playas are truly being lost from the landscape, and 2) determine how many playas are missing from the GIS model. To determine rate of loss of wetlands, a comparison of the 1980's NWI data to current information could be made. To address the second source of uncertainty, in fall of 2007 we recorded all new playas encountered in the field as part of our data collection. This effort was limited in scope, however, and a more thorough sampling of the region will be needed. We expect that estimates of playa numbers in this region will continue to change with the acquisition of additional field and remotely sensed data for years to come.

The PLJV estimates that for BCR 18 in Nebraska, on average, 85% of playa acres are dry, 9% are wet and unexcavated, and 6% are wet in the pit only (PLJV 2007). Our data indicated that 38% of the playa acreage became wet following a heavy rain event. This does not refine the PLJV estimates of habitat because these were not average conditions. However, our delineation of pits in aerial photography suggests that only 2% of total playa acres are in pits, or 6% of the wet habitat. In comparison, the PLJV model suggests that 40% of the wet playa habitat is in pits. If our sample from Chase and Perkins counties is representative of conditions throughout the rest of the PLJV in Nebraska, then this suggests that the PLJV estimates of acreage in pits is too high.

Playas in Nebraska's Southwest Playa Complex are on average smaller than the estimated 15.6 ac for playas of the Southern High Plains (Guthery and Bryant 1982). This may have implications for hydroperiod, as smaller playas do not pond water for as long as larger playas (Smith and Haukos 2002; Howard et al. 2003) although during our fall study period, most playas retained wet conditions for the majority of the season due to a succession of rain events. We also found smaller playas were less likely to become wet following rain and hosted fewer waterfowl and shorebirds. In addition, larger playas in the Southern High Plains supported more wetland plant species (Smith and Haukos 2002).

Playa within a center pivot.

Farming was the most commonly encountered use or modification of playas within our study (80%). Tilling playas and their watersheds leads to increased sedimentation, which is one of the primary threats to playa wetlands. Sedimentation leads to reduced basin size, shorter hydroperiods due to increased evapotranspiration, and eventually may cause complete loss of the playa (Smith 2003). This highlights the need for buffer programs. We were impressed by both the number of buffer projects in the study area and by the interest in playa conservation by conservation partners.

4.2 Playa Hydroperiods and Buffer Evaluation

We found that playas surrounded by CRP were less likely to become wet following a rain event than those surrounded by grassland or cropland, although sample size was limited. This effect may be due to effects of the buffer planting itself, such as denser, taller vegetation utilizing more surface runoff or by physically impeding flows of water to the playas. Alternatively, this may be due to other characteristics of these playas or their locations that we have not included in our analysis. For instance, because CRP is a program designed to assist in soil conservation, perhaps playas enrolled in this program are located in different soil types than other playas. It may be that these soils are more permeable and thereby yield reduced surface flow of water to the playas. There may be other important factors such as history of modifications to the wetlands. To gain further insight into this pattern, we plan to analyze the soil types surrounding playas when watershed delineations become available. In addition, as more buffer projects are implemented, we can incorporate information about seed-mixes used in the buffer strips to determine if vegetation characteristics are important.

4.3 Avian Use

Solitary Sandpiper

In the fall of 2006, we documented 31,515 birds comprising 107 avian species using playas or adjacent uplands. This study adds to the body of knowledge regarding the use of playas by migrating birds, already well-documented for the Rainwater Basin of Nebraska and the High Plains of Texas (Brennan 2006, Davis and Smith 1998, Jorgensen 2004, Smith 2003). Playas appear to be an important part of the stepping stone mosaic of habitat utilized by transcontinental shorebirds stopping over in the Great Plains (Skagen and Knopf 1993). Migratory stopover habitats provide rest and replacement of depleted energy reserves for migrants traveling long distances between breeding and wintering grounds (Bolen *et al.* 1989, Skagen and Knopf 1993, Skagen and Knopf 1994a, Rivers and Cable 2003).

The playas we sampled generally lacked dense vegetation, averaged more than 50% bare ground, and provided shallow water throughout the migration season. A recent large-scale study of prairie potholes showed that shorebirds selected small wetlands that sustained inundated or saturated conditions throughout the spring (Niemuth *et al*. 2006). These size and hydrologic patterns are similar to those exhibited by the playas in this study. Furthermore, migrating shorebirds have been shown to select for shallow, sparsely vegetated wetlands with substantial mudflats (Colwell and Oring 1998, Helmers 1993).

