RECLAMATION

Managing Water in the West

Results of Brown-Headed Cowbird Control Program Monitoring

1999 - 2006 – Final Report

Alamo Lake State Wildlife Area and Bill Williams River National Wildlife Refuge, Arizona

Parasitized Southwestern Willow Flycatcher nest

U.S. Department of the Interior

Bureau of Reclamation

Fisheries and Wildlife Resources

Denver, Colorado

March 2007

Mission Statements

The mission of the Department of the Interior is to protect and provide access to our Nation's natural and cultural heritage and honor our trust responsibilities to Indian Tribes and our commitments to island communities.

The mission of the Bureau of Reclamation is to manage, develop, and protect water and related resources in an environmentally and economically sound manner in the interest of the American public.

Results of Brown-Headed Cowbird Control Program Monitoring

1999-2006 – Final Report

Alamo Lake State Wildlife Area and Bill Williams River National Wildlife Refuge, Arizona

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Bureau of Reclamation

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Introduction

This report summarizes eight years of monitoring of the Bureau of Reclamation's (Reclamation) Brown-headed Cowbird (BHCO – *Molothrus ater*) control and trapping program at Alamo Lake State Wildlife Area (SWA) and Bill Williams River National Wildlife Refuge (NWR). Cowbird trapping was conducted from 1999 to 2001 as a measure to prevent further declines and promote recovery of breeding populations of the Southwestern Willow Flycatcher (SWFL – *Empidonax traillii extimus*) and other neotropical migrant songbirds. This report includes five years of follow-up monitoring.

This program complied with terms and conditions set forth by the U.S. Fish and Wildlife Service (USFWS) in their Biological Opinion on Reclamation's Lower Colorado River Operations and Maintenance – Lake Mead to Southerly International Boundary (USFWS 1997). According to this Biological Opinion, Reclamation was directed to conduct cowbird trapping adjacent to SWFL habitat where parasitism rates exceeded 10 percent. Biologists from Reclamation's Technical Service Center, in cooperation with Reclamation's Lower Colorado Regional Office, conducted the BHCO control program starting in 1998. The results of the program have been documented in four annual reports (White et al. 1998, White and Best 1999, White et al. 2001, and White et al. 2002). The program included: (1) BHCO trapping in an attempt to reduce parasitism, (2) avian point counts to estimate relative abundance of BHCOs and host species, and
(3) nest monitoring to determine parasitism rates and nest success.

The occurrence of a breeding population of SWFLs, a rich and diverse population of breeding neotropical migratory BHCO host species, and initial population estimates of BHCOs at Alamo Lake SWA and Bill Williams River NWR indicated that these areas were suitable sites to implement a cowbird control program. For this study, trapping was conducted for 3 consecutive years from 1999 to 2001. As a result, totals of 1,341 and 526 BHCOs were removed from the populations at the Alamo Lake SWA and Bill Williams River NWR, respectively.

The results from our evaluation of the control program indicated that BHCO populations in riparian habitat at both sites were reduced during trapping to levels that may have lowered the parasitism potential during the program (White et al. 2002). BHCO capture rates dropped about 60 percent per year at the Alamo Lake SWA and Bill Williams River NWR. BHCO detection rates also decreased during trapping and became much lower than untrapped sites along the mainstem Lower Colorado River. BHCO to host ratios were reduced at both Alamo Lake SWA and Bill Williams River NWR, but

remained consistently higher at Havasu NWR where trapping had been suspended after 1998. Finally, during BHCO control, our nest monitoring of several host species, including SWFLs, indicated parasitism rates in study plots dropped from 8 percent to 1 percent at the Alamo Lake SWA and remained at zero at the Bill Williams River NWR.

BHCO trapping was terminated after the summer of 2001 as a result of re-initiation of Section 7 consultation with the USFWS. The most recent Biological Opinion (USFWS 2002) does not require cowbird trapping as a protective measure for the SWFL. Instead, a study was initiated beginning in 2002 to determine the effectiveness of trapping on SWFL reproductive success and population numbers[1]. Concurrently, biologists from the Technical Service Center continued to conduct point counts and nest monitoring at Alamo Lake SWA and Bill Williams River NWR to monitor the response of the avian community to the cessation of BHCO trapping (White and Ryan 2002 and 2003; Ryan and White 2004 and 2005). This report summarizes the results of follow-up monitoring during avian breeding seasons from 2002 to 2006 and compares BHCO abundances, BHCO and host species abundance ratios, and observed parasitism rates with data collected during the 3-year trapping program from 1999 to 2001.

Methods

Study Area

During the BHCO trapping program and follow-up monitoring conducted between 1999 and 2006, the general study area consisted of the Alamo Lake SWA adjacent to Alamo Lake State Park, Arizona, and the Bill Williams River NWR, Arizona (Figure 1). In addition, we continued BHCO/host species point counts at the Havasu NWR, Arizona, where we conducted one season of limited BHCO trapping in 1998 (White et al. 1998), and where trapping was re-initiated in June 2003 and continued through the 2006 breeding season by biologists from SWCA Environmental Consultants (SWCA 2004, 2005).

[1] A separate water transfer Biological Opinion directs Reclamation to control BHCOs below Parker Dam in areas where potential SWFL habitat is suspected pending the results of the controlled study to determine the effectiveness of trapping.

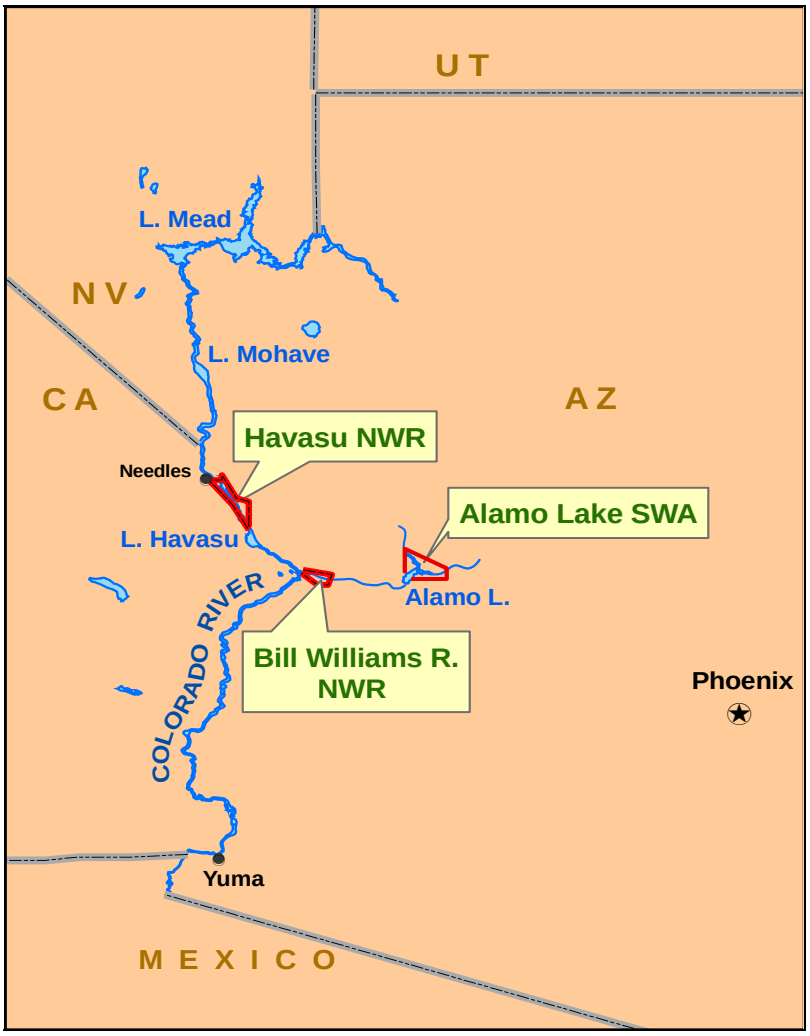


Figure 1. General map of study areas.

Alamo Lake SWA

Alamo Lake SWA is located 160 kilometers (km) northwest of Phoenix, Arizona in La Paz County. The study area encompassed the confluence of the Santa Maria, Bill Williams, and Big Sandy rivers upstream of Alamo Lake. The area contained three former trapping sites, three active nest monitoring plots, and two active point count routes. The habitat at this site underwent considerable changes during 2005 as a result of the above average precipitation and flooding during the spring of 2005. Large areas of riparian vegetation were scoured upstream of Alamo Lake and above average flows remained throughout the 2005 breeding season (Figure 2). We observed extensive areas where cottonwood (*Populus fremontii*), willow (*Salix* sp.), and saltcedar (*Tamarix* sp.) were germinating in the scoured depositional areas (Figure 3). The vegetation in the delta of Alamo Lake, which was previously occupied by nesting SWFLs, was inundated and mostly killed by at least 4 meters (m) of reservoir water throughout the 2005 breeding season. The reservoir level slowly declined at the delta of Alamo Lake,

Figure 2. Flooding during the winter and spring of 2005 caused scouring of riparian vegetation on rivers upstream of Alamo Lake. Surface water remained in the channel throughout much of the avian breeding season.

Figure 3. Large areas of regenerating riparian vegetation developed along the Santa Maria River as a result of high winter flows.

but due to the absence of understory vegetation, this habitat was unsuitable for SWFLS during the 2006 breeding season.

