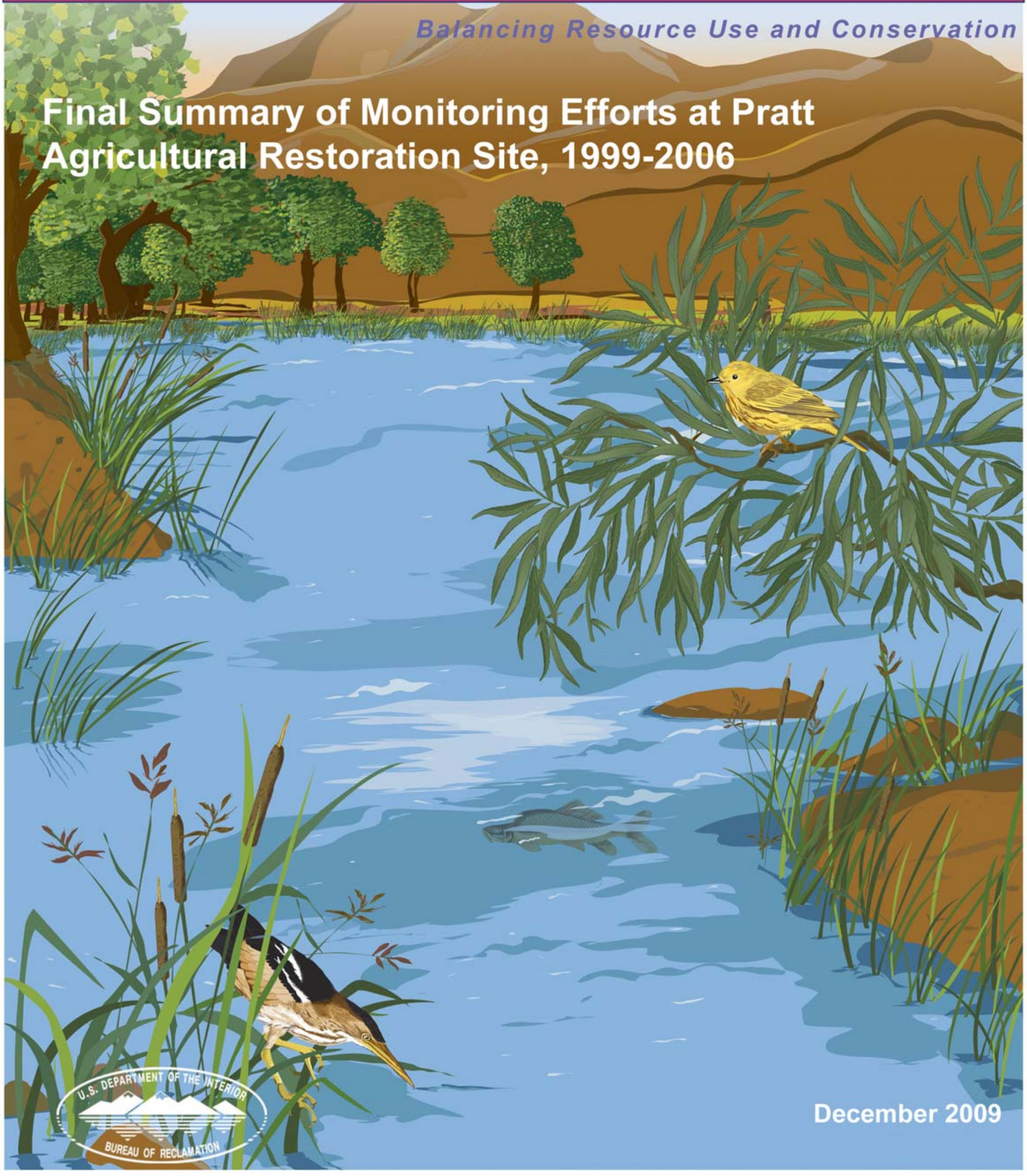
Lower Colorado River Multi-Species Conservation Program

Balancing Resource Use and Conservation

Final Summary of Monitoring Efforts at Pratt Agricultural Restoration Site, 1999-2006



December 2009

Lower Colorado River Multi-Species Conservation Program
Steering Committee Members

Federal Participant Group

Bureau of Reclamation
U.S. Fish and Wildlife Service
National Park Service
Bureau of Land Management
Bureau of Indian Affairs
Western Area Power Administration

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Arizona Department of Water Resources
Arizona Electric Power Cooperative, Inc.
Arizona Game and Fish Department
Arizona Power Authority
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City of Bullhead City
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Mohave Valley Irrigation and Drainage District
Mohave Water Conservation District
North Gila Valley Irrigation and Drainage District
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Unit "B" Irrigation and Drainage District
Wellton-Mohawk Irrigation and Drainage District
Yuma County Water Users' Association
Yuma Irrigation District
Yuma Mesa Irrigation and Drainage District

Other Interested Parties Participant Group

QuadState County Government Coalition
Desert Wildlife Unlimited

California Participant Group

California Department of Fish and Game
City of Needles
Coachella Valley Water District
Colorado River Board of California
Bard Water District
Imperial Irrigation District
Los Angeles Department of Water and Power
Palo Verde Irrigation District
San Diego County Water Authority
Southern California Edison Company
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Colorado River Commission of Nevada
Nevada Department of Wildlife
Southern Nevada Water Authority
Colorado River Commission Power Users
Basic Water Company

Native American Participant Group

Hualapai Tribe
Colorado River Indian Tribes
The Cocopah Indian Tribe

Conservation Participant Group

Ducks Unlimited
Lower Colorado River RC&D Area, Inc.

Lower Colorado River Multi-Species Conservation Program

Final Summary of Monitoring Efforts at Pratt Agricultural Restoration Site, 1999-2006

Lower Colorado River
Multi-Species Conservation Program
Bureau of Reclamation
Lower Colorado Region
Boulder City, Nevada
http://www.lcrmscp.gov

December 2009

Introduction

Reclamation established a small demonstration restoration project at the Pratt Agricultural Site, in 1999. The site is located near Yuma, Arizona, south of Mittry Lake. The Pratt Restoration Site is a demonstration restoration project that was established as a requirement of Reasonable and Prudent Alternative (RPA) 14 in the 1997 Biological and Conference Opinion on Routine Operations and Maintenance of the Lower Colorado River (LCR). RPA 14 requires Reclamation to establish demonstration projects to study ecological restoration techniques along the LCR (USFWS 1997). The Pratt Restoration Site was established by Reclamation and the Bureau of Land Management (BLM) to create specific habitat for the southwestern willow flycatcher (*Empidonax traillii extimus*) (Raulston 2003).

The Lower Colorado River Multi-Species Conservation Program (LCR MSCP) is a 50-year cooperative (federal, lower basin states, tribal, and private) effort to provide conservation measures for 26 covered species while providing regulatory relief for ongoing and future river management operations (LCR MSCP HCP 2004). Two principal conservation measures of the LCR MSCP are: 1) creation and maintenance of habitat, and 2) adaptive management through monitoring and research. Both conservation measures are expected to benefit LCR MSCP covered and non-covered species (LCR MSCP HCP 2004). One of the four components of the adaptive management process is post-development monitoring (LCR MSCP HCP 2004). The purpose of avian post-development monitoring is to collect avian abundance, diversity, and richness data at each restoration project to analyze effectiveness of created habitats. Reclamation has conducted avian post-development monitoring each breeding season since 2002 at the Pratt Restoration Site using two methods: avian area searches and tape playback surveys for the southwestern willow flycatcher (Sogge et al. 1997). Reclamation has monitored the site since the winter of 2002-03 using a combination of mist-net banding and avian area searches. Vegetation growth has also been monitored at the site since 1999. Post-development monitoring of this site provides ecological data to be utilized in the adaptive management process of the LCR MSCP.

Study Area

The Pratt Restoration Site is located north of Interstate 8 near Yuma, Arizona, on land administered by the Bureau of Land Management. The site is north of Laguna Dam, south of Mittry Lake, and is surrounded by farm fields and saltcedar (*Tamarix* spp.) A leaseholder has farmed the 4.9-ha site since 1949. In 1999, Reclamation established six planting regimes with Fremont cottonwood (*Populus fremontii*), Goodding's willow (*Salix gooddingii*), and coyote willow (*Salix exigua)* using potted plants, seeds, and poles. Potted plants and poles were planted densely, from 1 to 3 m apart (Raulston 2003). Seeded areas were planted with cottonwood and willow seeds collected locally and broadcast by hand over wet soils (Raulston 2003). *Baccharis* have been independently established in a potted cottonwood plot and saltcedar have been established in the seeded areas. New individuals have been independently established in the potted coyote willow population (Reclamation 2003). After four years of growth, the site has developed into a cottonwood-willow gallery forest with an understory of Bermudagrass (*Cynodon dactylon)* and *Baccharis* species (BLM 2004). In the fall of 2003, saltcedar was removed from adjacent fields and will be restored with native vegetation. The site has been jointly managed by Reclamation and the BLM to promote different size classes with an overstory, a sub-canopy, and a dense shrub layer through harvesting poles and cuttings in certain areas (BLM 2004). Starting in 2006, the site will be managed exclusively by the BLM.

Methods

Southwestern Willow Flycatcher Surveys

Starting in 2002, call/playback surveys for the presence of southwestern willow flycatchers were conducted at the Pratt site, 10 times per year, during the breeding season (May to July). Surveys were conducted over the entire site by one or two observers using a recording of willow flycatchers' "whit" and "fitz-bew" calls. These calls were used to elicit responses from any birds that may be present, and thus facilitated detections. Any birds heard or seen were recorded onto a standardized data sheet. If any birds were detected, attempts were made to record any observed behavior such as carrying nest material, territorial defense, or paired behavior. Birds were considered to be migrants if they were detected before June 22 and were considered to be residents if they were detected after June 21. This determination is based on the recommendations of the willow flycatcher survey protocol (Sogge et al. 1997).