We observed 22 species of shorebirds, while 28 species were observed during three fall seasons in the Eastern Rainwater Basins (Jorgensen 2004). The most common shorebirds differed in the two studies: we found high numbers of Killdeer, Baird's Sandpiper, and Wilson's Snipe, while in the Rainwater study, high numbers of Pectoral Sandpiper, Long-billed Dowitcher, and Stilt Sandpiper were reported. Lesser Yellowlegs and Least Sandpiper were in the top five species for both studies.

Avian densities are influenced by external factors such as timing during the migration season, large-scale weather patterns, and proximity to other wetlands, as well as on-site conditions such as water depth and vegetation composition (Austin et al. 2002). Indeed, we found that the species richness and numbers for shorebirds and waterfowl declined throughout the study period. These data concur with the migration chronology reported for shorebirds within 40°-45° latitude (Skagen *et al*. 1999). It is likely that our shorebird counts would have been much higher had we sampled earlier in the season, as we missed the peak abundances of July. We found very few shorebirds after the third week of September; Skagen *et al* report low densities after August (1999). Waterfowl were similarly low in abundance after the end of September.

In addition to seasonal changes in the abundance of shorebirds and waterfowl in our study area, we found that particular characteristics of playas were important in determining use by shorebirds and waterfowl. Playa size (acreage), percent cover by water, and percent of cover in wet mud within the playa influenced use by shorebirds. Because some species of shorebirds use mud and others prefer shallow water for foraging, these findings are not surprising. For example, Least Sandpiper and Western Sandpiper prefer mudflats (Davis and Smith 1998, Colwell and Landrum 1993), whereas Lesser Yellowlegs prefer shallow (<4 cm) water (Davis and Smith 1998). Dowitchers and American avocets are associated with even deeper water (Weber and Haig 1996). Waterfowl also were found in higher numbers on playas with greater percent cover by water, and on larger playas, which concurs with other studies (Brennan 2006, LaGrange and Dinsmore 1989).

Due to a succession of rainfall events, the playas we studied maintained wet habitat throughout the migration season. Playas provide a habitat mosaic not dissimilar from prairie potholes, a well-studied system.


Mallard (*Anas platyrhynchos*)

Direct measures of water depths in a sub-sample of playas within our study area indicate water depths that are very appropriate for meeting the needs of foraging waterfowl and shorebirds during the migratory season. Playas during fall of 2006 averaged 16.5 cm (6.5 in); the maximum depth recorded was 43 cm (16.9 in). A recent study shows that migrating shorebirds in the South Platte River corridor in Colorado were associated with unvegetated mudflat and open water less than 4 cm deep (and to a lesser extent, 20 cm deep; Cariveau and Risk 2007). Brennan also found a negative association between water depths and shorebird use in the Rainwater Basin (Brennan 2006). Combining all surveys to all playas for the entire season, we found that 11% of the playa habitat we profiled was unvegetated and less than 4 cm deep; 23% was unvegetated habitat less than 20 cm deep. Waterfowl in the South Platte River corridor were associated with water depths less than 40 cm (Cariveau and Risk 2007). When averaging conditions of all playas for the entire the season, we found that 51% of the habitat was flooded to 40 cm deep. One hundred percent of the flooded acres were less than 40 cm deep.

These data may be applied to refine some of the parameters used by the PLJV biological planning models. PLJV estimates the suitability of wet playa habitat as 10% for shorebirds and 100% for waterfowl. Although our sample size is very low (n=15), our fall 2006 profiles indicated that 17% of the habitat was suitable for shorebirds and 78% was suitable for waterfowl. This approach excludes the part of the playas that was dry each week from the percent suitable, taking into account that “wet” playas will not be full throughout the season. However, if one simply classifies playas as wet or dry, then our data indicate that 100% of the wet habitat is suitable for waterfowl and 22% for shorebirds. We collected additional water depth and vegetation density data in 2007, so we will have additional data in Phase II to contribute to this assessment.

Preliminary analyses indicate no difference in shorebird or waterfowl densities relative to the placement of roads, but our sample size of playas away from roads was very small (n= 12). LaGrange and Dinsmore (1989) found a negative effect of roads on the use of sheetwater wetlands by Mallards during spring migration. We will continue to analyze our additional survey data with respect to roads in Phase II. This has importance in evaluating the representativeness of roadside bird surveys, which are more cost-effective and efficient than interior surveys where landowner permission to access is required.

We recognize the interest of conservation partners such as the PLJV in the use of dry playas by landbirds. However, because we emphasized wet playas in 2006, we do not have a strong dataset for addressing this topic. In 2007 we surveyed many dry playas and will provide a summary of bird use of these playas in Phase II.

