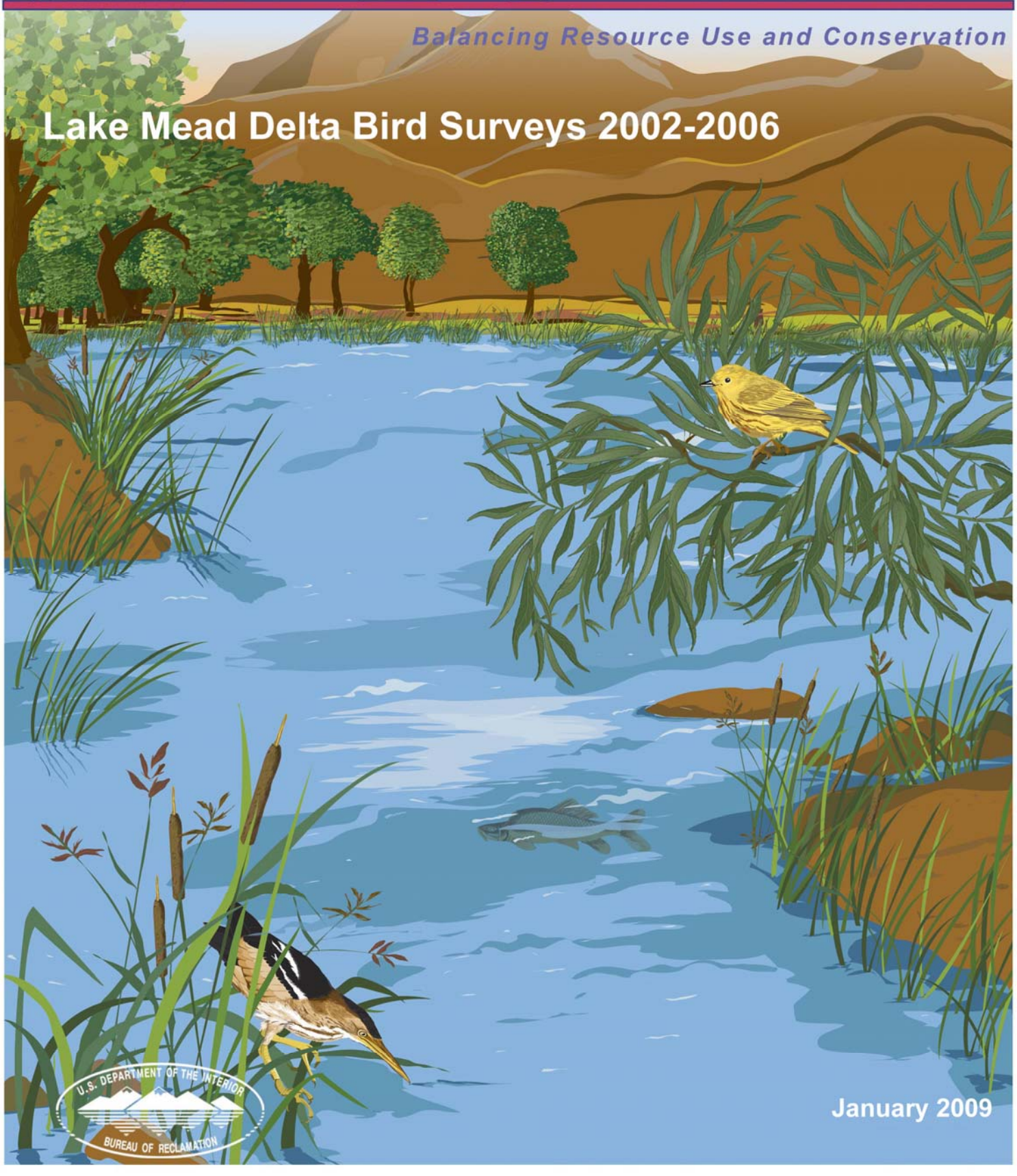
Lower Colorado River Multi-Species Conservation Program

Balancing Resource Use and Conservation

Lake Mead Delta Bird Surveys 2002-2006



January 2009

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Lower Colorado River Multi-Species Conservation Program

Lake Mead Delta Bird Surveys 2002-2006

Prepared by Christopher Dodge, Wildlife Group

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

January 2009

Introduction

From 2002 to 2006, the Bureau of Reclamation (Reclamation) conducted a series of point counts on the Lake Mead Delta. This area is located just west of the boundary of Grand Canyon National Park, within the full-pool elevation of Lake Mead reservoir, where the waters of the Colorado River flow out of the canyon through a short stretch of relatively flat land before entering the northeastern portion of Lake Mead. In some years, this delta area is covered in water, creating a wide, shallow stretch of river just before the entrance to the lake. However, in years where the water levels in Lake Mead are significantly reduced, parts of the area become very shallow or completely exposed. This leaves an ephemeral habitat for native willows (Goodding's willow, *Salix Goodding'sii,* and coyote willow, *Salix exigua*), tamarisk (*Tamarix ramosissima*), and a few cottonwoods (*Populus fremontii*). Riparian species have a high growth rate and can quickly establish themselves in a previously inundated area depending on such variables as time of year, type of exposure, and speed of occurrence. With dry land exposure, small forests of willow interspersed with tamarisk and cottonwood form along the banks of the Delta. In the past, little attention was paid to the possible use of this area by migrating and breeding birds, with the exception of the southwestern willow flycatcher (*Empidonax trailii extimus*). Southwestern willow flycatcher surveys have been conducted from 1996 to the present.