Area Searches During the Breeding Season

Starting in 2002, area searches were conducted during the summer breeding season to determine avian species composition and diversity at the site. The site was divided into five separate areas, which could be surveyed in 20 minutes. The site was divided in the following manner: potted section 1 and seeded section 1 formed the first area, potted 2 and seeded 2 formed the second area, potted 3 formed the third area, the fourth area was formed in potted 4 from the edge of potted 3 to the edge of the coyote willow, and the fifth area started from the edge of the coyote willows to the end of the habitat (Appendix 1). This allowed the entire site to be systematically surveyed in 20-minute increments. Each section was surveyed by one observer, and surveys began at sunrise and ended no later than 9:00 a.m. During the 20 minutes, the observers attempted to survey all areas within each section equally (Ralph et al.1993). Temperature, cloud cover, and wind speed were recorded before each area search. Each individual bird was recorded on a standardized data sheet, and type of detection was recorded (call, song, visual). If the bird was detected by more than one method, the method with the highest priority was recorded. Singing had the highest priority, visual had the second highest priority, and calling had the lowest priority. Behavior information recorded for each bird included foraging, carrying food, displaying, copulating, flocking, mating, nesting, and fledging (Ralph et al. 1993). Birds seen flying over the area but not utilizing it were recorded in a separate category as flyovers.

The area search data was compiled and several methods were used to analyze the data. For each year, mean abundance of detection, species diversity, and relative detection percentage per species were calculated. Community similarity was compared between years and overall species diversity was calculated for the entire 4-year period for which area searches were conducted during the breeding season. Species diversity and community similarity were calculated using the same methods utilized to analyze the winter banding data; those methods are detailed in the winter banding section of the methods (this report).

Winter Banding

Mist-netting/bird-banding occurred at the Pratt restoration site for four consecutive seasons from 2002 to 2006. During the first two years of banding, three 4-day periods of mist-netting/bird-banding were conducted between November and February at each site. In the 2004-05 season, the protocol was adapted to the system used by other organizations that have recently instituted winter banding efforts in North America, including Point Reyes Bird Observatory. The new protocol calls for six banding sessions of two days each, once a month, from November to March. Some months were missed due to long periods of inclement weather. This protocol was specifically designed to over-sample (more months of banding than strictly needed) in order to allow for missed months of banding.

Twelve 2.6-m × 12-m nets were placed in cottonwood/willow habitat at the Pratt restoration site. Mesh size for all nets was 30 mm. Initially, nets were set up at sunrise and were open for 5 hours unless conditions, such as wind or temperature, could harm the birds. In 2004, the hours of operation were extended by an hour from the protocol established for the two previous seasons and nets were opened 30 minutes after sunrise. This change was implemented because higher capture rates were generally experienced later in the day and because of the lack of heat related problems during the winter. Nets were checked every 50 minutes. A metal, numbered USFWS band was placed on all captured birds, except game species and hummingbirds. Each bird was identified to species, aged, sexed, measured for wing chord, body fat and pectoral muscle mass, weighed and released. Time, date, and net location from which each bird was captured were recorded as well as total hours of net operations. All data were recorded on a standardized data sheet (Desante et al. 2002). Birds were identified using Pyle (1997) and Sibley (2000).

All operations of the banding station were conducted with bird safety as the first priority. If weather conditions, number of captures, or other circumstances were deemed to be unsafe, nets were closed immediately and banding ceased for the day, or until conditions improved. Injured birds were cared for and released as soon as possible. All birds were processed in a quick and timely manner in order to reduce stress caused by handling. Standard protocols for bird extraction and handling as established by Ralph et al. (1993) and De Sante et al. (2002) were followed at all times.

The banding data were analyzed using several methods. For each year, species diversity, winter site persistence, annual return rate, species richness, and birds captured per net hour rate was calculated. A between-year analysis of community similarity using the Renkonen Index was also calculated.

Winter Site Persistence

Winter site persistence is a measure of birds captured in one banding period that are subsequently recaptured in a later banding period of the same banding season (Latta and Faaborg 2001, 2002). Persistence was determined by the percentage of birds recaptured in a banding period subsequent to their first period of capture, within the same winter banding season. Winter site persistence is used as an index measure of habitat suitability for birds in the winter.

Annual Return

Data from birds recaptured between years were used to measure annual return rate. Annual return rate is a measure of birds recaptured in subsequent field seasons after the field season of their initial capture (Latta and Faaborg 2001, 2002). Annual return rate was measured as a percentage of birds recaptured from previous years, from the total of all individually captured birds.

Species Diversity

Species diversity was calculated for each year using the Shannon-Weaver index (Krebs 1989 in Nur et al. 1999), which uses the formula:

$$H' = \sum_{i=1}^{i=s} (p_i)(\ln p), \ i=1,2....S$$

where S = the number of species in the sample, H' = the species diversity index, and p_i = the proportion of all birds detected belonging to the *i*th species. These values were then transformed into a value, N_1, using the formula $N_1 = e^H$. N_1 gives a value that expresses diversity in terms of species, giving a value that represents what the species richness (number of species detected) is when the data is statistically transformed to represent even detection numbers for all species (Macarthur 1965 in Nur et al. 1999). This gives a more readily understandable value to use for site comparison in the analysis.

Renkonen Index of Community Similarity

A community similarity index was created to compare results between years using the Renkonen index (Nur et al. 1999). The Renkonen index (P) is calculated using the formula:

$$P = \sum_{i=1}^{i=s} \text{minimum}(p^A_i, p^B_i)$$

where p^A_i is the proportion of species *i* to all species for sample A, p^B_i is the proportion of species *i* to all species for sample B, and S is the number of species in the sample.

Winter Area Search

In conjunction with the winter banding effort, area searches were conducted once each month during the same time period banding was conducted. Initially area searches were conducted in the morning, just after sunrise; however, the area searches were changed to the afternoon anytime from 3 hours before sunset to sunset. The change was made after less bird activity was observed at sunrise, especially during the coldest months of December, January, and February, and increased activity was observed in the afternoon. This change also allowed banding and area searches to be conducted on the same day, which facilitated the logistical organization of both the banding and area search efforts.

The same methodology was used in the winter, as was described in the area searches during the breeding season section above. The only changes to the methodology were the change in times surveyed, as previously detailed. For the winter area searches, species richness and species diversity were calculated for each year and for the entire 4-year period. A Renkonen Index of Community Similarity was calculated between sequential years, for all four years, and for the first and last year.

Total Vegetation Volume

In 2003 vegetation measurements were instituted at all banding sites that would tie in specifically to data collected from banding efforts. Initially, it was decided to measure vegetation twice a year, once during summer banding, and once during winter banding. Data from the winter were only collected in the 2003-04 and 2004-05 seasons, as it was determined to be unnecessary to collect data more than once a year.

The protocol was based on Mills et al. (1991). This information was collected once during the winter banding season. At each site, measurements were taken from a starting point located at the center of each net lane. Two randomly chosen transects were established from each net lane. One transect was run on either side of the lane, at a length of 20 m. Along each transect, points were taken at every 2 m for a total of 20 points taken from each net lane. At each point, a 7.5-m pole was used to measure vegetation “hits” at every 10-cm section of the pole. At every 10-cm section, a hit was recorded if any vegetation fell within a 10-cm radius of the pole. This gave measured sections of 0.1 m tall and 0.1 m radius. For each hit, the plant species was recorded. Hits were estimated for all vegetation over 7.5 m in height. The data were then used to estimate TVV for each meter of height, and for the entire site as a whole. The data were also broken down to the relative percentage of each plant species surveyed over the entire site and per meter of height. Transects were staked and flagged to allow exact location of each transect in future surveys. TVV was calculated using the formula:

$$TVV = h/10p$$

where h = the total numbered of hits recorded for all the plots measured at one site, and p = all the decameter height sections measured.

General Vegetation Monitoring

In December 1999, 196 Fremont cottonwoods and 200 Goodding's willows were randomly selected from the potted sections. DBH, height, condition, and foliage area were measured. The number of live trees in seeded areas #1 and #2 were counted and a random sample of each species was measured. Trees were selected at random by establishing a transect through each section and selecting points an equal distance apart. Distances were measured using a GPS unit. Four trees were measured at each point, one in each of the four cardinal directions (Raulston 2003).

In the winter of 2000, 100 trees of each species (Fremont cottonwood and Goodding's willow) were measured in potted #2, and 100 of each species in potted #3. DBH, height, and condition were measured. The number of live trees in seeded areas #1 and #2 were counted and 10 percent of each species were measured for DBH, height, and condition (Raulston 2003).

Beginning in 2001 and continuing to 2005, trees were monitored for height, DBH, and condition in all sections at the Pratt Agricultural Restoration site during the fall or winter of each year. In the potted sections, each tree was counted and categorized by species, whether it was live or dead, and whether it had been cut. In potted sections 1-3, Fremont cottonwood and Goodding's willow were randomly selected and height, DBH, and condition were recorded. In potted 4, coyote willow were also randomly selected and measured along with the other tree species. Height was measured using a telescoping level rod up to 7.0 m. If the height of the tree was greater than 7.0 m, a clinometer was used. DBH was measured using a steel diameter tape.

Within the seeded sections, a transect was run diagonally across the section and at random points along the transect, and trees were measured in each cardinal direction for height, DBH, and condition. In seeded areas 1-2, density was also measured. We measured density by walking a transect and counting all trees, including saltcedar, that fell within 5 ft on either side of the transect. Density was calculated per hectare by extrapolating the number of stems counted and the total size of the transect measured (in square meters).

Small Mammal and Bat Species

Some presence surveys for small mammals using Sherman live traps were conducted at the Pratt site over the winters of 2004-05 and 2005-06. ANABAT acoustic surveys were also conducted for bat species in 2005-06. These projects are ongoing and have not yet gathered enough data for meaningful analysis. Therefore, the data will be summarized in future annual reports of bat and small mammals and will not be summarized here.