Finally, we are also interested in how bird use might vary by buffer type, but because of low numbers of playas in grassland and buffer programs on the landscape, we were unable to analyze this in the 2006 data. In 2007 we attempted to increase our sampling of grassland and CRP playas, and will analyze this as part of our Phase II reporting.

4.4 Anurans

Our data suggest that playas in this region are well-utilized by frogs and toads; anurans were found in 94% of playas surveyed. Woodhouse's Toad, Western Striped Chorus Frogs, Great Plains Toads, and Plains Spadefoot Toads were found in abundance.

We found that nocturnal call surveys were more effective than daytime surveys, detecting both a greater number of species and higher occupancy rates despite a higher number of playas surveyed during the day. This is probably due to the nocturnal or crepuscular habits of Woodhouse's Toad, Great Plains Toad, and Plains Spadefoot Toad (Hammerson 1999). In addition, lowland Western Striped Chorus Frogs are diurnal in early spring, but shift to a more nocturnal or crepuscular schedule as weather warms (Hammerson 1999). Our findings concur with the approach of other studies that used nocturnal surveys or collections for these species (Bolek et al. 2003; Sullivan 1986, Woodward 1982; Krupa 1994; Trowbridge and Trowbridge 1937).

Anuran species composition and abundance fluctuated throughout the study period. Fewer individuals of each species were detected during our second window of surveys (May 7 – June 4) than the first or third survey windows. Low temperatures prior to surveys may have impacted anuran performance. According to Putman and Bennet (1981), the optimum performance temperature of similar anurans is between 20-30 ºC, below which performance levels (e.g., territory defense, mating) decline.

Plains Spadefoot Toad detections dropped significantly throughout the season. A three-year study of Plains Spadefoot Toads in OK (Trowbridge and Trowbridge 1937) indicated that the breeding season of this species is late April to early May and lasts no longer than two weeks. Several studies indicate that Plains Spadefoot Toads have a short breeding season and they rarely breed after the first breeding congregation, or congress (Bragg 1945, Woodward 1982, Mabry and Christiansen 1991). It has also been noted that these toads do not sing when they emerge for food, so hearing them in an aural survey outside their short breeding period would be unlikely (Smith 1934). Thus, it is likely that a breeding congress was initiated by rainfall early in our surveys and Spadefoot Toad calling rapidly decreased as their short breeding season came to a close.

The calling frequency of Great Plains Toads decreased throughout the season as well. In Oklahoma, choruses indicate breeding activity, which takes place from March to June (Bragg 1937, Krupa 1988, Krupa 1994). Great Plains Toads are reported to spend fewer nights of breeding per rainfall event as the season progresses (Krupa 1994), which corresponds with out findings.

Western Striped Chorus Frogs appeared to be most abundant during our second window of surveys (May 7-June 4). This timing fits with what is described for Colorado, that these frogs just begin to chorus in late March and early April in Colorado, and calling may finish by late spring (Hammerson 1999).

Woodhouse Toad abundance remained relatively unchanged throughout the season. This is likely due to the wide range of their breeding season (April-June) and long period over which breeding occurs (for 3-7 weeks after rain; Hammerson 1999).

4.5 Vegetation

Our data indicate similar plant species as have been found in studies in other parts of the playa region (Reed 1930; Hoagland and Collins 1997; Smith and Haukos 2002). We identified 49 non-cultivated plant species in the vegetation of sampled playas. This smaller subset of the 346 species potentially occurring in playas of the PLR (Haukos and Smith 2004) is to be expected, as this study included only 12 playas in a small portion of the region. We expect that the species list will increase as more playas are sampled in future phases of this project. It was recently brought to our attention that an inventory of the plants of Nebraska's southwest playas was conducted (Rolfsmeier 1992). We will relate our findings to this work in our Phase II reporting.

In our study area playas, total percent cover was made up of more annuals than perennials in nine out of twelve playas. This corresponds with the findings by Haukos and Smith (1993), who found that the seed banks of playas with cropland watersheds were dominated by annuals. The productivity of playas in producing seeds and invertebrates is well-recognized as being important for supporting migrating waterbirds (Anderson and Smith 1999). Based on their analysis of Northern Pintail (*Anas acuta*) crop contents, Sheeley and Smith (1989) found that barnyard grass, curly dock, spikerush, and smartweed were important food resources for migratory birds. We observed all of these plants during surveys, and barnyard grass was the dominant plant on three of the playas we surveyed. In addition, while it is well-documented that migrating shorebirds forage on invertebrates as a protein source, seeds may also be an important part of their diet, as seeds comprised approximately 20% of the dietary mass for five species of migrating shorebirds on a Texas playa (Baldassarre and Fisher 1984).