The Delta area has a great potential for use by a large and diverse number of avian species, but may be limited in its importance due to its ephemeral nature. From 1997 to 2002, the Delta had a vegetation community that was largely composed of native willow, with relatively low numbers of tamarisk (McKernan 1997) providing nesting habitat for southwestern willow flycatchers (Mckernan 1997, and Mckernan and Braden 1998-2002). The native willow and cottonwood ecosystem is important for many bird species, and is used for breeding, migration stopover, and as wintering habitat. Ephemeral habitats of this type used to be common along the Colorado River and formed the principal habitat for most birds utilizing the river (Rosenberg et al. 1991). However, over the last century, much of this habitat has disappeared and has been replaced by nonnative species. As a consequence, bird numbers and diversity have decreased along the Lower Colorado River (Rosenberg et al. 1991).

Methods

Point Count Surveys

The point count surveys were carried out using a modified protocol established for Nevada's Breeding Bird Monitoring Plan (Ammon 2001). This protocol closely follows the general point count protocol, which is widely used in the United States (USDA Forest Service 1995). A total of 21 points (the Delta Points) were selected from a satellite image of the study area, with the points placed 250 m apart in a grid system. In 2004, six more

point counts (the MB Points) were added to survey newly emergent vegetation that formed along the banks of the river, after the condition of the original vegetation had degraded. Conducted between sunrise and 10 a.m., each point count was sampled a total of three times: once each in May, June, and July. After the first year of surveys, point counts were not conducted past 9 a.m. due to the lack of bird activity past this time. In 2002, the study area was divided into two sections containing 10 points and 11 points, respectively, so that two surveyors could complete the count in one morning. In 2003, new challenges arose as habitat grew and plants became more difficult to walk through. Increases in vegetation height and density made it harder to complete the points in the time allowed, so the points were completed over two consecutive mornings by two observers. When the MB Points were added in 2004, these were also incorporated into the two mornings of surveys. The point counts were located using a GPS receiver.

From each point, observers identified individual birds within hearing or sight distance. For each bird detected, the distance from the observation point to the bird was estimated by the observer and recorded on the data form. The data form consisted of a center point representing the observer location, and two concentric circles representing a radius of 50 m or 100 m from the observer. Surveys were conducted for a total of 10 minutes. Detections were divided into three time periods. These time periods were 0-3 minutes, 3-5 minutes, and 5-10 minutes. The division of detections into discrete time periods was done to allow comparison with other point count protocols, which use varying time periods. For each bird seen or heard, the observer recorded whether the bird was singing, calling, in territorial display, engaging in nesting/mating behaviors, observed only, or seen only as a flyover. In addition, wind speed, percentage of cloud cover, start and stop time, temperature, date, observer name, and UTM location were recorded for each point. All identifications were made based on observer knowledge, and with the use of the Sibley (2000) and National Geographic (1999) field guides.

Vegetation Monitoring

In 2003, the second year of the monitoring study, vegetation was monitored using the basal area method. Twelve points of the 21 points where point counts were conducted that year were surveyed for vegetation. A 20-factor prism was used at each point to determine which trees would be measured for height and Diameter at Breast Height (DBH). The prism is used to determine which trees have a large enough diameter to be measured, and a larger diameter is needed the farther the tree is located from the observer. In addition, at each point all trees were tallied by species within a 5.06-meter radius (16.6 feet).

In 2005, the vegetation monitoring protocol was changed. The protocol was changed to the standard protocol developed by Reclamation to monitor vegetation at restoration sites. By using this protocol the vegetation monitoring at the Delta and MB Points was standardized to the same method used on other study sites along the LCR. This protocol was used in 2005 and 2006.

At randomly chosen point-count locations a vegetation plot of 0.04 hectares (0.1 acre) with a radius of 11.3 m was surveyed. Four types of sampling were conducted at each point, with measurements taken of overstory trees, sapling and shrub, understory/herbaceous layer, and vertical foliage density.