Bill Williams River NWR

The Bill Williams River NWR is located 32 km south of Lake Havasu City, Arizona. The study site is located entirely within the NWR along the Bill Williams River. BHCO trapping was conducted at four sites in this area from1998 to 2001. From 1999 to 2006 this area included three nest monitoring plots,

and one active point count route . Flooding during the spring of 2005 significantly changed the Bill Williams River channel and floodplain, scouring vegetation from two of three nest monitoring plots and destroying the 4-wheel drive interior road (Figure 4).

Figure 4. The Bill Williams River flooded the interior road and scoured vegetation at a nest monitoring plot in the Bill Williams River NWR.

Havasu NWR

The Havasu NWR is located in the vicinity of Topock Marsh along the Colorado River in Arizona, just across the border from Needles, California. Here point counts were conducted for songbird host species and BHCOs along the same transect since 1998 (White et al. 1998). Point counts were conducted to evaluate the ratio of BHCOs to host species at a site where BHCO control was implemented in 1998, subsequently terminated for 4 years, then re-initiated in 2003. The location of the point counts were identical to those designated as the "Glory Hole to North Dike" point count transects for the 1998 control program concurrent with our study (White et al. 1998). McKernan and Braden (2002) conducted SWFL surveys and nest monitoring to determine population levels and parasitism rates through the breeding season of 2002. The study was taken over by SWCA (2004) in 2003 and included the re-initiation of BHCO trapping. Nest monitoring for host species was not conducted at the Havasu NWR.

BHCO Point Counts

We conducted bi-weekly fixed-radius point counts as a measure of BHCO distribution and abundance in

the study areas from mid-May through July. We used a modified version of the point count methodology described by Ralph et al. (1993) where individual BHCOs were recorded within 60 meters (m) of the observer during 5-minute intervals. We used a 60-m threshold (instead of 50-m) to better compare data with 60-m point counts conducted by Lynn and Averill (1996) in the Lower Colorado River Valley. BHCO point count routes started approximately 30 minutes before sunrise and never continued for more than 3.5 hours.

Statistical analysis used the average number of BHCO's detected per point to examine abundance over time. Linear regression was used to determine trends in BHCO detections within both the trapping and the post-trapping periods. Depending on normality of data, a Student's t-test of means or a Mann-Whitney test of medians was used to compare BHCO abundance the first year of the study with the last year. Abundance during trapping and post-trapping years were compared using this method as well. An alpha of 0.05 was used for all statistical analysis.

Alamo Lake SWA

From mid-May through July, we conducted bi-weekly point counts along two established transects within the study area: Brown's Crossing and Santa Maria River. These transects were located in and adjacent to riparian habitat in the floodplain area. The Brown's Crossing BHCO point count transect consisted of 20 points approximately 200 m apart covering 3.8 km beginning in the delta of Alamo Lake and following the dry riverbed of the Bill Williams River to the confluence of the Big Sandy River. In 2005, since the area was flooded, the transect was surveyed by kayak and modified to include the remaining stands of riparian vegetation. In 2006, the reservoir receded but deep mud prevented access by kayak, foot or vehicle. Therefore, no data were collected in 2006.

The Santa Maria River BHCO point count transect consisted of 20 points ranging from 200 to 400 m apart and was about 4 km in length. This transect formed a loop on both sides of a broad reach of the Santa Maria River flood plain. The riparian vegetation and river channel had changed in places along this transect in 2005. However the location of the points remained essentially the same.

Bill Williams River NWR

The BHCO point count route ran through or adjacent to riparian habitat for 6 km along the interior road from the gate near the start of the 4-wheel drive road to a point upstream of Mineral Wash. This route consisted of 20 points spaced 200 to 400 m apart. The riparian vegetation and river channel had significantly changed along this transect in 2005. However, the location of the points remained essentially the same.

Host Species Point Counts

To monitor the distribution and abundance of the avian community in the BHCO control study area, we conducted 5-minute, 60-m fixed-radius point counts targeting host species and female BHCOs three times during the breeding season along established transects at the Alamo Lake SWA (Santa Maria River), the Bill Williams River NWR as described above, and the Havasu NWR. All were surveyed during the same time period each year and were conducted simultaneously with the BHCO point counts described above. Each consisted of 20 points surveyed three times in a 5-week period from mid-May to mid-June. All songbirds were counted and classified as host species if there were any records for that species being parasitized by BHCOs based on the compilations of Friedmann and Kiff (1985). Obviously, certain species [i.e., Bell's Vireo (BEVI – *Vireo bellii*)] are more susceptible and are parasitized more frequently compared to others (i.e., Mourning Dove – *Zenaida macroura*). Nevertheless, all species identified as known hosts are included in our analysis.

Statistical analysis used ANOVA (Analysis of Variance) tests to compare a number of variables by year. These variables included pooled bird group detections (neotropical migrants and riparian obligates), four individual species detections [Abert's Towhee (ABTO – *Pipilo aberti*), Bell's Vireo, Yellow-breasted Chat (YBCH – *Icteria virens*), and Yellow Warbler (YEWA – *Dendroica petechia*)], and female cowbird to host ratios.

Nest Monitoring

Between 1999 and 2006 we conducted nest searches and nest monitoring for all potential host species at the Alamo Lake SWA and the Bill Williams River NWR within three plots at each site. Since much of the vegetation was flooded and/or scoured out in 2005, we monitored two plots at Alamo Lake and one at the Bill Williams in 2006. Nest monitoring was conducted in proximity to previous BHCO trapping sites and existing point count transects to determine parasitism rates and any correlations between the abundance of BHCOs, the parasitism rates of host songbird species, and the effects of previous BHCO removal. In addition, in coordination with Arizona Game and Fish biologists, we monitored SWFL nests at the Alamo Lake SWA in all years except 2000. Arizona Game and Fish protocol was used when monitoring SWFL nests, with emphasis placed on minimizing disturbance (Rourke et al. 1999).

For each species and site, we calculated the proportion of nests that was parasitized, predated, abandoned, or successfully fledged at least one host chick. For consistent and comparable analysis, we compared the year-to-year variation of parasitism and other variables for the four most common host

species: ABTO, BEVI, SWFL, and YBCH. In addition, as a quantitative indicator of nest success, we used a "modified Mayfield index" used by Lynn (1996) during avian studies in the Lower Colorado River Valley. The degree of success of each nest was ranked: 0 = did not finish nest construction or no host eggs laid; 1 = at least one host egg laid; 2 = at least one host egg hatched; 3 = at least one host chick fledged.

The Chi-squared test of independence was used to statistically compare cowbird parasitism, predation, and nest success between the pooled trapping years (1999-2001) and the pooled post-trapping years (2002-2006). Mayfield success was analyzed between pooled trapping and post-trapping years (Mann-Whitney test), between years for all species found (Kruskal-Wallis test), and between years for four individual species (ABTO, BEVI, SWFL, YBCH; ANOVA or Kruskal-Wallis test).

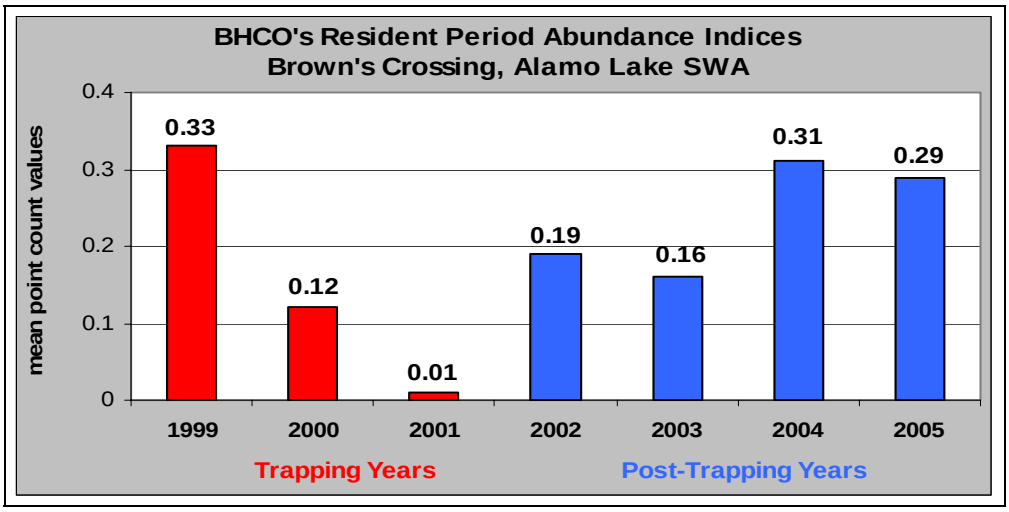
Results

Cowbird Point Counts

For our analysis, we used point count data collected during the neotropical migrant resident period for the Lower Colorado River (approximately late-May through the third week of July). During this period, we could be assured that documented BHCOs were residents.

Alamo Lake SWA

During the eight study years, resident period mean BHCO detection rates ranged from 0.01 (2001) to 0.33 (1999) BHCOs per point at Brown's Crossing and 0.01 (2001) to 0.61 (2006) at Santa Maria River (Figure 5). During the trapping years (1999-2001), BHCO detections declined at both sites, which correlated with decreasing BHCO capture rates during our control activities at Alamo Lake SWA (Figure 6). Post trapping data indicate that BHCO mean values have increased from the low detection rates observed during 2001 (the third year of BHCO control) along the two transects. This correlates with the increase in parasitism rates observed in the adjacent nest monitoring plots (see Nest Monitoring section).