Results

Southwestern Willow Flycatcher Surveys

The number of area searches conducted at the Pratt site was changed as the protocol was adapted to changing needs and goals of the monitoring program. In 2002, three area searches were conducted, in 2003, four were conducted, in 2004, nine were conducted (10 were planned but 1 was missed due to weather), and 10 were conducted in 2005. Over the 4-year period the transformed Shannon-Weaver Index of Species Diversity was calculated to be 16.922. Species richness for the 4-year period was 40. Only two species, the mourning dove (*Zenaida macroura*) (16%) and the red-winged blackbird (*Agelaius phoeniceus*) (17%), made up more than 10% of the total number of species detected.

Table 1. Results of WIFL surveys by year, with number of periods with at least 1 detection.

	2002	2003	2004	2005
Residents	0	1	0	0
Migrants	19	4	32	13
# of Periods	5	3	5	4

Table 2. Average total bird detections for all sections, per year, for all birds and resident birds.

	2002	2003	2004	2005
Resident	64.00	69.50	59.78	75.40
All	74.00	70.75	65.00	76.10

Table 3. Transformed species diversity values (N_1) for each year, for resident species and for all species detected.

	2002	2003	2004	2005	Standard Error
Resident	5.70	13.73	15.90	14.43	2.292
All	7.96	14.84	18.39	15.60	2.216

Table 4. Renkonen Index values for community similarity, for resident species and for all species detected. All four years, and each 2-year period are compared.

	4 year	02-03	03-04	04-05
Resident	0.170	0.359	0.607	0.772
All	0.157	0.331	0.580	0.741

Table 5. Species Richness, per year, for resident and all species detected.

	2002	2003	2004	2005
Resident	19	26	32	33
All	23	27	37	38

Figure 1. Yearly Comparison of commonly detected species with standard error bars.

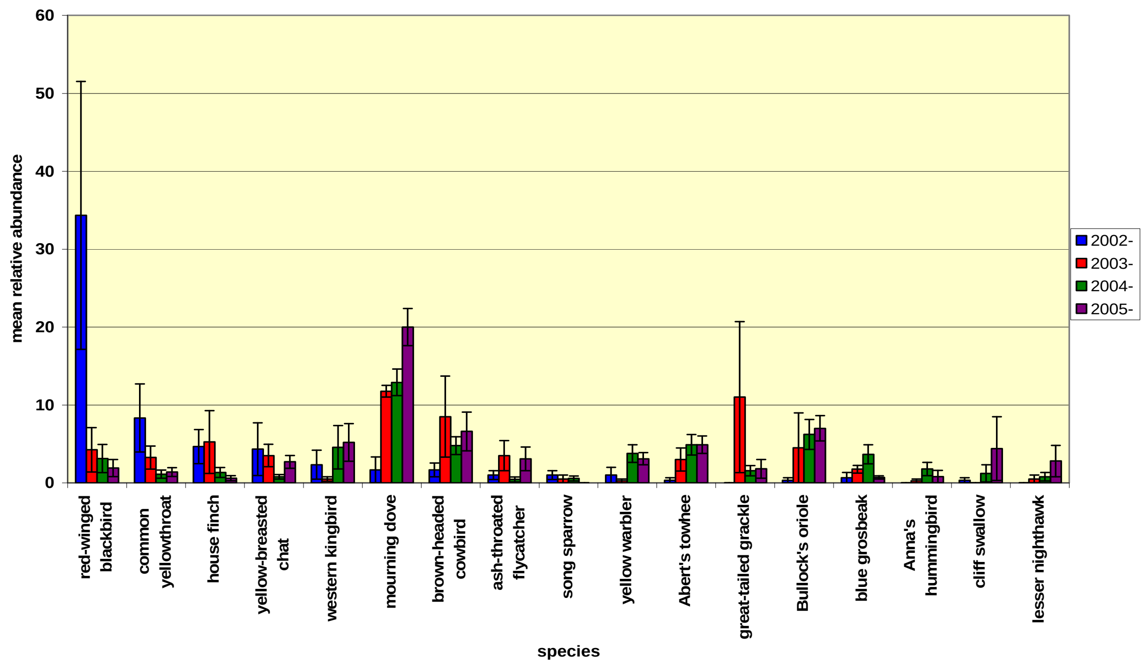
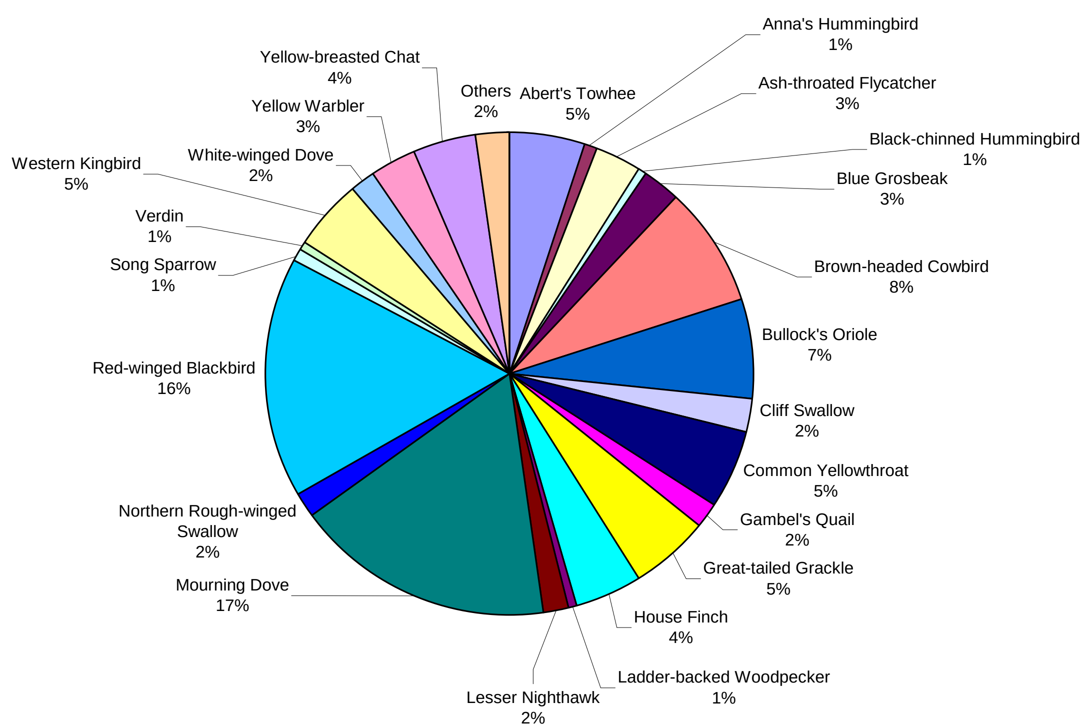


Figure 2. Pie Chart of relative percentage of detections per species, for resident birds, over the entire four years of surveys.



Winter Banding

Over the four years of winter banding a total of 33 species were captured, and 1871.03 net hours of banding were conducted. A total of 679 birds were captured that were uniquely individual to a banding season. The four-year average for birds captured per net hour was 0.363; the birds per net hour for each year are summarized in Table 6. Each year a decline was experienced in the birds per net hour rate. The species diversity values (N_1) increased for each year (Table 5) and the Renkonen index of community similarity was above 50% for all yearly comparison except for the four-year comparison, which was slightly below 50% (table 7). For the entire four-year period, the transformed species diversity value (N_1) was 5.300.

Three species made up the large majority of the captures for all species. These species were the ruby-crowned kinglet (*Regulus calendula*), Audobon's (yellow-rumped) warbler (*Dendroica coronata auduboni*), and the orange-crowned warbler (*Vermivora celata*). Together, these three species comprised 85% of all captures over the four-year banding period (Figure 3), and no other species comprised more than 2% of total captures.

Annual return rate and over-winter site persistence were calculated for the three most commonly captured species; no other species had a large enough sample size to allow any meaningful results to be calculated. Figure 5 shows these rates for the ruby-crowned kinglet and the orange-crowned warbler. No results are shown for the Audobon's warbler because no inter-period captures, and only one annual return, occurred for this species.

Table 6. Species diversity values (N_1) per year, with standard error, for all four years.

2002-03	2003-04	2004-05	2005-06	Standard Error
3.388	5.526	4.458	6.335	0.641

Table 7. Birds per net hour for all individuals captured, per year.

2002-03	2003-04	2004-05	2005-06	Standard Error
0.493	0.392	0.297	0.258	0.053

Table 8. Renkonen index values of community similarity between subsequent years, for all four years, and between the first (02-03) and last (05-06) years.

02-03 & 03-04	03-04 & 04-05	04-05 & 05-06	All 4 years	First and last
0.799	0.625	0.567	0.468	0.701

Figure 3. Captures (in birds per net hour) totaled for the four years of banding, by species. All birds captured in numbers which total less than 1% of all captures are combined into the "others" category.

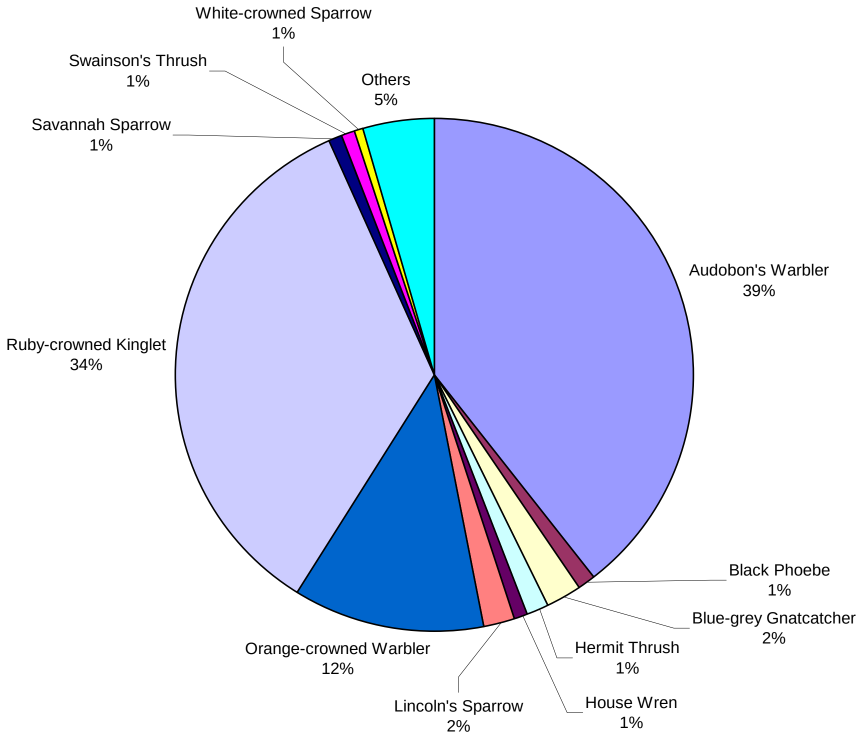


Figure 4. Birds per net hour for the three commonly captured species, per year.