For the overstory tree measurement, all trees within the full 11.3-m plot radius measuring at least 1.37 m in height and 12.7 cm at DBH, were measured and recorded by species, height, and DBH. Trees less than 7.0 m in height were measured to the nearest 0.1 meter using a telescoping level rod. Trees exceeding 7.0 m were measured to the nearest meter using a metric clinometer. The DBH was recorded to the nearest 0.1 cm. Any individual at least 1.37 m in height and 8-12.7 cm DBH was tallied by species if it fell between 5 and 11.3 m of plot center.

Within a 5-meter radius from plot center, all tree and shrub species were measured and recorded using the following criteria. For single-stem species, any individual at least 1.37 m in height and 8 cm DBH was measured and recorded by species, height, and DBH. Any single-stem species at least 1.37 m but less than 8 cm DBH was tallied by species and DBH class (<1 cm, 1-2.5 cm, 2.6-5.5 cm, and 5.6-7.9 cm). For individuals with multiple trunks (branched between 10 cm and 1.37 m in height) that were at least 1.37 m in height, only the largest trunk was tallied using the above DBH classes. If a stem measured over 8 cm DBH, it was treated as an individual and height and DBH were measured. Individuals with multiple trunks were noted.

The understory and herbaceous ground cover was estimated by sampling four 1-m square quadrants, located 1 m from plot center in each cardinal direction. In each quadrant, percent herbaceous cover was estimated and recorded by species. All woody stems within each quadrant less than 1.37 m in height were tallied and recorded by species. If stems originated outside of the sample quadrant, they were not counted. Percent cover of bare ground and leaf litter was recorded.

At each quadrant, vertical foliage density was also measured. A 7.5-m survey rod was used to record the presence of vegetation, by species, within a 10-cm radius at one decameter intervals for a total of 10 possible “hits” (a hit consisting of the presence of vegetation within the 10 cm radius) within each meter layer. Dead vegetation was recorded as dead material but not identified to species. Percent vegetation per meter layer was calculated with this method.

Results

A total of 47 species were detected over five years at the Delta points, and a total of 35 species were detected over three years at the MB points. The following two tables demonstrate the ratio of total bird detections per point, for each year at each set of point counts.

Table 1. Total detections per point at the Delta Points.

2002	2003	2004	2005	2006
12.000	7.085	5.492	5.127	5.508

Table 2. Total detections, per point, at the MB Points.

2004	2005	2006
13.083	9.833	12.278

Chart 1. Comparison of the proportion of detections, per species, per year, at the Delta Points.