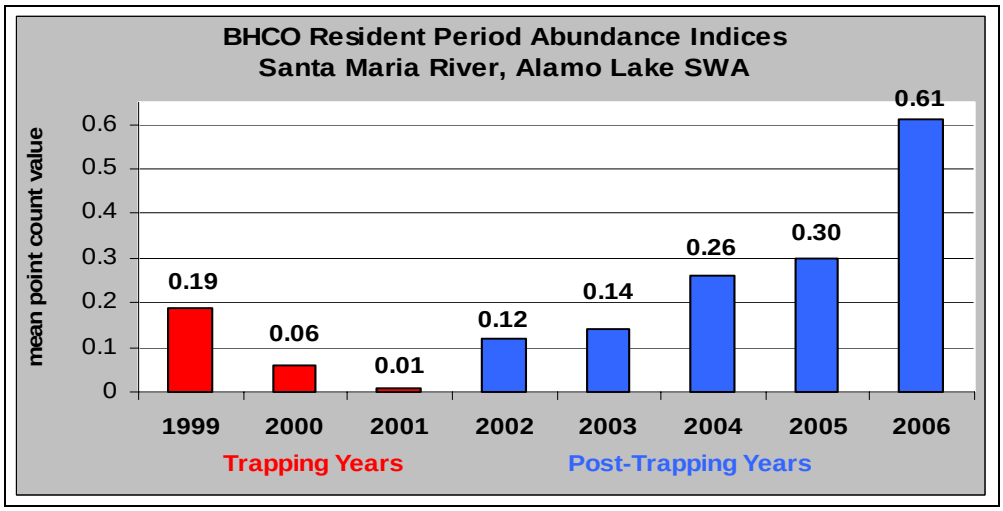


Figure 5. Results of BHCO point counts (1999-2006) at Alamo Lake SWA.

The trend in resident period mean BHCO detections at Santa Maria River significantly decreased during trapping from 1999 to 2001 ($r^2 = 0.53$, Df = 17, $P = 0.001$) and significantly increased during post-trapping from 2002 to 2006 ($r^2 = 0.64$, Df = 26, $P < 0.001$). The pattern was the same at Brown's Crossing, where BHCO abundance significantly decreased during the trapping years ($r^2 = 0.72$, Df = 18, $P < 0.001$) and increased during the post-trapping years ($r^2 = 0.24$, Df = 21, $P = 0.02$).

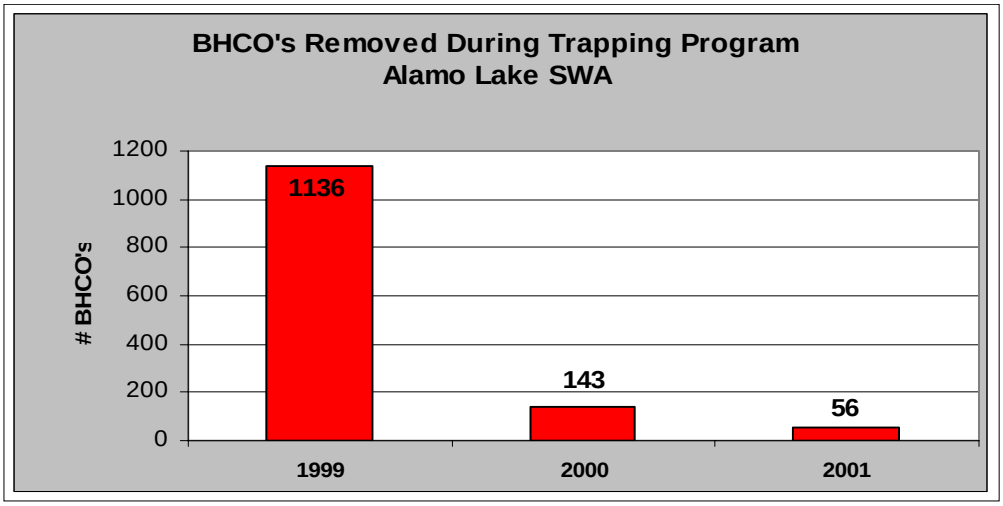


Figure 6. Number of BHCOs removed at Alamo Lake SWA (1999-2001).

The Santa Maria River point counts showed a significant increase in BHCO detection rates between 1999 (first year of trapping) and 2006 (last year of monitoring) (W = 14.0, *P* = 0. 010). BHCO detections were significantly lower during the pooled trapping years (1999 – 2001) than during the pooled post-trapping years (2002 – 2006; W = 138.0, *P* = 0.001).

There was not a statistical difference between 1999 and 2005 (t = 0.590, *P* = 0.570) in BHCO detections in the Brown's Crossing point count. This suggests that BHCO abundance has returned to or surpassed former levels at both point count sites six years after cessation of trapping at Alamo Lake. There was also not a statistical difference in BHCO detections between pooled trapping and post-trapping years (t = -1.34, *P* = 0.189)

Bill Williams River NWR

During the eight study years, resident period mean BHCO detection rates ranged from 0.06 (1999) to 0.38 (2006) BHCOs per point along the transect (Figure 7). Unlike what was observed at Alamo Lake, BHCO detections actually increased during the trapping years from a low value during the first

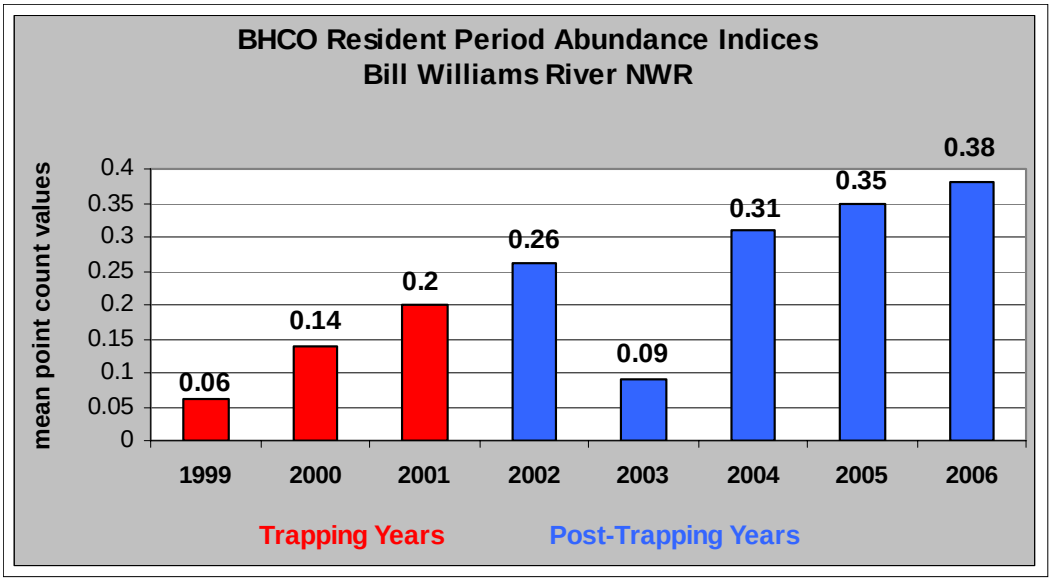


Figure 7. Results of BHCO point counts (1999-2006) at Bill Williams River NWR**.**

year of trapping. With the exception of 2003, this increase continued and reached the highest level of BHCO abundance in 2006. There was a significant increasing trend in BHCO mean values during the trapping years (r^2 = 0. 41, Df = 23, P = 0.001) as well as during the post-trapping years (r^2 = 0.34, Df = 26, P = 0.001). The average number of BHCOs detected was significantly less in 1999 than in 2006 (t = -7.47, P < 0.001). BHCO abundance rates were significantly less during the trapping period than during the post-trapping period (t = -3.48, P = 0.001). Prior to our control efforts, 621 BHCOs had been removed from the Bill Williams River NWR from 1996 to 1998 by refuge personnel (Morrison and Averill-Murray 2002 – Figure 8).

Host Species Point Counts

During host species point count analysis, data regarding the relative abundance of individual species were compiled, as well as pooled data for species groups including neotropical migrants and riparian obligates. BHCO female to host ratios were also calculated.