For the playas we studied, non-native species accounted for slightly more cover than native plants, indicating heavy impacts by exotic species. This concurs with the findings of Haukos and Smith (2004), who found that native plant communities of playas have been degraded or eliminated due to intensive grazing or cultivation in much of the PLR.

4.6 Management Recommendations

Playa in pivot corner

Conservation partners are interested in applying our work to resource management and conservation planning, and we are eager for such applications to be made. However, because we worked only in this one geographic location and our sample sizes were limited, we urge caution in extrapolating our finding to areas beyond Chase and Perkins counties. With that in mind, we have two main findings. First, larger playas appear to have higher conservation values than smaller playas, all other conditions being the same, for two reasons. Larger playas were more likely to become flooded following a rain event than smaller playas, and in addition, waterfowl and shorebird use was higher on larger playas. Another main finding was that playas surrounded by CRP were less likely to become wet following a rain event than those surrounded by grassland or cropland. This may be due to the buffer planting itself or due to other characteristics of these playas or their locations that we have not included in our analysis. Further study of the effect of seed-mixes, surrounding soil type, and other management practices will greatly assist conservation partners in assessing the success of their buffer programs and in designing optimal buffer projects.

4.7 Future Directions

Because of the sensitivity of playa ecosystems to amount, duration and timing of rainfall, several seasons of investigation are required to describe the ecological function of these wetlands. Future phases of this project will build on the data presented here. Future goals include: 1) revisit playas with the status of possible playa to confirm their status, 2) increase the number of playas in grass and CRP landcover types to more accurately evaluate the effect of landcover on hydrology and wildlife use, 3) delineate watersheds of a subset of playas to evaluate the effect of watershed size, condition and soil type on playa hydrology, 4) compare the number of birds observed during vantage counts to flush counts so that roadside vantage counts can be adjusted to more accurately depict avian numbers, and 5) Analyze the relationship between amphibian use and habitat variables within the wetland and landscape attributes of the surrounding watershed. If the amount, timing, and location of rainfall are appropriate, we would also like to acquire aerial photography of another area within the Southwest Playa Complex. Sampling in another area will improve our inference regarding the numbers, conditions, and proportion of playas that become wet following significant rainfall events.

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6 Appendix A. Bird Species Documented on Southwest Playa Complex Playas Fall 2006

Common Name	Scientific Name	Total Number
American Avocet	*Recurvirostra americana*	1
American Coot	*Fulica americana*	28
American Crow	*Corvus brachyrhynchos*	215
American Golden-Plover	*Pluvialis dominica*	1
American Goldfinch	*Carduelis tristis*	24
American Kestrel	*Falco sparverius*	2
American Pipit	*Anthus rubescens*	279
American Robin	*Turdus migratorius*	34
American Tree Sparrow	*Spizella arborea*	10
American Wigeon	*Anas americana*	106
Baird's Sandpiper	*Calidris bairdii*	214
Bank Swallow	*Riparia riparia*	2
Barn Swallow	*Hirundo rustica*	808
Black Tern	*Chlidonias niger*	51
Black-bellied Plover	*Pluvialis squatarola*	9
Blue Grosbeak	*Passerina caerulea*	3
Blue Jay	*Cyanocitta cristata*	6
Blue-winged Teal	*Anas discors*	532
Brewer's Blackbird	*Euphagus cyanocephalus*	133
Brewer's Sparrow	*Spizella breweri*	1
Brown-headed Cowbird	*Molothrus ater*	412
Bufflehead	*Bucephala albeola*	1
Bullock's Oriole	*Icterus bullockii*	1
Burrowing Owl	*Athene cunicularia*	24
Chestnut-collared Longspur	*Calcarius ornatus*	485
Chipping Sparrow	*Spizella passerina*	1
Cinnamon Teal	*Anas cyanoptera*	6
Clay-colored Sparrow	*Spizella pallida*	12
Cliff Swallow	*Petrochelidon pyrrhonota*	6
Common Grackle	*Quiscalus quiscula*	294
Common Yellowthroat	*Geothlypis trichas*	4
Cooper's Hawk	*Accipiter cooperii*	6
Dark-eyed Junco	*Junco hyemalis*	8
Dickcissel	*Spiza americana*	2
Eared Grebe	*Podiceps nigricollis*	2
Eastern Kingbird	*Tyrannus tyrannus*	5
Eastern Phoebe	*Sayornis phoebe*	3
European Starling	*Sturnus vulgaris*	230
Gadwall	*Anas strepera*	42
Grasshopper Sparrow	*Ammodramus savannarum*	3
Great Blue Heron	*Ardea herodias*	9
Great Horned Owl	*Bubo virginianus*	6
Greater Yellowlegs	*Tringa melanoleuca*	104
Green-winged Teal	*Anas crecca*	1149
Horned Lark	*Eremophila alpestris*	1302