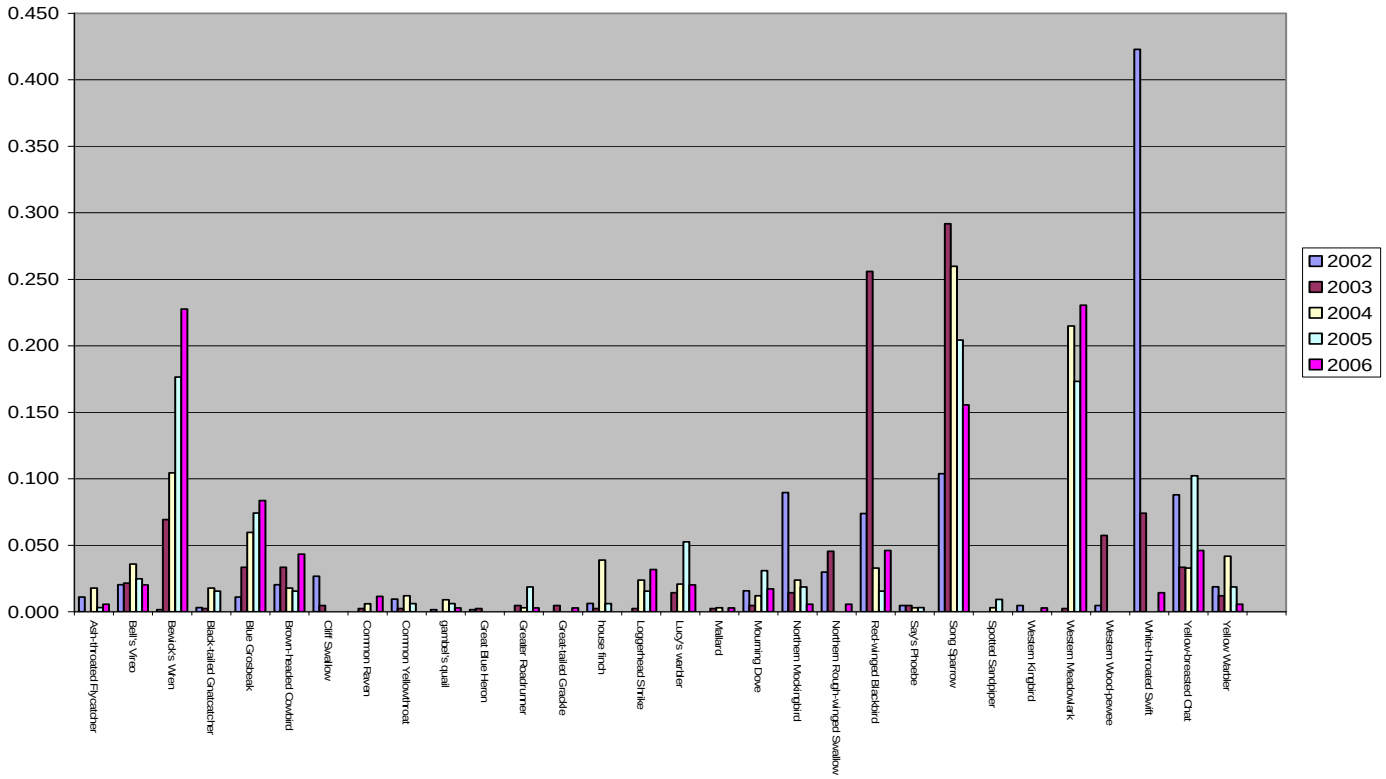


Chart 2. Proportion of detections, per species, per year for the MB Points.

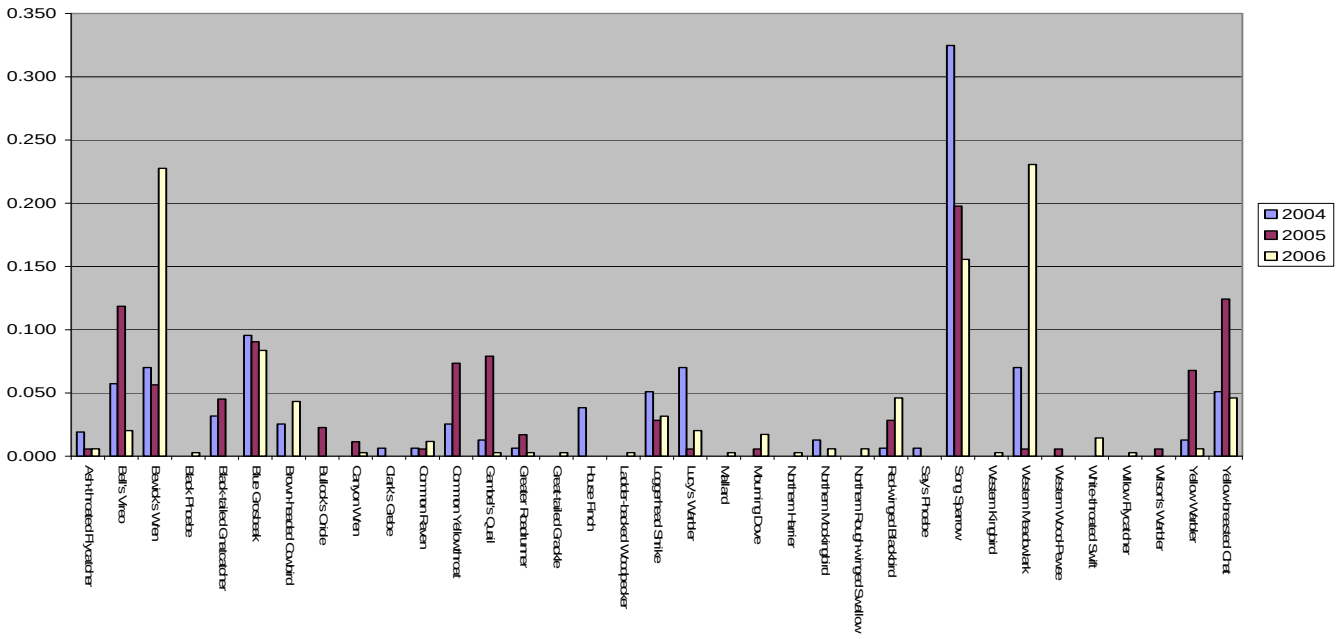
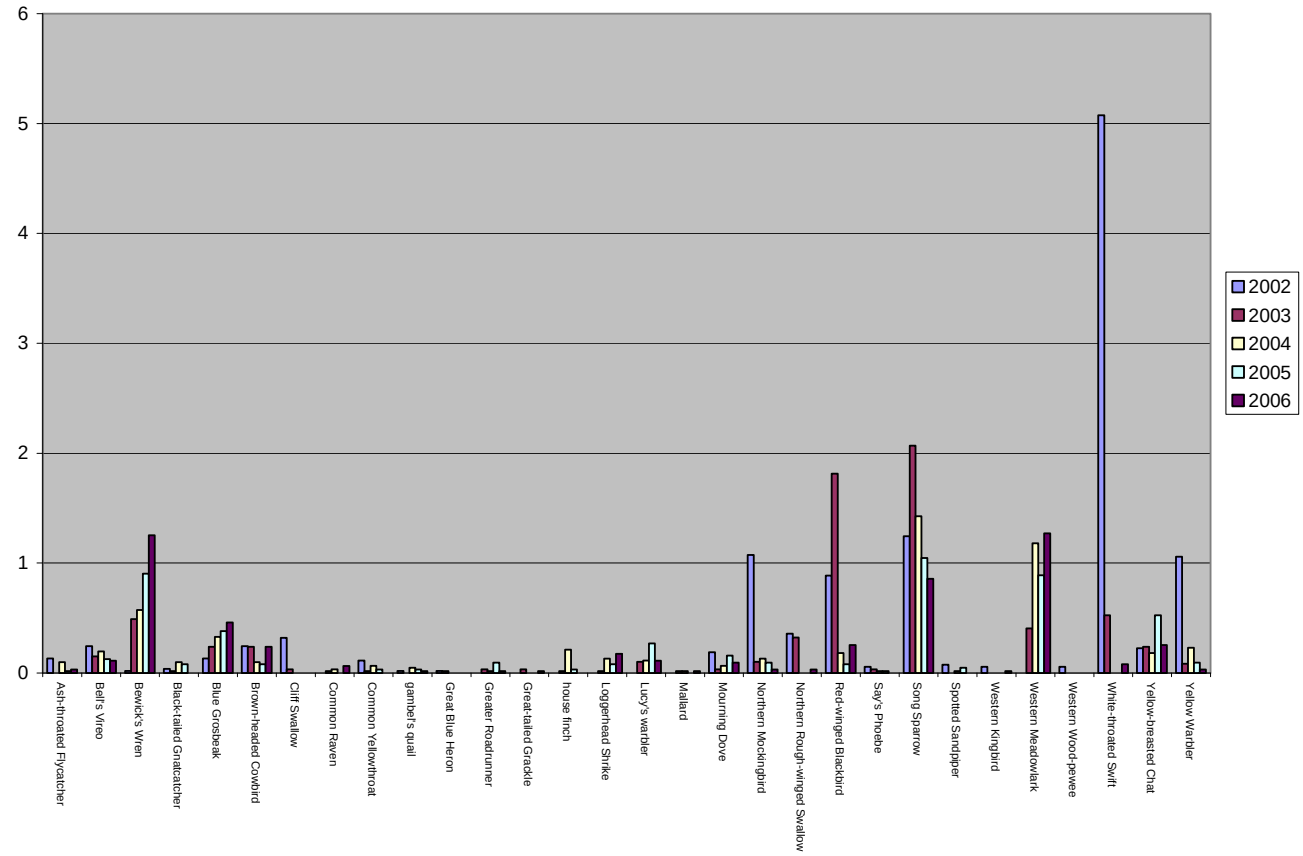