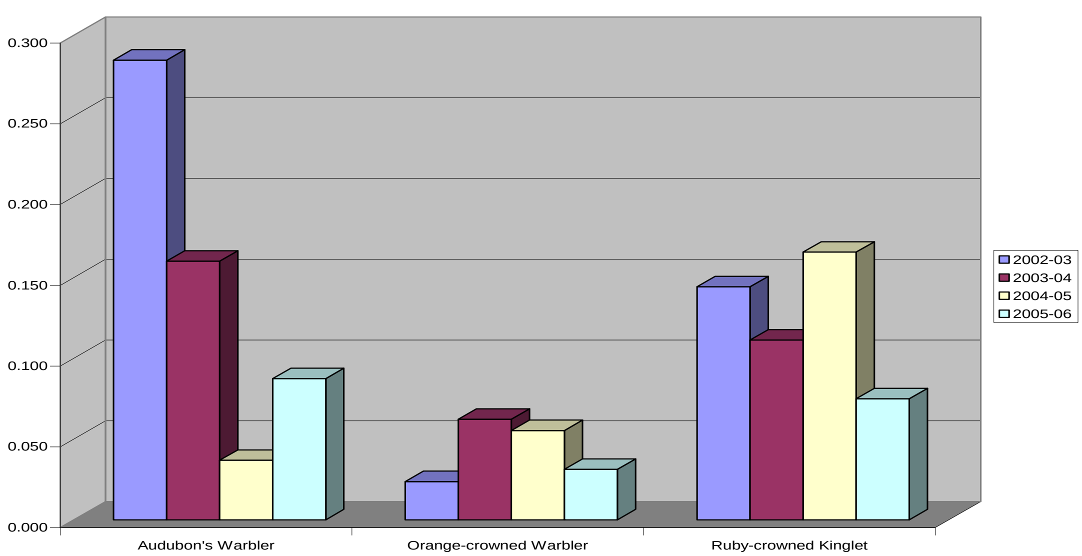


Figure 5. Overwinter site persistence for two of the three most commonly captured species.

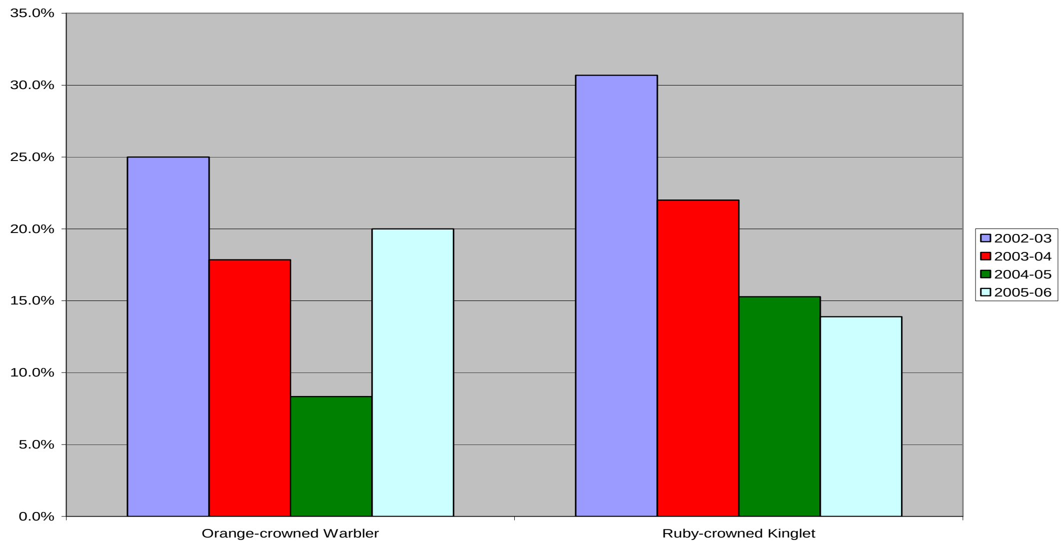
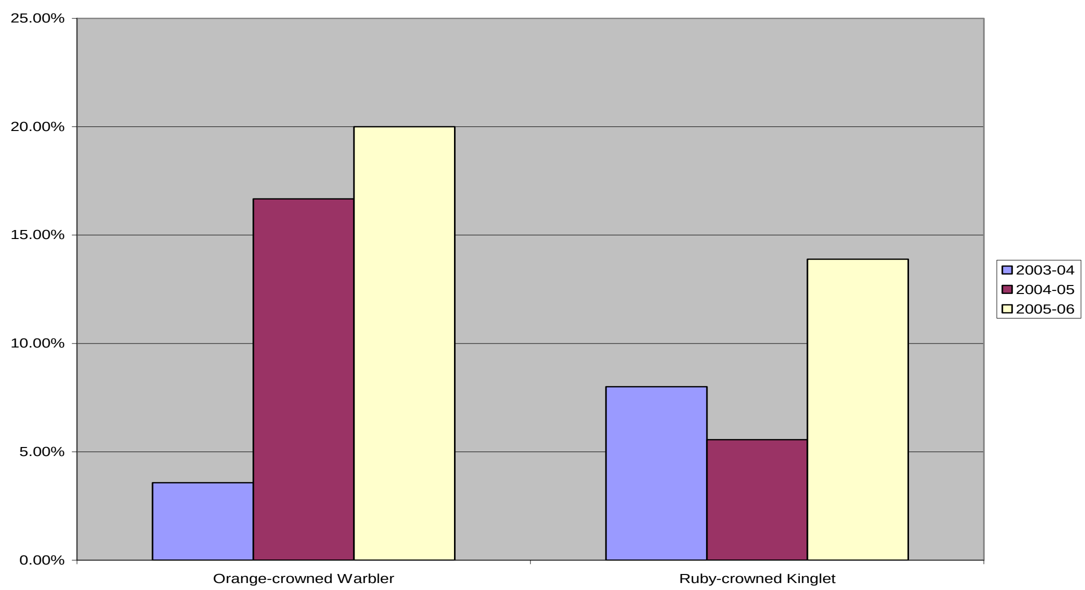


Figure 6. Annual return percentages, per year, for the two of the three most commonly captured species (only one annual return was recorded for Audobon's warbler).



Winter area search

In each period winter banding was conducted, one area search was to be conducted. For various reasons some area searches could not be conducted. In 2002, two searches were conducted, in 2003, two searches were conducted, in 2004, three searches were conducted, and in 2005, four searches were conducted.

Table 9. Species diversity values (N_1) for each year.

02-03	03-04	04-05	05-06	Standard Error
3.922	4.735	4.221	6.708	0.627

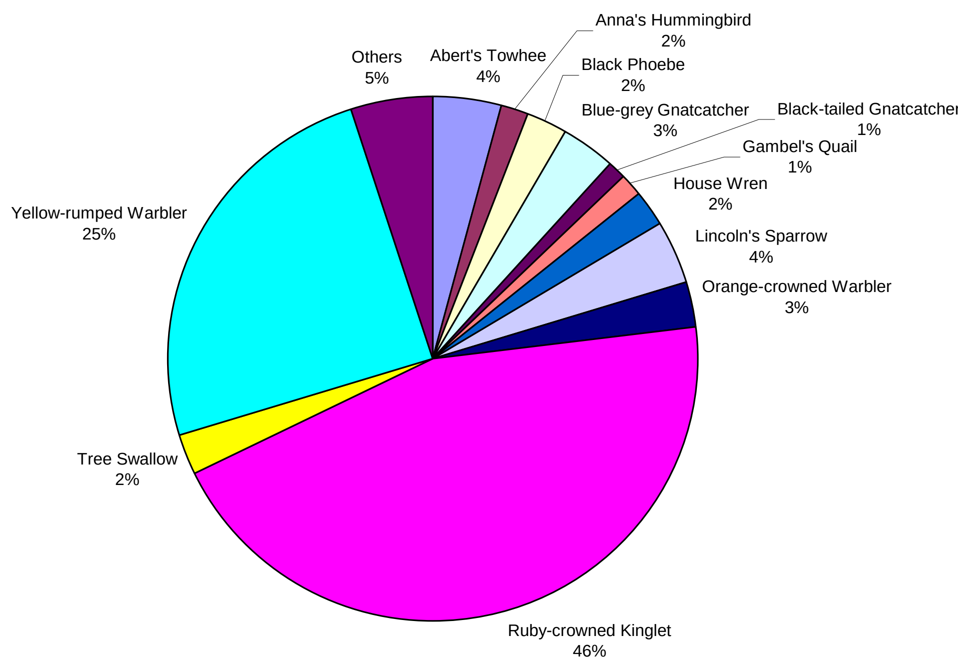
Table 10. Species richness per year.

02-03	03-04	04-05	05-06	Standard Error
8	13	12	16	1.652

Table 11. Renkonen index values for for sequential years, all four years, and the first and last years of monitoring.

Year 1 & 2	Year 2 & 3	Year 3 & 4	All 4 Years	First & Last
0.614	0.380	0.415	0.352	0.633

Figure 7. Pie chart demonstrating relative detections for each species commonly detected; species with less than 1% detections are grouped into "others".