Common Name	Scientific Name	Total Number
House Sparrow	*Passer domesticus*	6
House Wren	*Troglodytes aedon*	1
Killdeer	*Charadrius vociferus*	1685
Lapland Longspur	*Calcarius lapponicus*	5
Lark Bunting	*Calamospiza melanocorys*	3
Least Sandpiper	*Calidris minutilla*	158
Lesser Scaup	*Aythya affinis*	1
Lesser Yellowlegs	*Tringa flavipes*	251
Long-billed Dowitcher	*Limnodromus scolopaceus*	26
Mallard	*Anas platyrhynchos*	6027
Marbled Godwit	*Limosa fedoa*	1
Marsh Wren	*Cistothorus palustris*	5
McCown's Longspur	*Calcarius mccownii*	16
Merlin	*Falco columbarius*	2
Mourning Dove	*Zenaida macroura*	103
Northern Flicker	*Colaptes auratus*	10
Northern Harrier	*Circus cyaneus*	40
Northern Pintail	*Anas acuta*	2510
Northern Rough-winged Swallow	*Stelgidopteryx serripennis*	3
Northern Shoveler	*Anas clypeata*	387
Pectoral Sandpiper	*Calidris melanotos*	40
Peregrine Falcon	*Falco peregrinus*	2
Pied-billed Grebe	*Podilymbus podiceps*	42
Prairie Falcon	*Falco mexicanus*	1
Redhead	*Aythya americana*	1
Red-headed Woodpecker	*Melanerpes erythrocephalus*	3
Red-necked Phalarope	*Phalaropus lobatus*	3
Red-tailed Hawk	*Buteo jamaicensis*	4
Red-winged Blackbird	*Agelaius phoeniceus*	777
Ring-necked Pheasant	*Phasianus colchicus*	4
Rock Pigeon	*Columba livia*	7
Rock Wren	*Salpinctes obsoletus*	1
Ruby-crowned Kinglet	*Regulus calendula*	3
Sandhill Crane	*Grus canadensis*	148
Savannah Sparrow	*Passerculus sandwichensis*	280
Semipalmated Plover	*Charadrius semipalmatus*	5
Semipalmated Sandpiper	*Calidris pusilla*	28
Solitary Sandpiper	*Tringa solitaria*	68
Song Sparrow	*Melospiza melodia*	11
Sora	*Porzana carolina*	5
Spotted Sandpiper	*Actitis macularia*	13
Spotted Towhee	*Pipilo maculatus*	2
Stilt Sandpiper	*Calidris himantopus*	9
Swainson's Hawk	*Buteo swainsoni*	5
Unknown Bird		10
Unknown Blackbird		1210

Common Name	Scientific Name	Total Number
Unknown Dowitcher	*Limnodromus griseus*	16
Unknown Duck		1125
Unknown Peep	*Calidris Sp.*	40
Unknown Sandpiper		1
Unknown Shorebird		5
Unknown Sparrow		157
Unknown Swallow		44
Unknown Teal	*Anas sp.*	7898
Unknown Yellowlegs	*Tringa sp.*	2
Upland Sandpiper	*Bartramia longicauda*	8
Vesper Sparrow	*Pooecetes gramineus*	246
Western Kingbird	*Tyrannus verticalis*	5
Western Meadowlark	*Sturnella neglecta*	368
Western Sandpiper	*Calidris mauri*	3
White-breasted Nuthatch	*Sitta carolinensis*	1
White-crowned Sparrow	*Zonotrichia leucophrys*	22
White-faced Ibis	*Plegadis chihi*	1
Willet	*Tringa semipalmata*	3
Wilson's Phalarope	*Phalaropus tricolor*	26
Wilson's Snipe	*Gallinago delicata*	169
Wilson's Warbler	*Wilsonia pusilla*	1
Wood Duck	*Aix sponsa*	5
Yellow Warbler	*Dendroica petechia*	3
Yellow-crowned Night-Heron	*Nyctanassa violacea*	1
Yellow-headed Blackbird	*Xanthocephalus xanthocephalus*	856
Yellow-rumped Warbler	*Dendroica coronata*	11
Total Species		**106**
Total Birds		**31515**