Chart 3. Detections per point at the Delta Points.



Statistical Analysis

For each set of point counts (the Delta and MB Points) a Renkonen Index of Community Similarity between all years and between two or three distinct years of data was conducted. A transformed Shannon-Weaver Index of Diversity was also used to compare diversity values of detections between each year.

A community similarity index was created 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. P was calculated for all five years, between the first (2002) and last years (2006), between the first two years (2002-03), and between the last three years (2004-06).
Values were calculated for the Delta points between the first two years and between the last three years due to the substantial changes to the vegetation that occurred after the second year of the monitoring study. Values were calculated between the first and last years of the study to determine the overall change that occurred between the beginning and end of the study. P was calculated for all three years of the MB points, and the calculated value was 0.431. Results for the Delta Points are summated in the table below (Table 3).

Table 3. Renkonen Index values for between year comparisons at the Delta Points.

5-year value	2002 & 2006	2004 to 2006	2002 to 2003
0.184	0.307	0.612	0.423

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

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

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, N1, 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 useful value to use for site comparison in the analysis. Table 5 summarizes the values calculated per year at the Delta points (Table 4) and at the MB points.

Table 4. N_1 values (Transformed Shannon Weaver Index Value for Species Diversity) for the Delta Points.

2002	2003	2004	2005	2006
8.813444	9.326379	11.53305	11.27206	10.2646

Table 5. N_1 values (Transformed Shannon Weaver Index Value for Species Diversity) for the MB points.

2004	2005	2006
11.479	12.663	15.350

Vegetation

In 2003, vegetation was measured at 12 of the 21 delta points. This measurement was done with the basal area method and the results are summarized in Table 6.

In 2005 and 2006, a different methodology was used to measure vegetation parameters. There were no trees greater than 12.7 cm diameter at breast height, so no results are given for this portion of the vegetation sampling. In 2005, 17 Delta Points were surveyed, and 2 MB Points were surveyed. In 2006, 10 Delta Points were surveyed and 6 MB Points were surveyed. The results are summarized in tables 7-12.

Table 6. Summation of the results for the 2003 basal area vegetation survey of the Delta points.