Alamo Lake SWA

The number of detections in the neotropical migrant pooled bird group was significantly lower in 2002 (Figure 9) as compared to all years except 2006, when numbers began to decrease again (F = 3.46, Df = 5, 17, P = 0.036). There was also a significantly lower number of detections in the riparian

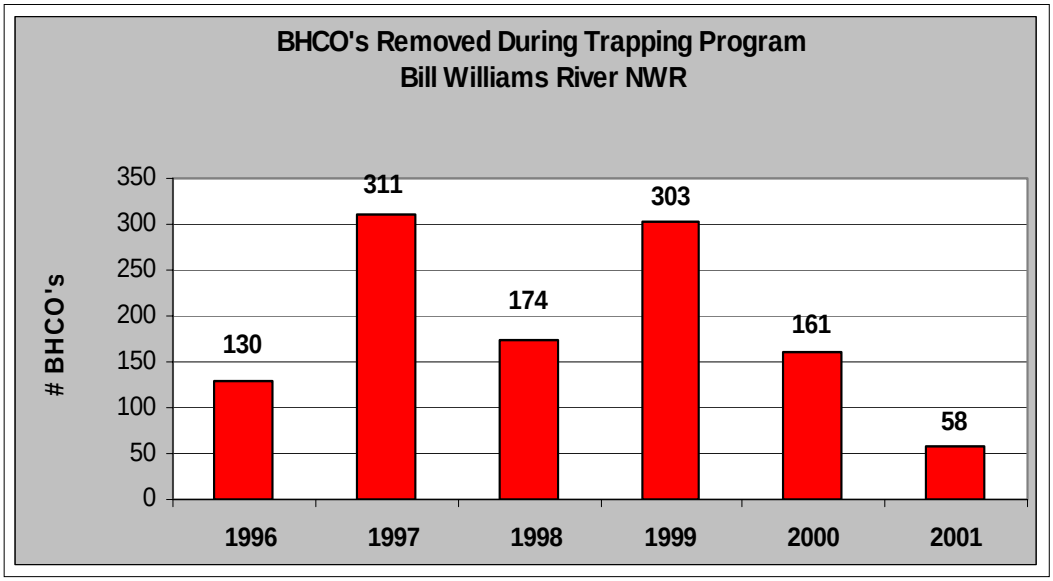


Figure 8. Number of BHCOs removed at Bill Williams River NWR (1996-2001).

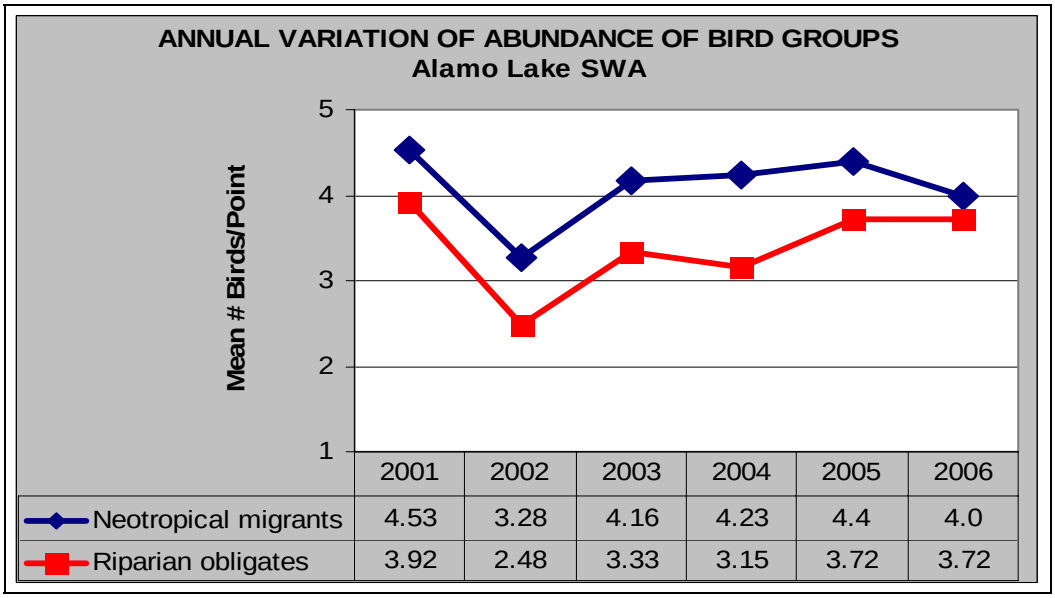
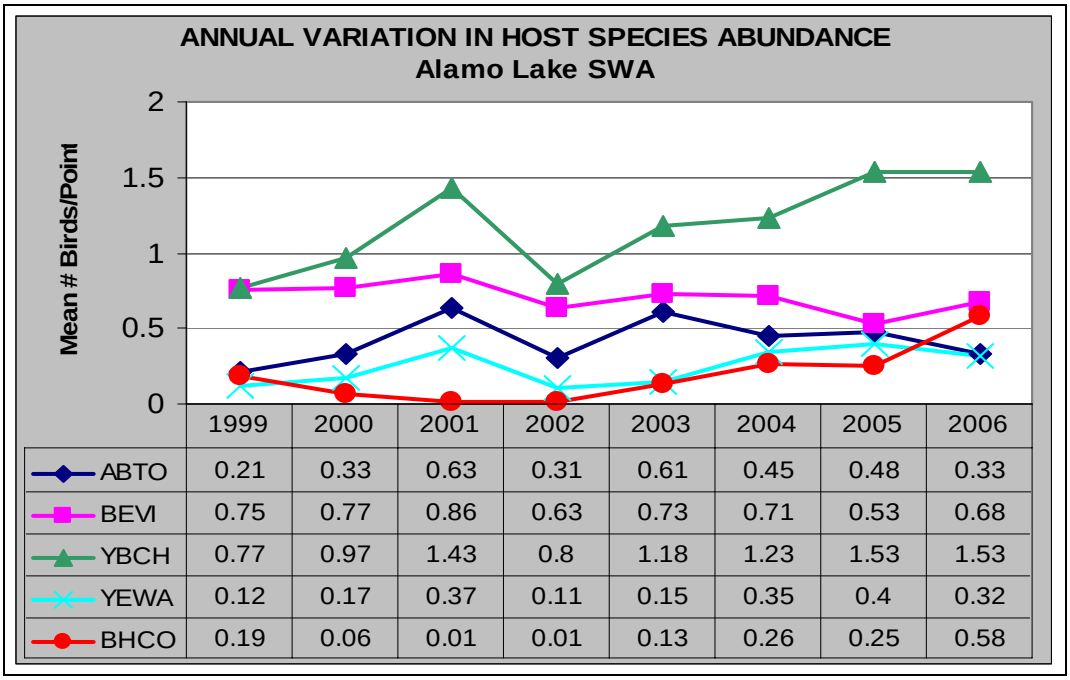


Figure 9. Mean number of neotropical migrants and riparian obligates detected during point counts at Alamo Lake SWA (2001-2006)**.**

obligate pooled bird group in 2002 (F=9.4, Df= 5, 17, $P = 0.001$) as compared to all other years. Within this group, the years 2002 through 2004 were also found to have significantly lower detection rates than the years 2001, 2005, and 2006.

The most common host species during the study were consistently YBCH, BEVI, and ABTO (Figure 10). YBCH annual mean detection rates ranged from 0.77 to1.53 birds/point with the low value in 1999; the high value occurred in both 2005 and 2006.



	1999	2000	2001	2002	2003	2004	2005	2006
ABTO	0.21	0.33	0.63	0.31	0.61	0.45	0.48	0.33
BEVI	0.75	0.77	0.86	0.63	0.73	0.71	0.53	0.68
YBCH	0.77	0.97	1.43	0.8	1.18	1.23	1.53	1.53
YEWA	0.12	0.17	0.37	0.11	0.15	0.35	0.4	0.32
BHCO	0.19	0.06	0.01	0.01	0.13	0.26	0.25	0.58

Figure 10. Mean number of common host species and BHCOs detected during point counts at Alamo Lake SWA (1999-2006).

BEVIs ranged from 0.53 in 2005 to 0.86 in 1999; ABTO from 0.21 in 1999 to 0.63 in 2001. Detection rates for YEWA, a species of regional concern, were relatively low ranging from 0.11 to 0.40. YEWA lowest values were observed in 1999 and 2002; higher values were observed in 2001, 2005 and 2006. Higher numbers of YEWA were detected at Alamo Lake SWA than at the Bill Williams River or Havasu NWRs. The only statistical difference in the annual detection rates for these four individual species was for YBCH in which the years 1999, 2000, and 2002 were significantly lower than the years 2001, 2005, and 2006 ($F = 3.14$, $Df=7, 23$, $P = 0.028$).

The ratio of BHCO females to host species at Alamo Lake decreased during the trapping years, from 0.03 (1999) to 0.01 in both 2000 and 2001. During the post-trapping years, this ratio increased from 0.02 (2003) to 0.05 (2004), then leveled off at 0.02 in both 2005 and 2006 (Figure 11).

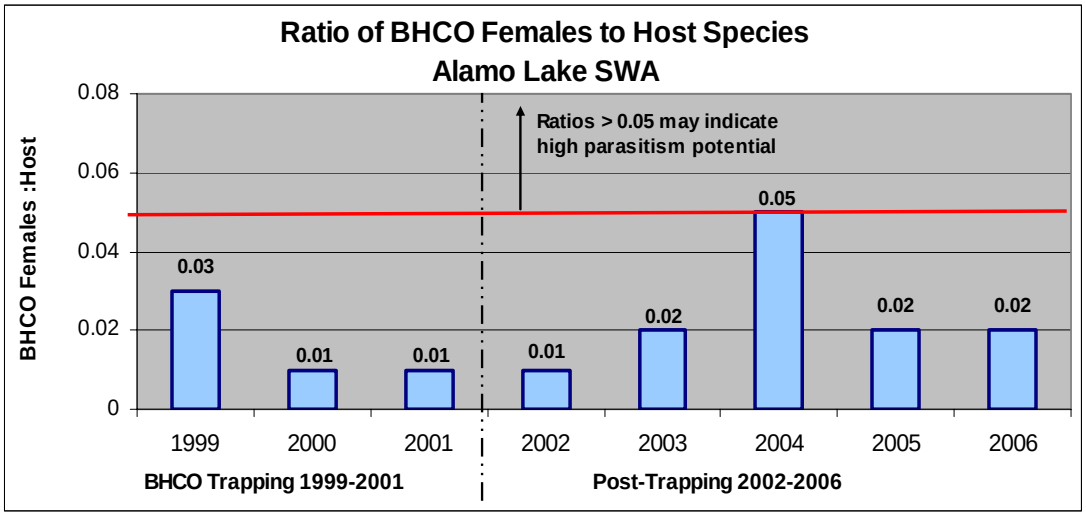


Figure 11. Ratio of BHCO females to host species detected during point counts at Alamo Lake SWA – 1999-2006.