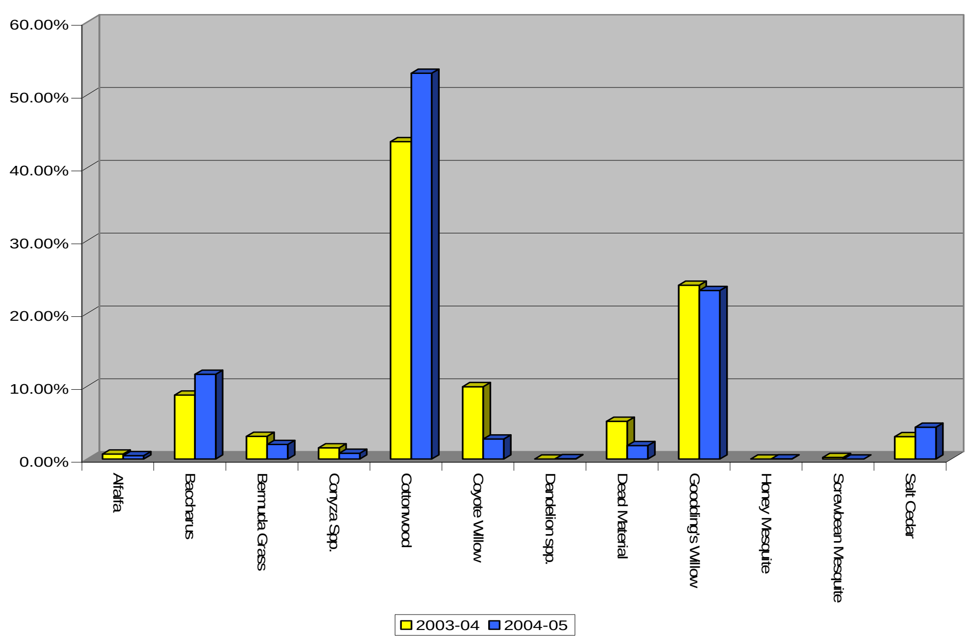
Total Vegetation Volume

For the 2003-04 season, 10 nets were operated and 20 transects were surveyed. During the 2004-05 season, 12 nets were operated and 24 transects were surveyed. For each year the transformed diversity index (N_1) was calculated; in 2003-04, N_1 was 3.980, and in 2004-05, N_1 was 5.096. In 2003-04, 11 species were encountered, and in 2004-05, 10 species were encountered.

Table 12. Percent vegetation found at each meter layer, per year.

Meter Level	2003-04	2004-05
0-1	21.05%	22.25%
1-2	22.60%	25.21%
2-3	23.35%	26.46%
3-4	20.10%	22.17%
4-5	18.85%	21.54%
5-6	14.90%	16.13%
6-7	6.50%	15.42%
7-8	2.00%	12.92%
8-9	1.05%	7.63%
9-10	0.45%	3.00%
10-11	0.10%	1.04%
11-12	0.00%	0.04%

Figure 8. Relative percentage for each species surveyed, for all hits of vegetation, per year.



General Vegetation Monitoring

A standard methodology for surveying growth of the created vegetation at the Pratt site was implemented in 2001. Before that, in 1999 and 2000, a somewhat different methodology, which divided the site based on planting scheme, was used to measure height and DBH of randomly selected trees at the site. The results are summarized in tables 13 and 14 below.

Table 13. Summary of tree measurements taken in 1999 (Raulston 2003). Standard error values for a 95% Confidence Interval are shown in parentheses.

	Rooted Stock		**Poles**		**Seed**	
	Cottonwood (n = 196)	Willow (n = 200)	Cottonwood (n = 39)	Willow (n =41)	Cottonwood (n = 170)	Willow (n= 49)
Average DBH	1.1 (.07)	2.1 (.97)	0.9 (.13)	2.1 (.21)	n/a	n/a
Average Height	2.3 (.06)	3.4 (.83)	2.1 (.16)	3.7 (.21)	1.4 (.06)	1.3 (.07)

Table 14. Summary of tree measurements taken in 2000 (Raulston 2003). Standard error values for a 95% Confidence Interval are shown in parentheses.

	Rooted Stock		**Poles**		**Seed**		
	Cottonwood (n = 201)	Willow (n = 196)	Cottonwood (n = 41)	Willow (n = 39)	Cottonwood (n = 130)	Willow (n = 87,126)	Saltcedar (n = 130, 191)
Average DBH	4.6 (.19)	4.9(.05)	4.1(.40)	4.7(.41)	2.1(.24)	3.4(.34)	0.5(.09)
Average Height	4.7(.14)	5.3(.04)	4.5(.28)	6.1(.38)	3.1(.16)	2.1(.19)	1.6(.09)

Starting in 2001, the methodology for measuring trees was standardized after the plantings were complete. The results, per year, are summarized for each section on the following pages.

Seeded 1

Table 15. Relative percentage of plant species surveyed during density transects, per year.

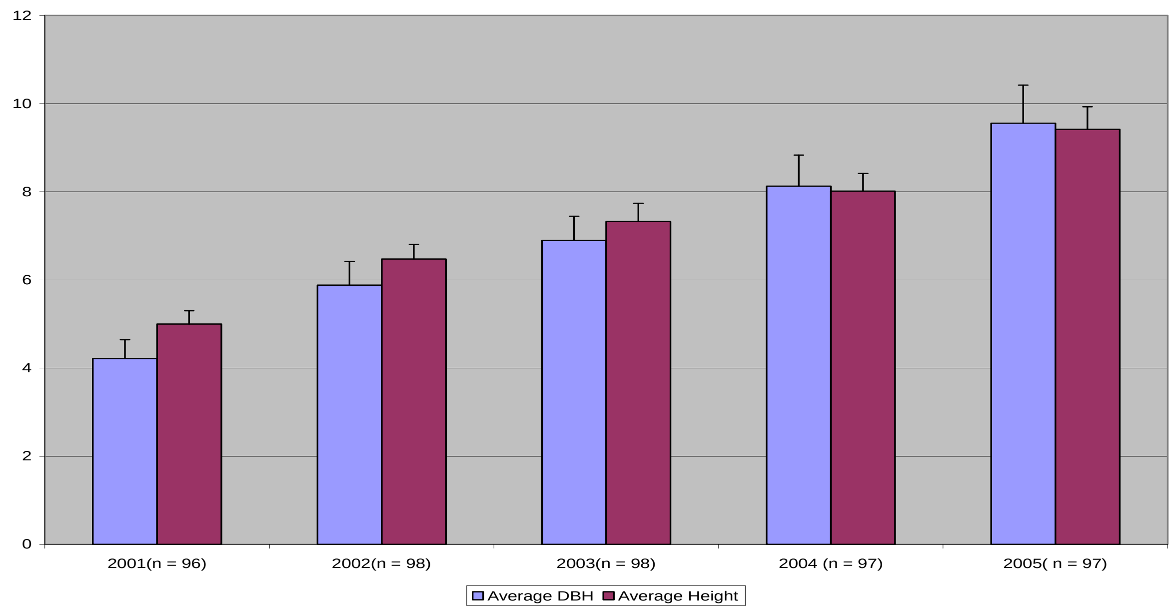
Species	2001	2002	2003	2004	2005	Average
Freemont Cottonwood	2.70%	2.82%	2.18%	1.93%	0.64%	2.05%
Goodding's willow	1.32%	1.48%	1.57%	1.38%	0.31%	1.21%
Saltcedar	95.98%	95.70%	96.25%	96.69%	99.05%	96.74%

Seeded 2

Table 16. Relative percentage of plant species surveyed during density transects, per year.

Species	2001	2002	2003	2004	2005	Average
Freemont Cottonwood	22.10%	13.70%	24.58%	27.08%	4.92%	18.47%
Goodding's willow	1.29%	0.63%	0.56%	0.55%	0.59%	0.73%
Saltcedar	76.61%	85.67%	74.86%	72.25%	65.37%	74.95%
Honey Mesquite	0.00%	0.00%	0.00%	0.11%	0.00%	0.02%

Figure 9. Average DBH (cm) and Height (m) of cottonwoods, with standard error bars (95% Confidence Interval).



Potted 1

Figure 10. Average DBH (cm) and Height (m) of cottonwoods, with standard error bars (95% CI).