Point	Species	DBH (cm)	Height	Number of trees in circle		Notes
1	Goodding's Willow	7.4	4	25		
	Tamarisk			81		
	Baccharis			7		
2	Tamarisk			18		No trees measured
	Goodding's Willow			0		
3	Goodding's Willow			41		No trees measured
	Tamarisk			133		
4	Tamarisk	0.5	1.9	189		No trees measured
	Goodding's Willow	3	2.2	8		
8	Tamarisk			189		No trees measured
	Goodding's Willow			8		
9	Goodding's Willow	1.5	2.5	17		
	Goodding's Willow	2.5	3			
	Goodding's Willow	3.6	3			
	Tamarisk			125		
12	Tamarisk			59		No trees measured
	Goodding's Willow			4		
13	Tamarisk			48		No trees measured
	Goodding's Willow			6		
14	Tamarisk	1.2	3	82		
	Goodding's Willow	2.4	3.5			
19	Goodding's Willow	4.6	5	21		
	Tamarisk			116		
20	Tamarisk	1.8	3	73		
	Goodding's Willow			3		
21	Tamarisk			57		No trees measured
	Goodding's Willow			12		

Table 7. Vertical Foliage sampling, vegetation per meter layer, at the Delta Points.

Year	0-1	1-2	2-3	3-4
2005	31.29%	33.65%	13.88%	0.47%
2006	30.50%	25.50%	5.50%	0.00%

Table 8. Vertical foliage sampling, vegetation per meter layer, at the MB Points.

Year	0-1	1-2	2-3
2005	28.00%	15.00%	6.00%
2006	22.92%	10.42%	1.67%

Table 9. Stem tally for the Delta Points.

Species	Class	2005%	2005 Density	2006%	2006 Density
Goodding's Willow	<1 cm	0.10%	7.5	0.00%	0.0
Goodding's Willow	2.6-5.5 cm	0.21%	15.0	0.00%	0.0
Tamarisk	<1 cm	42.30%	3025.8	62.77%	5194.8
Tamarisk	1-2.5 cm	47.54%	3400.3	36.46%	3017.6
Tamarisk	2.6-5.5 cm	9.84%	704.0	0.77%	63.7

Table 10. Stem tally for the MB Points.

Species	Class	2005%	2005 Density	2006%	2006 Density
Arrowweed	<1 cm	0.00%	0.0	17.45%	2758.7
Baccharis	<1 cm	0.61%	0.0	0.94%	148.5
Baccharis	1-2.5 cm	9.63%	63.7	8.99%	1421.8
Baccharis	2.6-5.5 cm	0.00%	997.4	0.27%	42.4
Dead	<1 cm	0.00%	0.0	3.49%	551.7
Goodding's Willow	<1 cm	50.82%	5262.7	4.56%	721.5
Goodding's Willow	1-2.5 cm	29.10%	3013.3	9.66%	1527.9
Goodding's Willow	2.6-5.5 cm	4.10%	424.4	13.56%	2143.3
Goodding's Willow	5.6-7.9 cm	0.00%	0.0	0.54%	84.9
Tamarisk	<1 cm	2.05%	212.2	33.83%	5347.6
Tamarisk	1-2.5 cm	3.48%	360.8	5.37%	848.8
Tamarisk	2.6-5.5 cm	0.20%	21.2	1.34%	212.2

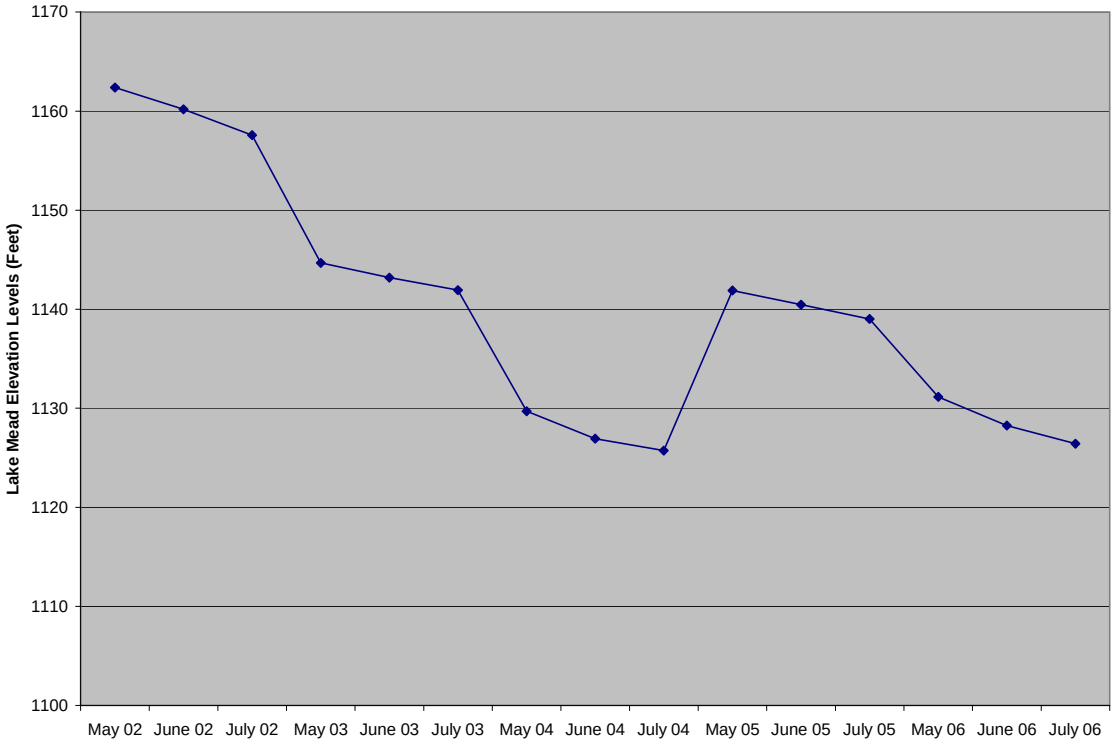
Table 11. Results from the meter squared plots, from the Delta Points.