Bill Williams River NWR

Overall, the number of pooled bird group detections exhibited a considerable decline from 2001 to 2002 (Figure 12). There was not a significant difference in the number of neotropical migrant detections between years (F = -2.79, Df = 5, 17, *P* = 0.068). When comparing each year individually, however, differences were identified between 2001 and all other years except 2003. Riparian obligate detections were significantly higher in 2001 than in all other years, and detections in 2003 were significantly higher than in 2002 and 2005 (F = 7.21, Df = 5, 17, *P* = 0.003).

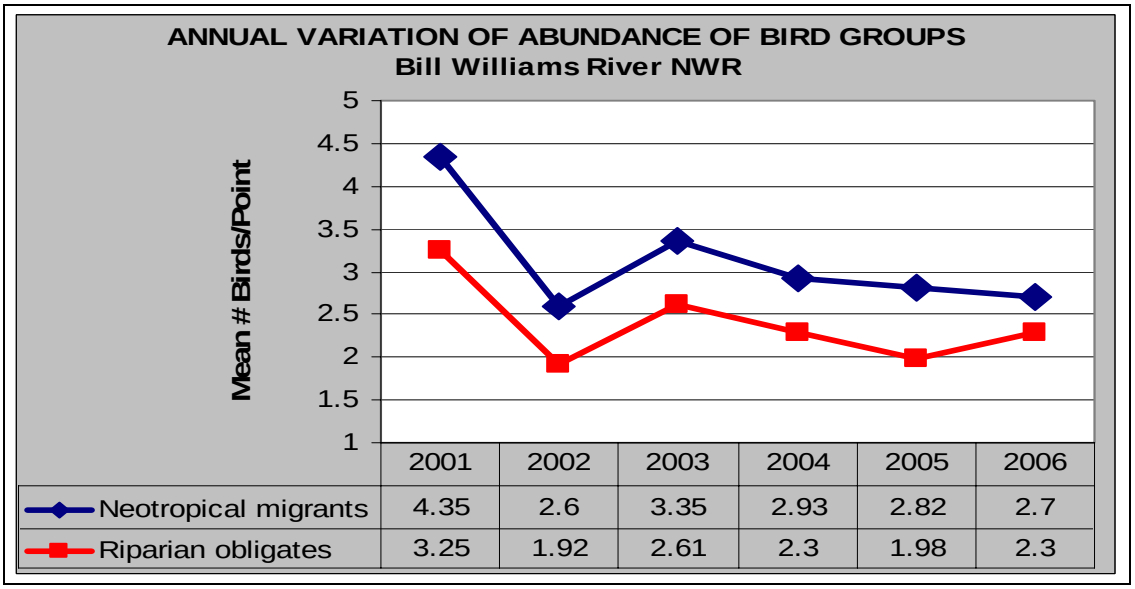
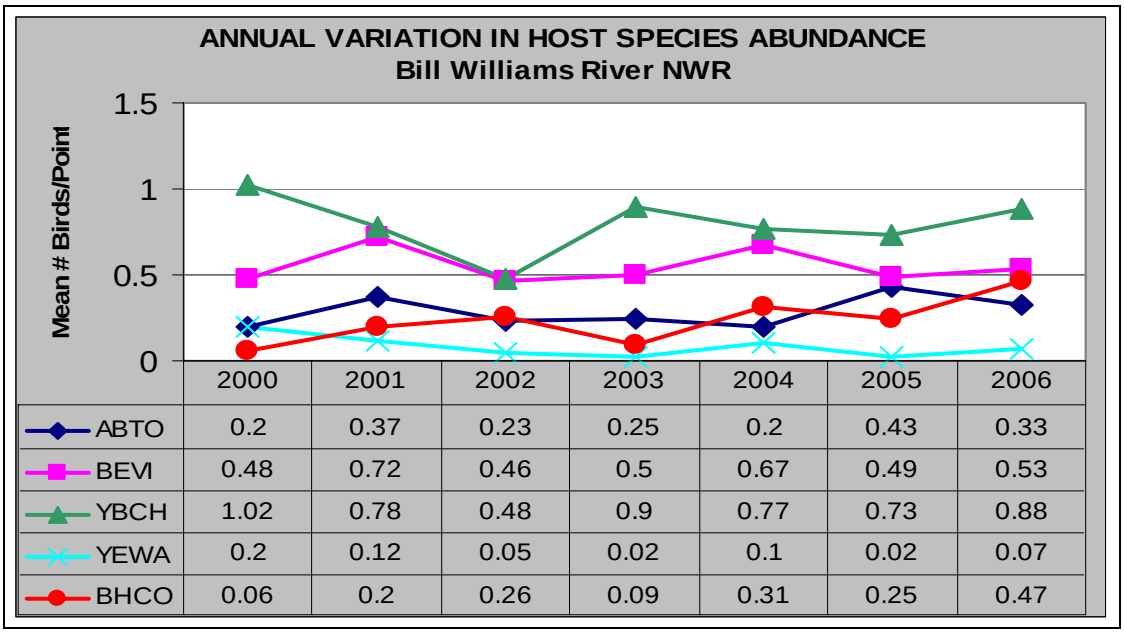


Figure 12. Mean number of neotropical migrants and riparian obligates detected during point counts on the Bill Williams River NWR (2001-2006).

Similar to Alamo Lake SWA, the most abundant host species were YBCH, BEVI, and ABTO (Figure 13). YBCH annual mean detection rates ranged from 0.48 birds/point in 2002 to 1.2 in 2000; BEVI from 0.46 in 2002 to 0.72 in 2001; ABTO from 0.20 in 2000 and 2004 to 0.43 in 2005. Detection rates for the YEWA ranged from 0.02 (2002, 2003, 2005) to 0.20 (2000). No statistical differences between annual detection rates were indicated for these four individual species with the exception of BEVI abundance, which was significantly higher in 2001 and 2004 ($F = 3.97$, $Df = 5, 17$, $P = 0.016$).



	2000	2001	2002	2003	2004	2005	2006
ABTO	0.2	0.37	0.23	0.25	0.2	0.43	0.33
BEVI	0.48	0.72	0.46	0.5	0.67	0.49	0.53
YBCH	1.02	0.78	0.48	0.9	0.77	0.73	0.88
YEWA	0.2	0.12	0.05	0.02	0.1	0.02	0.07
BHCO	0.06	0.2	0.26	0.09	0.31	0.25	0.47

Figure 13. Mean number of common host species and BHCOs detected during point counts on Bill Williams River NWR (2000-2006).

The ratio of BHCO females to host species at the Bill Williams River NWR increased from 0.01 (1999) to 0.04 (2000), however, during the final year of trapping (2001) no BHCO females were detected (Figure 14). The first year of post-trapping (2002), the ratio jumped to 0.09, which was the highest ratio of our 8 year study. In 2003 this ratio dropped to 0.03, but then increased again to 0.08 (2004), and then leveled off in 2005 and 2006 to 0.04 and 0.05 respectively. Ratios were significantly higher in 2002 and 2004 in all other years ($F = 3.65$, $Df = 6, 20$, $P = 0.022$).

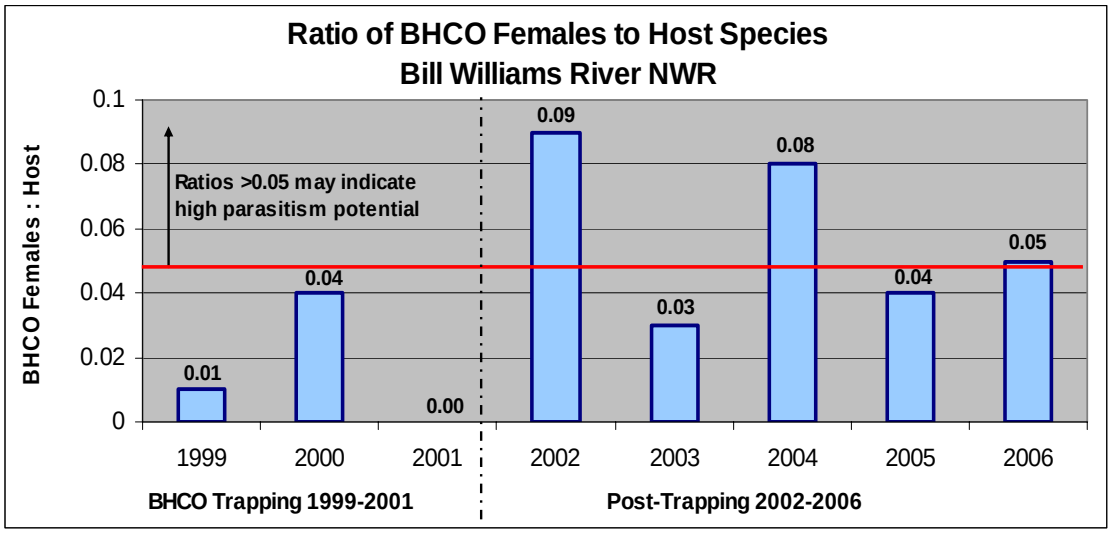


Figure 14. Ratio of BHCO females to host species detected during point counts at Bill Williams River NWR – 1999-2006.