7 APPENDIX B. PLANT SPECIES DOCUMENTED ON SOUTHWEST PLAYA COMPLEX PLAYAS FALL 2006

Common Name	Scientific Name (USDA Plants)	Nativity	Wetland Indicator Status* (Region 5)
American Licorice	*Glycyrrhiza lepidota*	Native	Facultative Upland
Arrowhead	*Sagittaria sp.*		
Aster	*Aster sp.*		
Barnyardgrass	*Echinochloa crus-galli*	Exotic	Facultative Wetland
Bearded Flatsedge	*Cyperus squarrosus*	Native	Wetland Obligate
Bearded Sprangletop	*Leptochloa fusca*	Native	Wetland Obligate
Bigbract Verbena	*Verbena bracteata*	Exotic	Facultative Upland
Blue Mudplantain	*Heteranthera limosa*	Native	Wetland Obligate
Buffalobur Nightshade	*Solanum rostratum*	Exotic	
Bushy Knotweed	*Polygonum ramosissimum*	Native	Facultative
Canadian Horseweed	*Conyza canadensis*	Exotic	Facultative Wetland
Cheatgrass	*Bromus tectorum*	Exotic	
Chickweed	*Cerastium sp.*		
Common Sunflower	*Helianthus annuus*	Native	Facultative Upland
Cottonwood	*Populus deltoides*	Native	Facultative
Cuman Ragweed	*Ambrosia psilostachya*	Native	Facultative
Curly Dock	*Rumex crispus*	Exotic	Facultative Wetland
Dandelion	*Taraxacum sp.*		
Disk Waterhyssop	*Bacopa rotundifolia*	Native	Wetland Obligate
Dwarf Spikerush	*Eleocharis parvula*	Native	Wetland Obligate
Eared Redstem	*Ammannia auriculata*	Native	Wetland Obligate
Evening-primrose	*Oenothera sp.*		
Foxtail Barley	*Hordeum jubatum*	Native	Facultative Wetland
Goatsbeard	*Tragopogon sp.*		
Golden Tickseed	*Coreopsis tinctoria*	Native	Facultative
Green Bristlegrass	*Setaria viridis*	Exotic	
Green Carpetweed	*Mollugo verticillata*	Exotic	Facultative
Knotweed	*Polygonum sp.*		
Kochia	*Kochia scoparia*	Exotic	Facultative Upland
Mustard	*Brassica sp.*		
Pennsylvania Smartweed	*Polygonum pensylvanicum*	Native	Facultative Wetland+
Pigweed	*Amaranthus sp.*		
Pitseed Goosefoot	*Chenopodium berlandieri*	Native	
Prairie Cordgrass	*Spartina pectinata*	Native	Facultative Wetland
Prostrate Pigweed	*Amaranthus albus*	Exotic	Facultative Upland
Purslane	*Portulaca sp.*		
Redroot Amaranth	*Amaranthus retroflexus*	Exotic	Facultative Upland
Russian Thistle	*Salsola tragus*	Exotic	Facultative Upland
Sand Lovegrass	*Eragrostis trichodes*	Exotic	
Sandbur	*Cenchrus sp.*		
Sedge	*Carex sp.*		
Spikerush	*Eleocharis sp.*		

Common Name	Scientific Name (USDA Plants)	Nativity	Wetland Indicator Status (Region 5)
Spreading Yellowcress	*Rorippa sinuata*	Native	Facultative Wetland
Stinkgrass	*Eragrostis cilianensis*	Exotic	Facultative Upland
Sweetclover	*Melilotus sp.*		
Switchgrass	*Panicum virgatum*	Native	Facultative
Thistle	*Carduus sp.*		
Tumble Windmill Grass	*Chloris virgata*	Exotic	No Indicator
Waterclover	*Marsilea sp.*		
Western Wheatgrass	*Pascopyrum smithii*	Native	Facultative Upland
Winged Pigweed	*Cycloloma atriplicifolium*	Native	Facultative
Witchgrass	*Panicum capillare*	Exotic	Facultative
Woollyleaf Burr Ragweed	*Ambrosia grayi*	Native	Facultative

*As defined in PLANTS database; see http://plants.usda.gov/wetinfo.html.