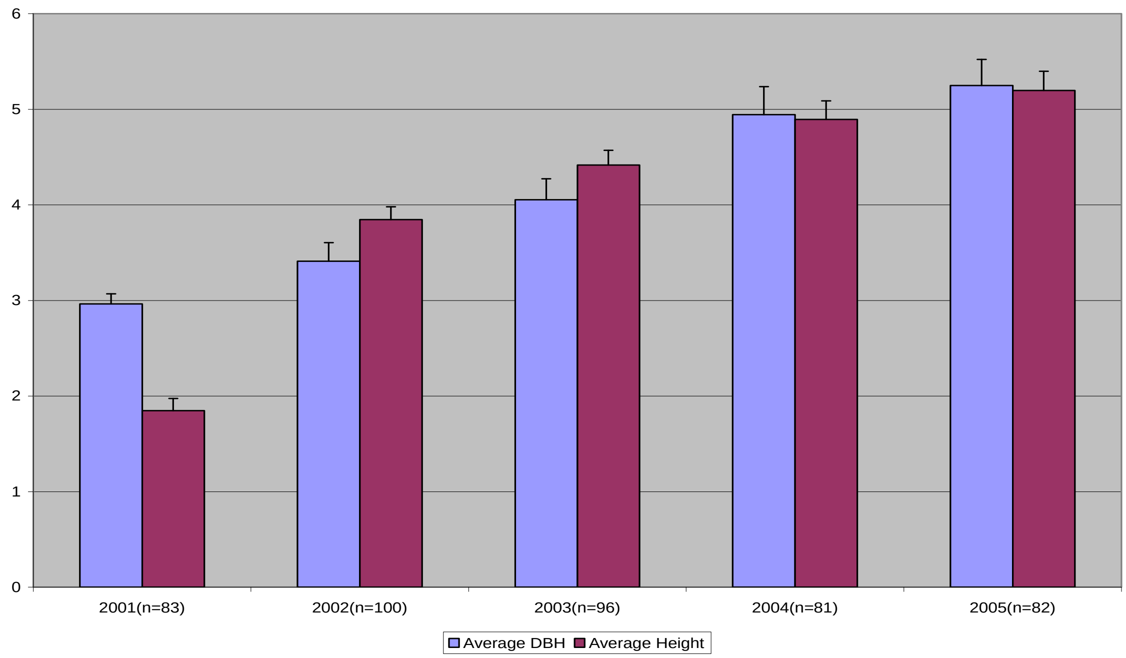
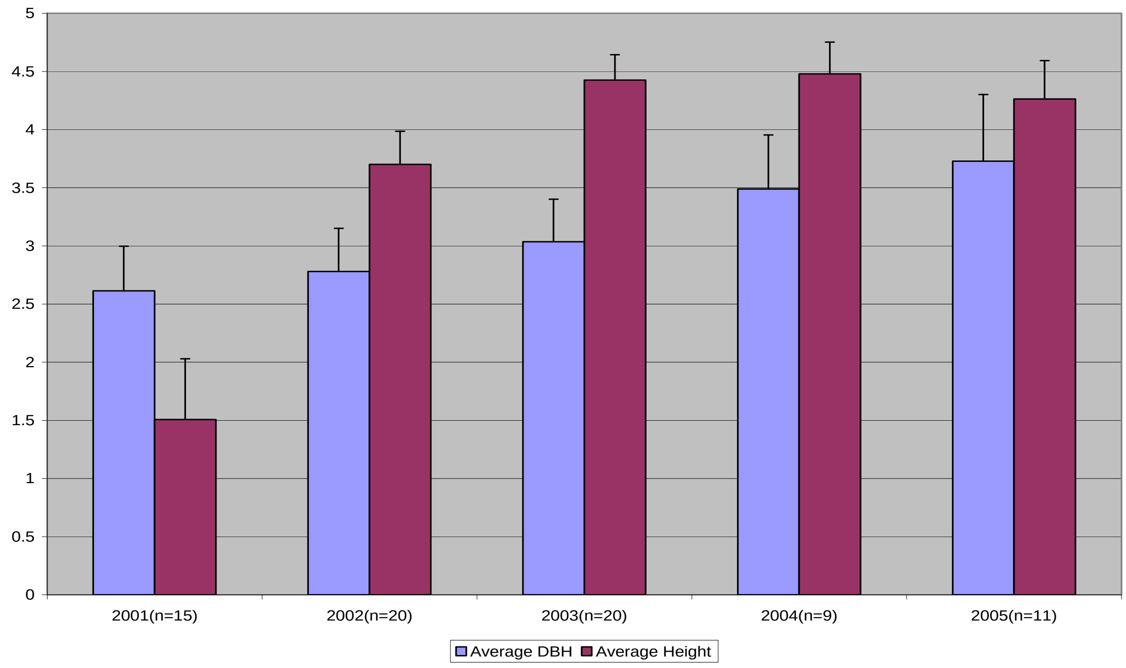


Figure 11. Average DBH (cm) and Height (m) of willows, with standard error bars (95% CI).



Potted 2

Figure 12. Average DBH (cm) and Height (m) of cottonwoods, with standard error bars (95% CI).

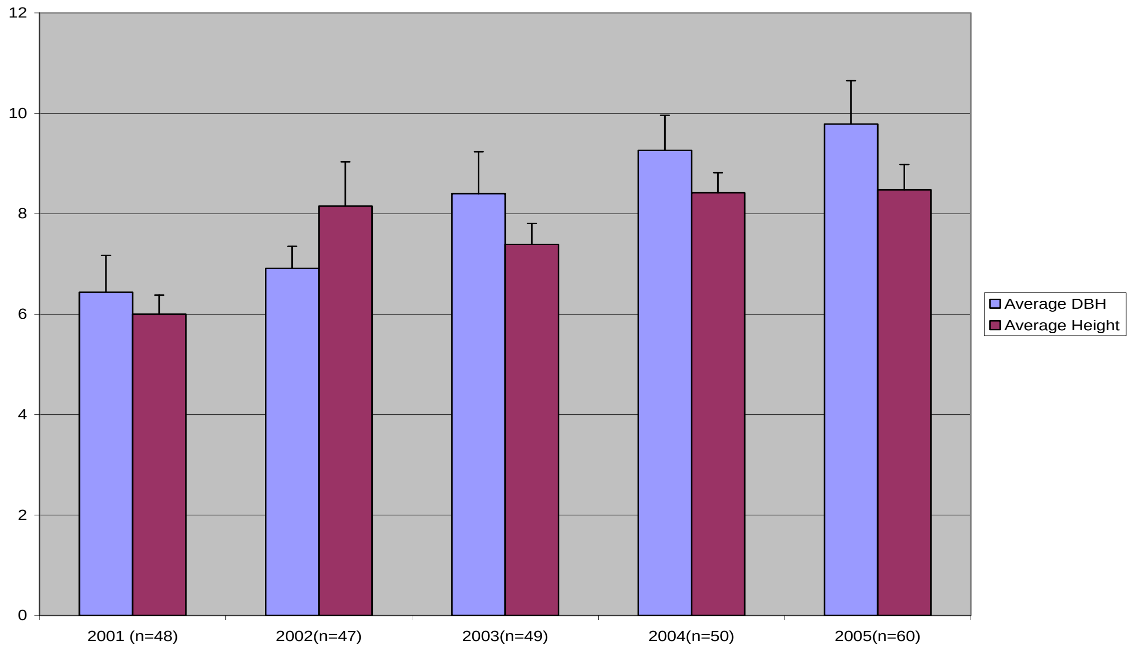
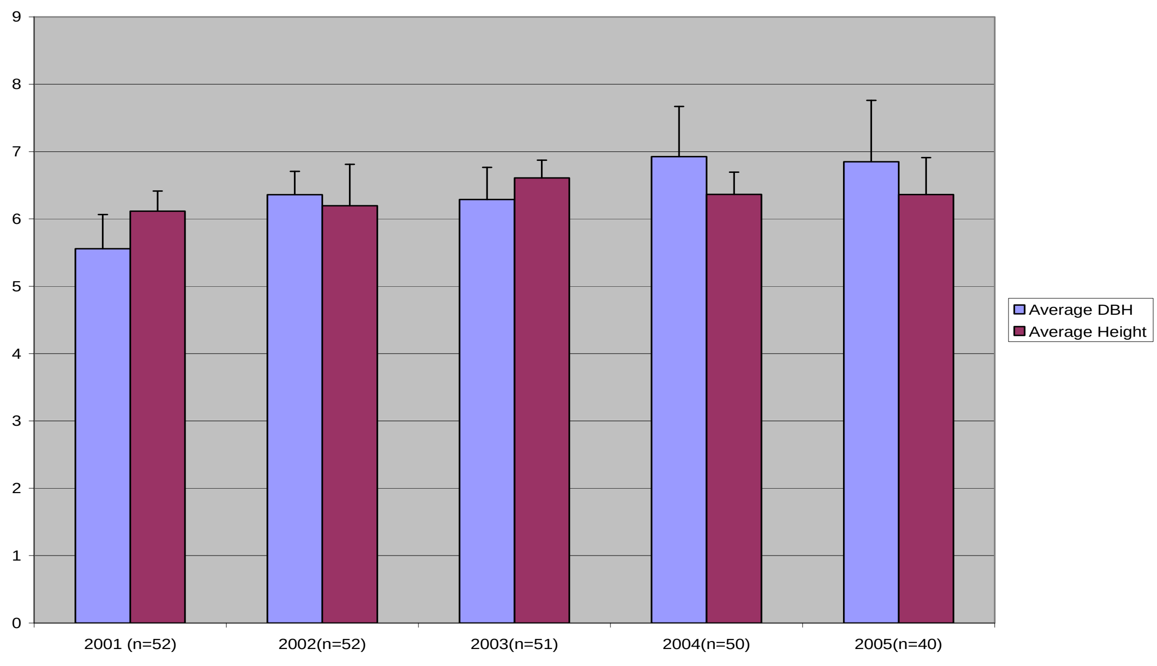


Figure 13. Average DBH (cm) and Height (m) of willows, with standard error bars (95% CI).



Potted 3

Figure 14. Average DBH (cm) and Height (m) of cottonwoods, with standard error bars (95% CI).