Havasu NWR

Similar to the trends at Alamo Lake SWA and Bill Williams River NWR, the number of pooled bird group detections at the Havasu NWR significantly declined in 2002 (Figure 15). There was a significant reduction in neotropical migrants in 2002 and an increase by 2004, although numbers decreased again slightly in 2005 and 2006 ($F = 7.56$, Df = 5, 17, $P = 0.002$). The number of riparian obligate bird detections were significantly lower in 2002 and 2003 compared to other years ($F = 8.24$, Df = 5, 17, $P = 0.001$).

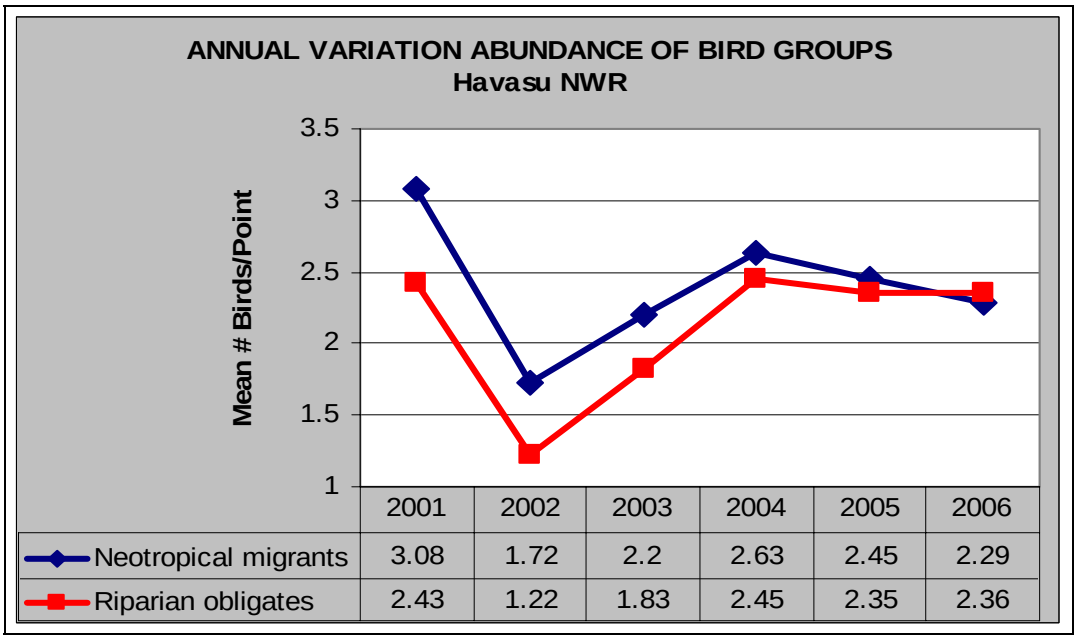
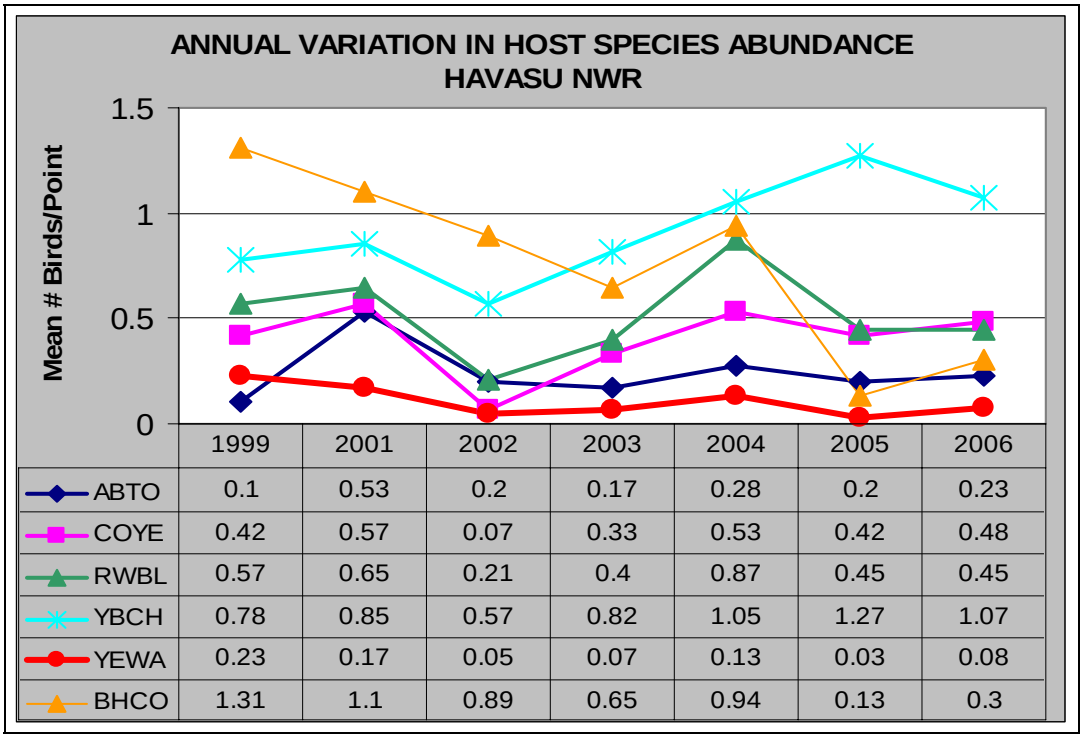


Figure 15. Mean number of neotropical migrants and riparian obligates detected during point counts on the Havasu NWR (2001-2006).

The most common host species documented during the study were YBCH, Red-winged Blackbird (RWBL – *Agelaius phoeniceus*), Common Yellowthroat (COYE - *Geothlypis trichas*), and ABTO (Figure 16). YBCH mean detection rates ranged from 0.57 birds/point in 2002 to 1.27 in 2005; RWBL from 0.22 in 2002 to 0.53 in 2004; COYE from 0.07 in 2002 to 0.57 in 2001; ABTO from 0.10 in 1999 to 0.53 in 2001. Detection rates for the YEWA were relatively low, ranging from 0.03 (2005) to 0.23 (1999).



	1999	2001	2002	2003	2004	2005	2006
ABTO	0.1	0.53	0.2	0.17	0.28	0.2	0.23
COYE	0.42	0.57	0.07	0.33	0.53	0.42	0.48
RWBL	0.57	0.65	0.21	0.4	0.87	0.45	0.45
YBCH	0.78	0.85	0.57	0.82	1.05	1.27	1.07
YEWA	0.23	0.17	0.05	0.07	0.13	0.03	0.08
BHCO	1.31	1.1	0.89	0.65	0.94	0.13	0.3

Figure 16. Mean number of common host species and BHCOs detected during point counts on the Havasu NWR (1999-2006).

When analyzing three of the common species individually (ABTO, COYE, YBCH), along with YEWA, statistical differences between years for ABTO, YBCH, and YEWA detection rates were identified. Detection rates for ABTO were significantly higher in 2001 than in all other years ($F = 4.35$, $Df = 6, 20$, $P = 0.010$). Detection rates for YBCH were significantly higher in 2005 than in years 1999 through 2003 ($F = 6.57$, $Df = 6, 20$, $P = 0.002$). Detection rates for YEWA were significantly higher in 1999 than in all other years except 2001 and 2004 ($F = 3.34$, $Df = 6, 20$, $P = 0.030$).

Total numbers of BHCO females averaged two per count in 2006. This is slightly higher than 2005, but less than all of the surveys in previous years. We calculated an average cowbird female:host ratio of

0.03 which represented a decrease from 1999-2004 ratios as well. Ratios significantly decreased from the 1999 and 2002 levels ($F = 4.03$, $Df = 6, 20$, $P = 0.015$).

Nest Monitoring

Alamo Lake SWA

During the eight study years, a total of 473 nests of 15 species, including 83 SWFL nests, were monitored[2]. The number of SWFL nests found each year ranged from 9 to 24 with the high in 2001 and low in 2005. Table 1 summarizes the nest monitoring results from 1999-2006 for the four common host species (ABTO, BEVI, SWFL, YBCH).

During the eight study years, combined parasitism rates for the four species ranged from one percent in 2000 to a high of 17 percent in 2004 with an increasing trend after the termination of the BHCO control program (Figure 17). Twelve percent of nests were parasitized in 2006, which is the second highest of the eight study years. BEVI nests experienced the overall highest parasitism with rates increasing from no parasitism in 1999 to 29 percent in 2004. One SWFL nest was parasitized in 1999 and one in 2004, which represents an overall 2.4 percent rate for the 83 SWFL nests monitored (7.7 percent in 1999; 10.0 percent for 2004). When comparing parasitism rates of the four pooled species during the trapping years (1999- 2001) to parasitism rates during the post-trapping years (2002-2006), parasitism rates were significantly lower during trapping years ($\chi^2 = 6.44$, $P = 0.011$).