Year	Leaf Litter	Bare Ground	Grass species	Tamarisk	Herbaceous
2005	43.68%	37.97%	8.50%	8.26%	1.59%
2006	45.80%	48.50%	0.10%	5.60%	0.00%

Table 12. Results from the meter squared plots, from the MB points.

Year	Leaf Litter	Bare Ground	Grass species	Tamarisk	Herbaceous	Baccharis spp.	Goodding's willow	Tumbleweed	Arroweed
2005	46.25%	21.25%	9.38%	0.63%	11.25%	9.38%	1.88%	0.00%	0.00%
2006	46.83%	46.96%	0.83%	3.25%	0.21%	0.00%	0.25%	0.46%	1.21%

Chart 4. Lake Mead elevation levels from May to July, from 2002 to 2006.



Discussion

In 2002, when this monitoring effort began, much of the Lake Mead Delta had recently emerged and a mixture of tamarisk and Goodding's willow developed as the dominant vegetation type at the study site. By the end of the summer of 2002, a noticeable decline in the condition of the majority of the willow at the site had begun. By the following year many willows had died, or were severely stressed, and tamarisk had begun to dominate the entire study area. In year three of the study, almost all the willow had died off and the original 21 Delta points were completely dominated by tamarisk. All of this change was brought about by the rapidly declining water levels at Lake Mead and along the Colorado River. In 2004, six points adjacent to the river, between Iceberg Canyon and the location of the original Delta Points, were established. These new points were designated the MB Points and all were located in habitat dominated by Goodding's willow and tamarisk, similar to the habitat originally found at the Delta Points. This was done to allow sampling of less degraded habitat after the quality of avian habitat at the Delta Points had declined.

The change in Lake Mead elevation levels (Chart 4) shows a steady, precipitous decline in lake levels from 2002 to 2004. Lake levels increased over the winter of 2004-05 and in May of 2005 returned to the levels of July 2003. From this increase in levels in May of 2005, the levels continued to steadily decline. By the end of the study, in July 2006, the lake levels were near the same levels of July 2004, when the lake was at its lowest level for all the survey periods.

The change in lake levels would correspond to the changes seen in vegetation. The willow community declined and almost totally disappeared at the Delta Points over the first two years. After the third year, when lake elevations increased, the willows at the Delta Points had already died off, but in other areas newly emergent stands of Goodding's willow formed. In 2004, the MB Points were initiated, and the habitat at these points continued to grow and remained fairly stable. This coincides with no net decrease in lake levels from July 2003 to July 2006. Lake levels initially increased, and then decreased to nearly the same levels by the end of this period. This allowed those trees that established themselves in 2003 to survive lower lake levels more successfully than when they first emerged, unlike the trees which emerged at the Delta points.

A shift in bird species composition and diversity was shown throughout the whole five-year period. Differences were especially noticeable when the first two years of data were compared to the last three years of data. The index for community similarity for the first two years of data was 0.423 and for the last three years was 0.612. This shows a fairly strong similarity between the last three years, when the area had almost no willows left. In the first two years a greater similarity was demonstrated than for the whole five-year period (0.182), or for the comparison of the first and last years (0.307). Overall, this may indicate that the species composition of the bird populations at the study site stabilized in the third year through the fifth year. This would coincide with the disappearance of willow at the study site and the domination of tamarisk throughout the area.