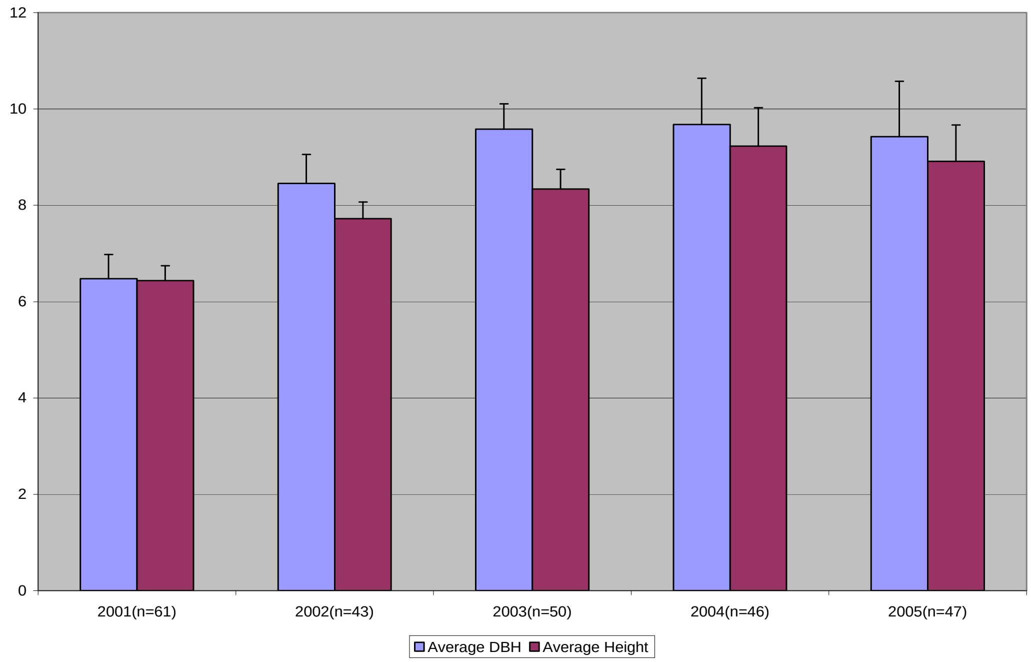
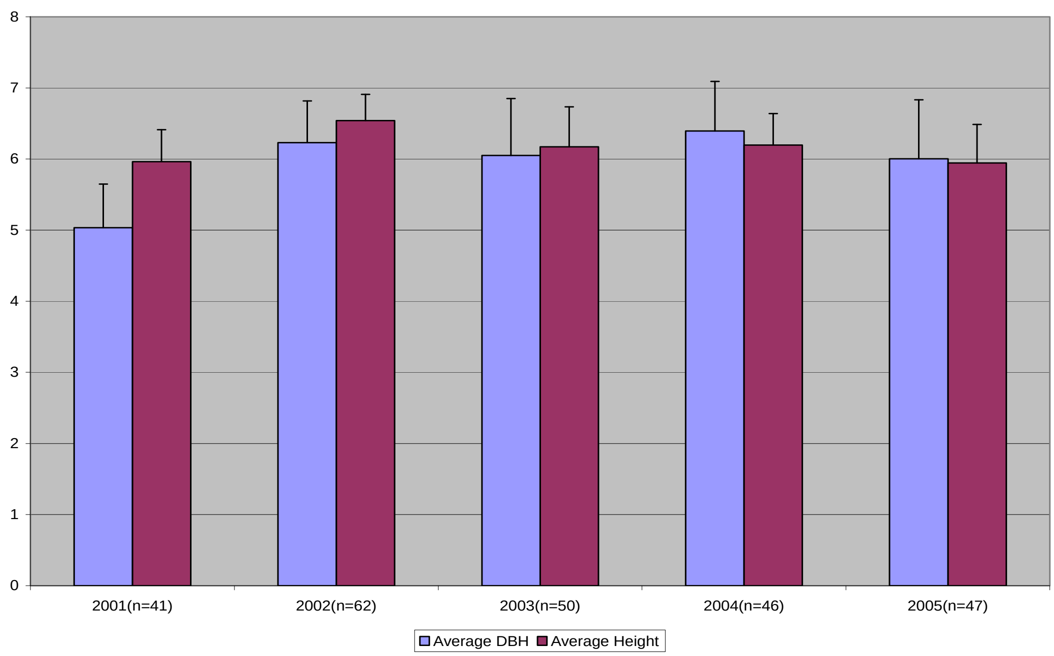


Figure 15. Average DBH (cm) and Height (m) of willows, with standard error bars (95% CI).



Potted 4

Figure 16. Average DBH (cm) and Height (m) of cottonwoods, with standard error bars (95% CI).

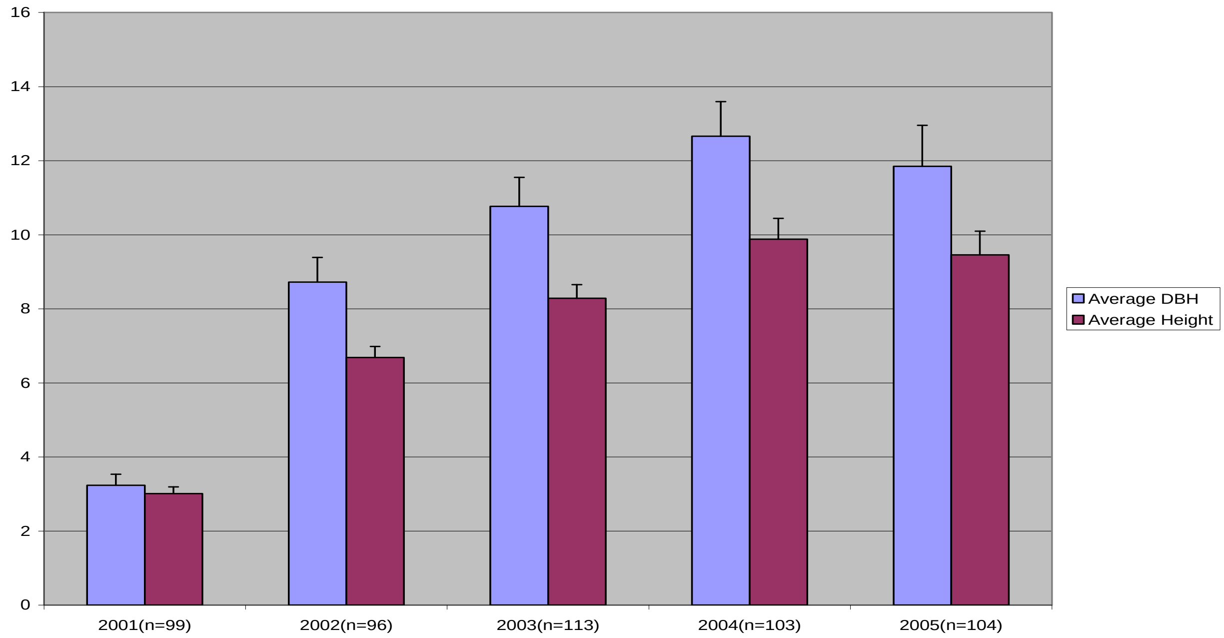
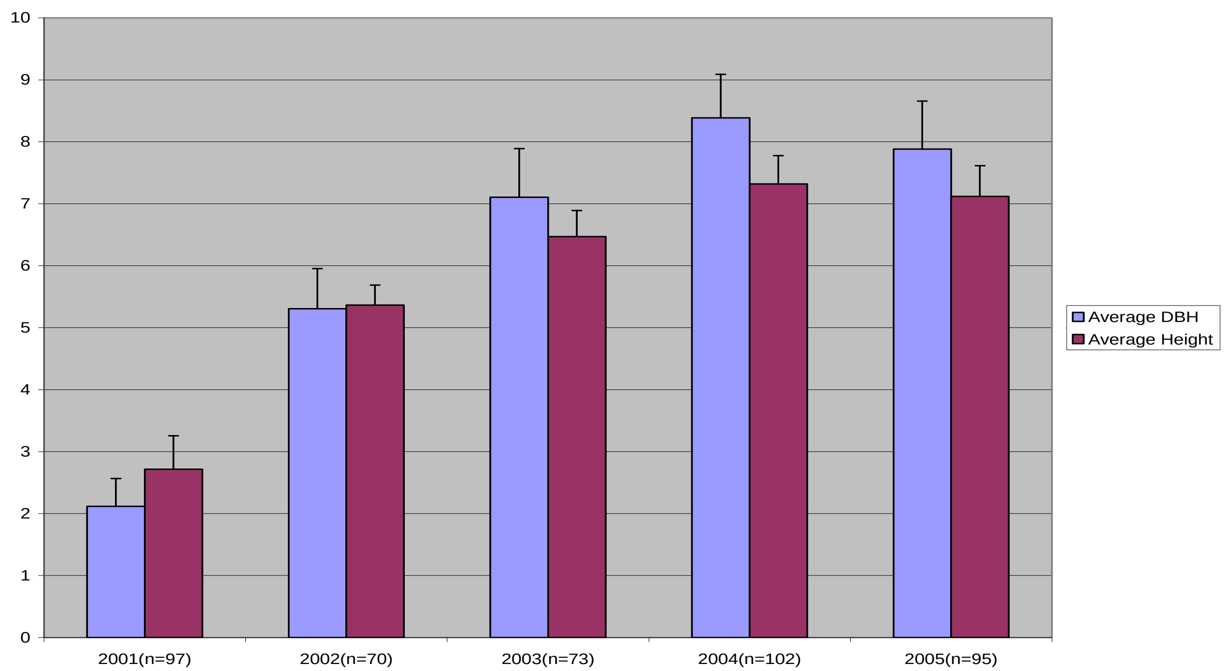


Figure 17. Average DBH (cm) and Height (m) of willows, with standard error bars (95% CI).



Discussion

Over the five years of monitoring at the Pratt site, one of the biggest factors that affected the site from year to year was the irrigation regime. This changed due to difficulties with the arrangement that was established with the leaseholder of the surrounding agricultural lands to irrigate the Pratt site. After 2003, there was very little evidence of the site being watered as regularly as had occurred during 2002 and 2003. After 2003, the site was rarely seen to exhibit moist soils, even at times when the surrounding agricultural fields were inundated.

No records were kept of the irrigation schedule for the Pratt site, but repeated attempts to increase the watering rate and obtain dates and times when the site was watered were unsuccessful. Due to the lack of a watering schedule it is not possible to determine the exact amount of decrease in the watering rate, and to correlate this to the monitoring results from the site. This may have had an effect in decreasing the quality of the habitat as dry soils are not ideal conditions for many bird species, especially species of importance such as the southwestern willow flycatcher and the yellow-billed cuckoo. No real trends can be determined from the monitoring efforts as the lack of water at the site in later years may be a confounding factor.

One of the most important lessons learned from the monitoring efforts at the Pratt site is the importance of controlling and recording the water schedule of restoration sites. It would be very helpful to determine how much water is needed on a site to promote the conditions that provide for quality avian habitat. If a precise schedule of dates and times of watering at a restoration could be kept, this could be correlated to bird numbers detected or captured during wet or dry periods.

Southwestern Willow Flycatcher

As is shown in Table 1, only one resident willow flycatcher was detected. This bird was always detected alone and did not show any signs of nesting. Most likely it was a lone, unpaired bird. Since this detection in 2003, no more birds have been detected at a date which would allow them to be designated as resident, southwestern subspecies birds.