Predation rates also increased during the post trapping years. BEVI nest predation increased from 11 percent in 2001 to a high of 40 percent in 2002; YBCH increased from 4 percent in 2001 to 25 percent in 2005; ABTO increased from 13 percent in 2001 to 50 percent in both 2004 and 2005 (Figure 17). Predation rates on SWFL nests increased from 8 percent to 17 percent in the trapping years. In the post trapping years, predation rates increased to 33 percent in 2003, but decreased to 22 percent by 2005. Combined predation rates on the four common host species increased from a low of 4 percent in 1999 to 30 percent in 2002, then decreased to 21 percent by 2006. Predation of the four common host species was also significantly lower during the trapping years ($\chi^2 = 14.09$, $P < 0.001$).

Nest success for the four most common host species, defined as the percentage of host nests that fledge at least one host nestling, ranged from a high of 84 percent in 2001 to a low of 62 percent in 2004 and increased to 70 percent in 2006 (Figure 18). During 2004, SWFLs experienced the lowest nest success rate of 50 percent. However, nest success for SWFLs increased to 67 percent in 2005. The number of

[2] The total does not include the 13 SWFL nests found but not monitored in 2000.

SWFL nests decreased to 9 in 2005 from 10 nests in 2004. In 2002, 24 SWFL nests were found which represented the highest number of nests during the eight years of monitoring. Nest success was higher during trapping years ($\chi^2 = 7.93$, $P = 0.005$).

Table 1. Nest monitoring results for four species (ABTO, BEVI, SWFL, and YBCH) at Alamo Lake SWA (1999-2006).

1999 Results:

Species	# Nests	Parasitized	Predated	Abandoned/Other	Successful
ABTO	2	0	0	0	2
BEVI	5	0	0	0	5
SWFL	13	1	1	3	9
YBCH	8	1	0	3	5
TOTAL	28	2 (7%)	1 (4%)	6 (21%)	21 (75%)

2000 Results:

Species	# Nests	Parasitized	Predated	Abandoned/Other	Successful
ABTO	4	1	0	0	4
BEVI	3	0	0	0	3
SWFL	13	No data	No data	No data	No data
YBCH	27	0	2	4	21
TOTAL	34	1 (3%)	2 (6%)	4 (12%)	27 (79%)

2001 Results:

Species	# Nests	Parasitized	Predated	Abandoned/Other	Successful
ABTO	8	0	1	0	7
BEVI	9	1	1	0	8
SWFL	24	0	4	3	17
YBCH	28	0	1	1	26
TOTAL	69	1 (1%)	7 (10%)	4 (6%)	58 (84%)

2002 Results:

Species	# Nests	Parasitized	Predated	Abandoned/Other	Successful
ABTO	4	0	2	1	1
BEVI	10	1	4	1	5
SWFL	12	0	3	1	8
YBCH	17	1	4	0	13
TOTAL	43	2 (5%)	13 (30%)	3 (7%)	27 (63%)

2003 Results:

Species	# Nests	Parasitized	Predated	Abandoned/Other	Successful
ABTO	4	1	2	0	2
BEVI	12	3	1	2	8
SWFL	15	0	5	0	10
YBCH	25	1	4	2	19
TOTAL	56	5 (9%)	12 (21%)	4 (7%)	39 (69%)

2004 Results:

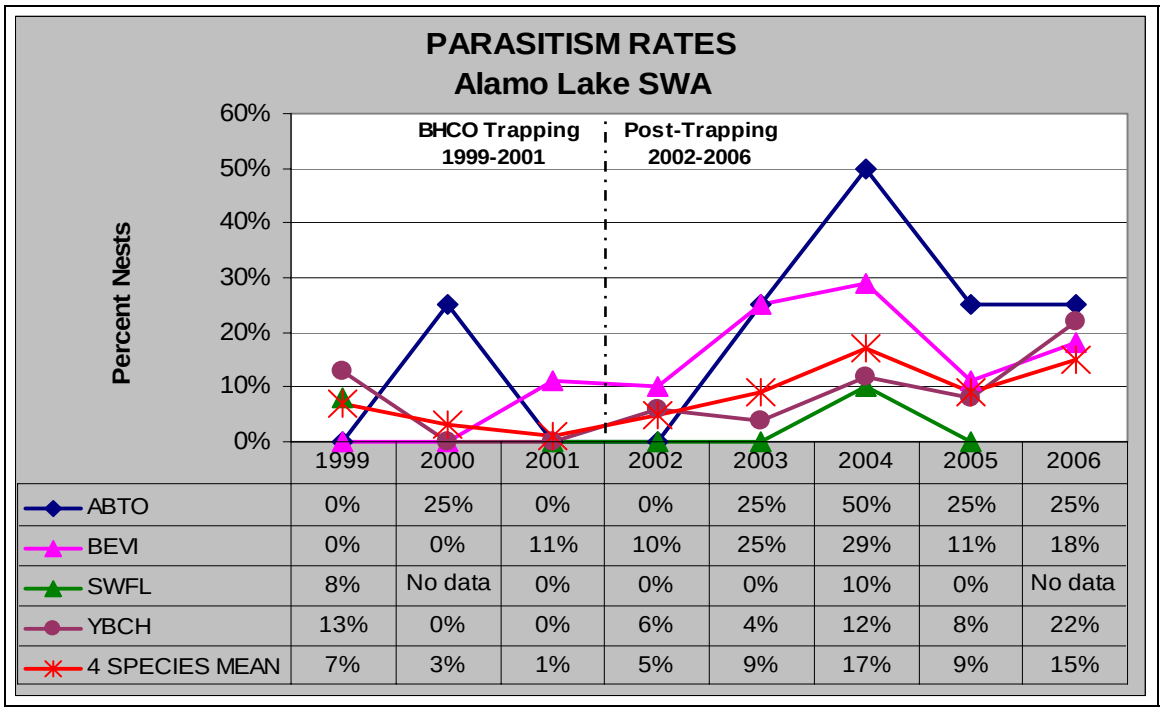
Species	# Nests	Parasitized	Predated	Abandoned/Other	Successful
ABTO	2	1	0	0	2
BEVI	14	4	4	1	9
SWFL	10	1	3	2	5
YBCH	26	3	5	4	16
TOTAL	52	9 (17%)	12 (23%)	7 (13%)	32 (62%)

2005 Results:

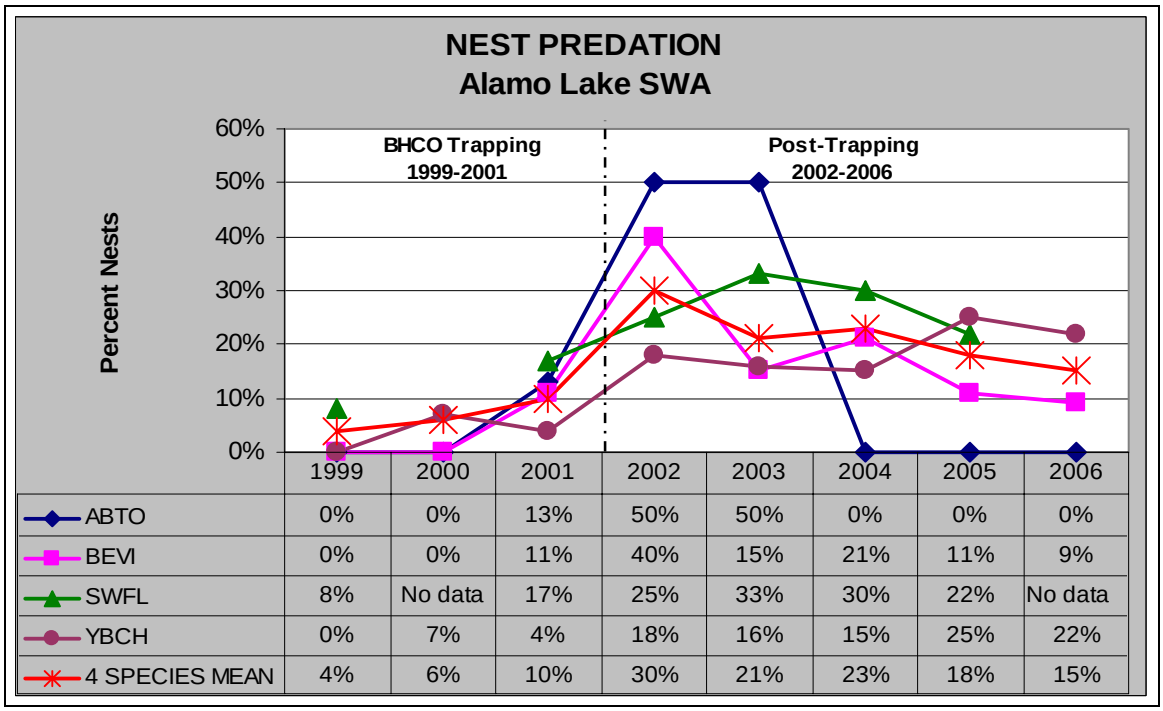
Species	# Nests	Parasitzed	Predated	Abandoned/Other	Successful
ABTO	4	1	0	1	3
BEVI	9	1	1	0	8
SWFL	9	0	2	1	6
YBCH	12	1	3	0	9
TOTAL	34	3(9%)	6(18%)	2 (5%)	26 (76%)