When the community index of similarity results are taken into consideration with the results from the transformed Shannon-Weaver values a bigger picture develops of changes in bird community use and composition over the five years of the study (Table 4). Transformed diversity index values actually increased from 2002 to 2005 and slightly decreased in 2006 (as compared to 2005). The dominant species, in terms of detections, changed at the Delta Points. In the first two years species such as red-winged blackbird (*Agelaius phoeniceus*), northern mockingbird (*Mimus polyglottos*), and white-throated swift (*Zonotrichia albicollis*) were proportionally some of the most commonly detected species (Chart 1). After the first two years these species made up very little of the proportion of total detections and species such as the blue grosbeak (*Passerina caerulea*), western meadowlark (*Sturnella neglecta*), and Bewick's wren (*Thryomanes bewickii*) increased proportionally to overall detections. The yellow warbler (*Dendroica petechia*) also declined in detections per point after the first two years. Because this species was less common, the proportional data does not demonstrate this decline as noticeably.

The data may indicate that while overall raw diversity numbers may have stayed the same, or slightly increased, over the five years, the species that occupied the Delta Points habitat did change. Furthermore, the total number of detections per point surveyed did decrease from 2002 to 2004 and then stayed nearly the same between 2004 and 2006 (Table 1). This may indicate that over the first two years the total number of birds using the habitat decreased, and different species began to dominate the area. Also, birds that are detected less often would start to have a greater effect on the diversity index numbers as overall bird detections decrease. Starting in 2004, after most of the willows had died, the number of birds, species diversity, and species composition stayed relatively the same.

At the MB Points, the diversity numbers increased over the three years in which they were monitored (Table 5), while the number of detections per point fluctuated (Table 2). The data shows that the MB Points were fairly stable, and consistently had higher values for diversity index and for detections per point. This is not surprising as the willows at the MB Points thrived and continued to grow from 2004 to 2006.

The vegetation data is incomplete, with only three years surveyed for vegetation, and the methodology was changed after 2003. Nonetheless, the data does show that in 2003 Goodding's willow was still present as a component of the vegetation community. At all but one point surveyed, Goodding's willow was present in 2003 (Table 6); by 2005, Goodding's willow only made up 0.31% of vegetation at the sites, and in 2006 was completely absent (Table 9). This corresponds with the decline in water levels over the five-year period (Chart 4), and the change in bird community composition discussed earlier.

Overall, the Lake Mead Delta has provided important and dynamic native habitat for bird use since it first emerged in 2002. While some of the original native habitat that emerged has degraded and now is made up of tamarisk almost entirely, more native habitat has established itself. This habitat may prove to be an important resource for avian

populations in the Lower Colorado River and would represent the only new habitat to appear on the river naturally in many years. Further monitoring of this area should continue as the dynamic nature of the area makes predictions as to further use difficult. The area of the MB points has remained relatively stable for three years and many other areas may also continue to provide quality, natural bird habitat. Some sort of point count monitoring of this newly emergent habitat should be continued to further document the importance of this area for bird use.

Literature Cited

Ammon, Elisabeth. 2001. Conceptual aspects and protocol for implementing Nevada's breeding bird monitoring plan. The Great Basin Bird Observatory. Reno, NV. 7 pp.

McKernan, Robert L. 1997. Status, distribution, and habitat affinities of the Southwestern Willow Flycatcher along the Lower Colorado River, Year 1 – 1996. Report to the Bureau of Reclamation, Boulder City, NV, and USFWS, Carlsbad, CA. 42 pp.

McKernan, Robert L. and Gerald Braden. 1998. Status, distribution, and habitat affinities of the Southwestern Willow Flycatcher along the Lower Colorado River, Year 2 – 1997. Report to the Bureau of Reclamation, Boulder City, NV, and USFWS, Carlsbad, CA. 67 pp.

McKernan, Robert L. and Gerald Braden. 1999. Status, distribution, and habitat affinities of the Southwestern Willow Flycatcher along the Lower Colorado River, Year 3 – 1998. Report to the Bureau of Reclamation, Boulder City, NV, USFWS, Carlsbad, CA, and Reno, NV, and BLM, Caliente, NV. 67 pp.

McKernan, Robert L. and Gerald Braden. 2000. Status, distribution, and habitat affinities of the Southwestern Willow Flycatcher along the Lower Colorado River, Year 4 – 1999. Report to the Bureau of Reclamation, Boulder City, NV, USFWS, Carlsbad, CA, and Reno, NV, and BLM, Caliente, NV. 67 pp.

National Geographic Society. 1999. Field guide to the birds of North America, Third edition. National Geographic Society, Washington, D.C. 457 pp.

Nur, N., S.L. Jones, and G.R Geupel. 1999. A statistical guide to data analysis of avian monitoring programs. U.S. Department of the Interior, Fish & Wildlife Service, BTP-R6001-1999, Washington, D.C.

Rosenberg, Kenneth V., R.D. Ohmart, W.C. Hunter, and B.W. Anderson. 1991. Birds of the Lower Colorado River Valley. The University of Arizona Press. Tucson, AZ. 416 pp.

Sibley, D.A. 2000. The Sibley guide to birds. Alfred A. Knopf, New York. 537 pp.

USDA Forest Service. 1995. Monitoring bird populations by point counts. USDA Forest Service General Technical Report PSW-GTR-149.