Migrants have been documented in somewhat large numbers given the small size of the area, and the small period of time that has been sampled (Table 1). This indicates that the area is being found and used by individuals passing through. It is an open question whether the site provides proper habitat conditions for nesting southwestern willow flycatchers, but the lack of water over the last few years may have discouraged nesting attempts.

The site is fairly open, with little understory vegetation in most areas with the exception of potted section 1, and the area planted with coyote willow in potted section 4. Many portions of the Pratt site lack the dense vegetation structure below the top canopy layer that is often associated with occupied willow flycatcher habitat (Sogge et al. 1997). The canopy layer is fairly even within the planted sections, but this may change over time.

Areas are currently being randomly selected to be cut and opened up to allow secondary growth to come in and provide a second canopy layer and less homogenous structure. This is being done by the local Bureau of Land Management (BLM) office and will continue on in further years. These efforts may help to bring in new vegetation nearer to the ground layer and increase vertical foliage structure. If these efforts are combined with a more regular watering regime during the summer breeding period, the site may be more likely to attract nesting birds.

Area Searches During the Breeding Season

At the Pratt site, the only LCR MSCP covered species that made up more than 1% of all detections was the yellow warbler. This would seem to indicate that while the site has seen use by both yellow warblers and, to a lesser extent, willow flycatchers, it still may not be providing habitat for the entire suite of LCR MSCP covered avian species.

Over the four years area searches were conducted during the breeding season, the average number of detections per visit remained fairly constant (Table 2). After the first year however, the N_1 species diversity value more than doubled for both residents and all species (Table 3). This coupled with lower index of community similarity shown between 2002 and 2003, as compared to any other consecutive pair of years (Table 4), would indicate that some sort of change took place in the habitat conditions that attracted greater avian diversity to the site. The most likely explanation is that a certain canopy height and vegetation density was reached that allowed utilization of the habitat by more species. Other factors, such as weather patterns, may have also played a role in this increase in diversity and species richness. After the noticeable increase in 2003, both species richness and species diversity stayed at relatively similar values (Table 3).

A final, confounding factor in trying to draw any solid conclusions from these results is the increase in area searches, which started in 2004. Only 3 or 4 area searches were conducted in the first two years, while 9 or 10 were conducted in the last two years. An increase in area searches would increase the chances of detecting more species, especially rare species, and this would increase species richness. However, rare detections would be less likely to affect species diversity values as these values are based both on number of detections per species, and species richness. With more area searches, the number of detections of common species should also increase, lessening the impact of the increased number of rare species detected.

In summary, the area searches may indicate that after 2003, the species diversity increased while overall bird numbers stayed relatively stable. While the number of birds using the habitat may have been near carrying capacity throughout the study, more species types began using the site after 2003. These conclusions are tentative however, due to the changes in the number of yearly surveys and the changes in the frequency of watering at the site.

Winter Banding and Area Searches

Both methods for surveying winter bird use will be discussed together because, when taken together, the two methods provide a more complete analysis of winter bird use. Generally, large species such as corvids and raptors are not captured in banding designed for passerine species, and small, cryptic species of birds, such as sparrows, are not detected very easily during area searches. Therefore, depending on the species, one method or the other is more likely to give greater accuracy and precision to the estimates of bird use.

As is demonstrated in Table 6 and Table 9, the species diversity values for the banding results and the area searches were fairly similar. In the banding data, three species dominated the captures (Figure 3) and in the area search data, two species dominated the detections. Both yellow-rumped warblers (Audobon's) and ruby-crowned kinglets were captured or detected at rates greater than 25%. Orange-crowned warblers were captured at a rate of 12%, but were only detected at a rate of 4% in the area search data. Orange-crowned warblers are less vocal than these other two species, and more cryptic and difficult to detect visually. This would account for the lower detection rate in the area search data, and the banding data is more likely to accurately reflect their relative presence at the site.

This means that from the banding data, it can be shown that three species, Audobon's warbler, orange-crowned warbler, and ruby-crowned kinglet comprised 85% of the birds using the site during the winter (Figure 3). No other species was captured at a rate greater than 2% (Figure 3) and no other species was detected at a rate greater than 4% (Figure 7). This indicates that the site was utilized extensively by these three species, and other species used the site only marginally. This could be caused by several factors including the lack of water, the lack of undergrowth at much of the site, and a lack of nearby suitable habitat.

Another factor limiting species diversity could be the lack of mesquite and dense grass habitat at the site. At the Cibola Nature Trail restoration site, which does have a grass/mesquite habitat component, there was greater species diversity than was found at the Pratt site, for each year surveyed. For three of the four years surveyed at both sites the species diversity value was more than double that of the Pratt site (2005-06 being the exception) (Reclamation 2007). This is mostly due to the presence of several sparrow species which are found in the grass/mesquite habitat at Cibola Nature Trail, but are mostly absent at the Pratt site. This would indicate that the presence of mesquite and dense, grassy habitat at ground level can increase overall bird diversity of a restoration site, during the winter.

For both the ruby-crowned kinglet and the orange-crowned warbler, use of the Pratt site was shown to be long-term. Both the winter site persistence rates (Figure 5) and annual return rates (Figure 6) were substantial. This would indicate that both these species are using the site consistently throughout the winter season, and that they are returning to the site in subsequent years. This information is important as it demonstrates that this site is likely preferred habitat for those individuals of these two species utilizing it. As both of these species spend more of their annual life cycle on their wintering grounds than anywhere else; the data supports the idea that the Pratt site is important habitat for both of these species.

Wood warblers, in general, have adult annual survival rates between 36% and 67% (Sibley 2001). The orange-crowned warblers increased their annual return rate every year with a high of 20% in the final year of banding. Given the fairly high annual mortality of birds of this type, and the fact that some returning birds may not have been captured, an annual return rate of 20% indicates that many birds that utilize the habitat in a particular winter, and survive to the next winter, are returning to the site in subsequent years. No annual survival rate is available for the ruby-crowned kinglet, but the annual return rate for this species is also substantial. This may indicate that the site is providing habitat of a quality that encourages regular and repeated use of the site, by these species.

The Renkonen indices of community similarity are variable both within and between the banding and area search data. This would follow the general pattern of use that has been seen at both the Cibola and Pratt site over the four years of winter monitoring. The three main species are seen in substantial numbers every year, but the occurrence of other species varies greatly between years. This leads to changes in the overall species present at the site from year to year and would explain the sometimes low values in similarity when comparing one year’s data to another.

Vegetation Monitoring

Much of the vegetation monitoring was largely descriptive in nature and as such demonstrates the growth of the trees. In most of the plots the height and DBH tended to level off in the last two years of monitoring (figures 9-17). This would indicate that the stage of rapid growth ended after 2003 and over the last two years of monitoring the trees reached a point where growth was slowed but continuing.

The largest trees, both in terms of height and DBH, were found in the potted 4 section (Figure 16 and 17). The smallest trees were found in the potted 1 section (Figure 10 and 11). This may be explained by the fact that the irrigation system has the gate that brings water into the site is locate in potted section 4. This side always receives the most water, as the water starts from this side and spreads out to the other side where potted section 1 is located. In potted section 1 a dense stand of *Baccarus* spp. came in naturally along with the trees, and persists as of early 2007. This stand of *Baccarus* spp. is competing with the trees for water, and this has likely had an effect on the growth of the trees in this section.

The vegetation monitoring results show that saltcedar did not become established in any of the sections except those which were seeded. In both seeded sections 1 and 2, saltcedar was the dominant species, comprising 97% and 76% of the vegetation, respectively (Table 15 and 16). This would indicate that the seeding method used here (hand seeding) was not very successful in establishing a cottonwood-willow habitat and changes should be made to this method if it is to be used in the future.

The total vegetation volume measurements were not set up to monitor the site as a whole, but instead were designed to monitor vegetation as it pertains to the locations where banding is conducted within the entire site. As such, the measurements show the density of vegetation, by species, in locations where birds were captured. The results are what would be expected for a cottonwood-willow restoration site—that the site comprises mainly cottonwoods, Goodding's willows, and coyote willows. The two other principal species, which came in naturally and without being planted, were saltcedar and Baccharis (Figure 8).

Summary

The Pratt Agricultural restoration site was one of the first demonstration projects restoring cottonwood and willow habitat initiated by Reclamation. As such, this project has provided a large amount of valuable information and should provide some direction to future restoration projects. Despite some problems in the management of the site, which has made it difficult to interpret the data, many lessons can be taken away from this effort.

One of the largest obstacles at the site was the inconsistency in the effort to irrigate the created habitat. This lead to possible biased results, as some years more water was put on the site than in other years. This is based on personal observations of those who collected the data from the site. Issues that were the largest problems experienced at the site over the four years of monitoring were the lack of water in the last two years monitoring efforts took place, and the lack of a method to track when the site was irrigated and the amounts of water irrigated. It is very important that both of these issues be resolved for future restoration efforts.

The importance of habitat structure and diversity in promoting diversity in the avian use of restored habitats stands out after the analysis of data. As compared to the Cibola Nature Trail site, the Pratt Agricultural site had less understory, ground cover, and plant diversity. This was partly by design, as mesquite was planted at Cibola and not at Pratt. When comparing the two sites, Cibola had higher avian species diversity, banding capture rates, and area search detections (Reclamation 2007). While these numbers were likely affected by different watering amounts at each site, it is probable that the diversity of habitat, and the dense vegetation structure contributed to the increased species diversity at the Cibola site.

Future restoration efforts may want to attempt to encourage dense habitat to develop, such as is found in potted section 1, or in the area planted with coyote willows in potted 4. The willow flycatchers that did use the site were usually found in the denser and higher trees of potted section 4. In some of the areas such as potted sections 2 and 3, there was very little understory, and this would not be as likely to develop as willow flycatcher habitat (Sogge et al. 1997).

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Appendix A. Aerial photo of the Pratt Agricultural Site. 1 = potted area 1; 2 = seeded area 1; 3 = seeded area 2; 4 = potted 2; 5 and 6 = potted 3; 7 and 8 = potted 4. Red lines indicate location of nets used for banding.