2006 Results:

Species	# Nests	Parasitized	Predated	Abandoned/Other	Successful
ABTO	4	1	1	0	3
BEVI	11	2	2	1	8
SWFL	No data	No data	No data	No data	No data
YBCH	18	1	4	2	12
TOTAL	33	4(12%)	7(21%)	3 (9%)	23(69%)

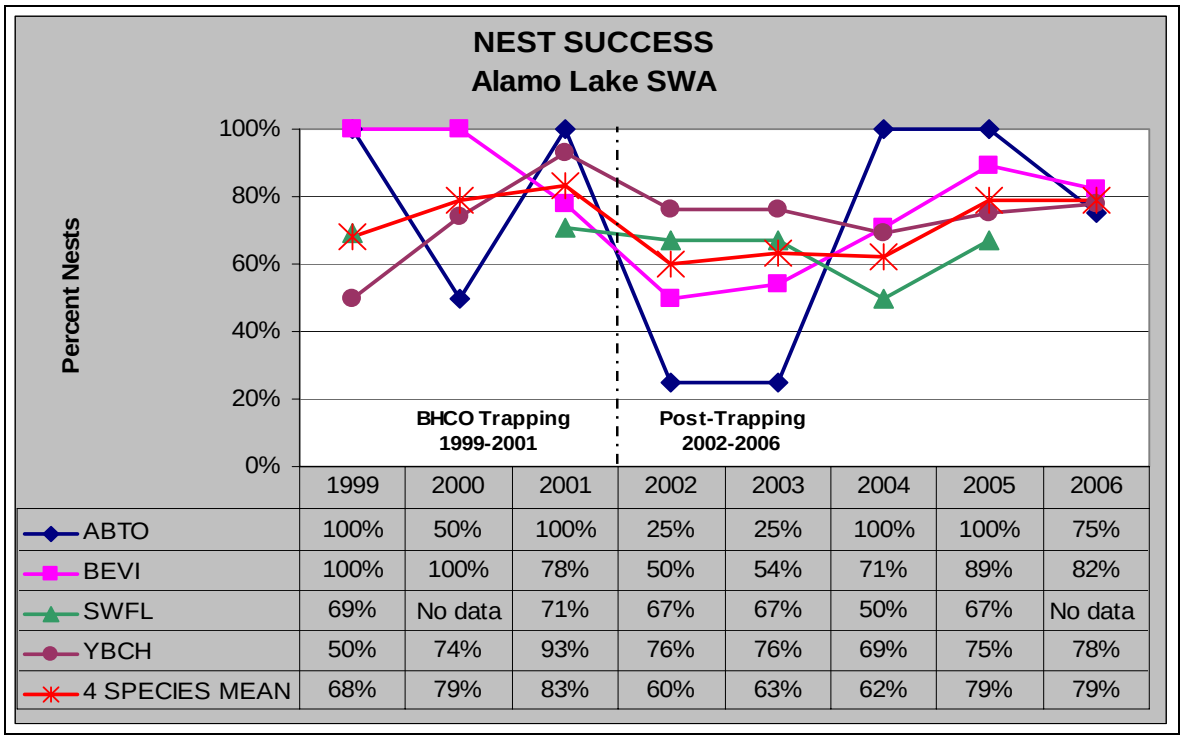


	1999	2000	2001	2002	2003	2004	2005	2006
ABTO	0%	25%	0%	0%	25%	50%	25%	25%
BEVI	0%	0%	11%	10%	25%	29%	11%	18%
SWFL	8%	No data	0%	0%	0%	10%	0%	No data
YBCH	13%	0%	0%	6%	4%	12%	8%	22%
4 SPECIES MEAN	7%	3%	1%	5%	9%	17%	9%	15%

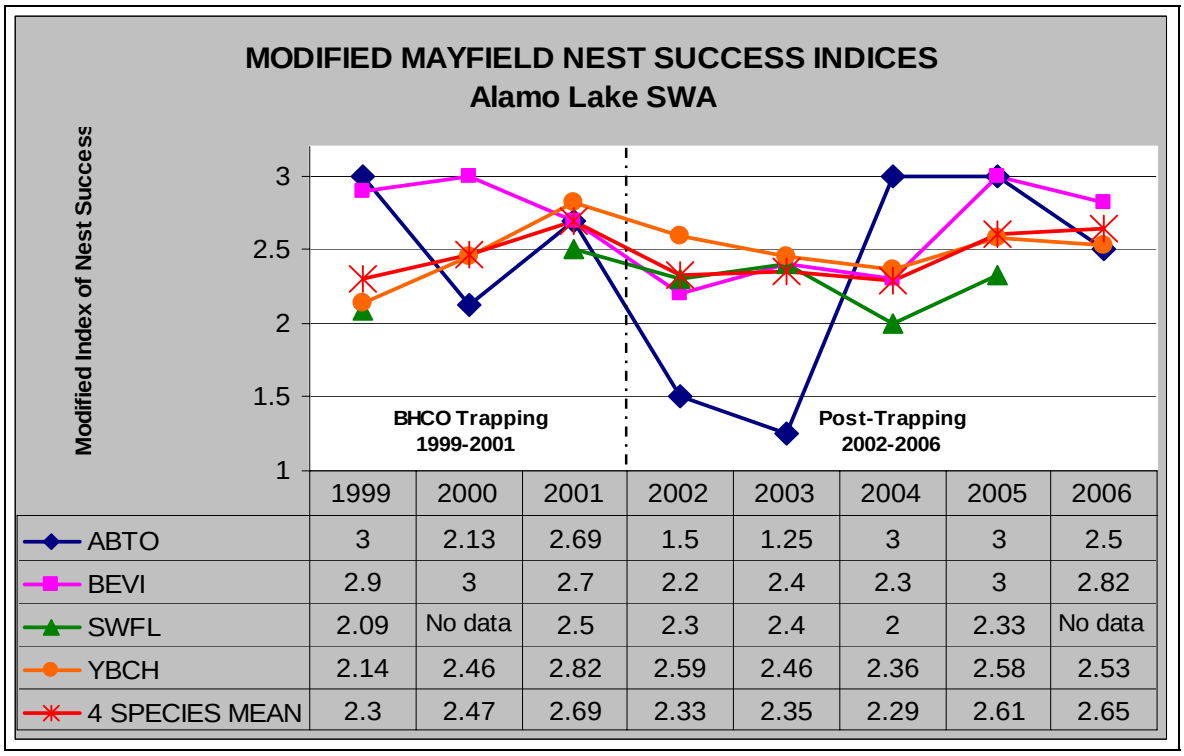


	1999	2000	2001	2002	2003	2004	2005	2006
ABTO	0%	0%	13%	50%	50%	0%	0%	0%
BEVI	0%	0%	11%	40%	15%	21%	11%	9%
SWFL	8%	No data	17%	25%	33%	30%	22%	No data
YBCH	0%	7%	4%	18%	16%	15%	25%	22%
4 SPECIES MEAN	4%	6%	10%	30%	21%	23%	18%	15%

Figure 17. Parasitism and nest predation observed at Alamo Lake SWA for four host species (1999-2006).



	1999	2000	2001	2002	2003	2004	2005	2006
ABTO	100%	50%	100%	25%	25%	100%	100%	75%
BEVI	100%	100%	78%	50%	54%	71%	89%	82%
SWFL	69%	No data	71%	67%	67%	50%	67%	No data
YBCH	50%	74%	93%	76%	76%	69%	75%	78%
4 SPECIES MEAN	68%	79%	83%	60%	63%	62%	79%	79%



	1999	2000	2001	2002	2003	2004	2005	2006
ABTO	3	2.13	2.69	1.5	1.25	3	3	2.5
BEVI	2.9	3	2.7	2.2	2.4	2.3	3	2.82
SWFL	2.09	No data	2.5	2.3	2.4	2	2.33	No data
YBCH	2.14	2.46	2.82	2.59	2.46	2.36	2.58	2.53
4 SPECIES MEAN	2.3	2.47	2.69	2.33	2.35	2.29	2.61	2.65

Figure 18. Nest success observed at Alamo Lake SWA for four host species (1999-2006).

Although nest success was found to be related to trapping, combined four species means of modified Mayfield indices were not significantly different between the trapping years and the post-trapping years (W = -607.5, $P = 0.412$; Figure 18). There was also no difference when comparing Mayfield indices between individual years (test stat = 8.98, $P = 0.253$). When examining Mayfield success of each of the four species individually, ABTO was the only species to show differences between years, with 2002 and 2003 being significantly lower than other years (F = 4.25, Df = 7, 30, $P = 0.004$).

Bill Williams River NWR

During the eight study years a total of 188 nests of 13 species including 12 SWFL nests were monitored[3]. The number of SWFL nests that was found each year ranged from zero to four; none were found in 2000 and 2004, two were monitored in 2005, and one in 2006. Table 2 and figures 19 and 20 summarize the nest monitoring results from 1999-2006 for the four common host species.

Parasitism rates for all species were zero during the 1999-2001 BHCO trapping years with an increasing trend after the termination of the BHCO control program (Figure 19). The parasitism rates for the combined four species - ABTO, BEVI, YBCH, and SWFL - were 10 percent in 2002, 20 percent in 2003, 21 percent in 2004, 13 percent in 2005, and 12 percent in 2006. Both BEVIs and ABTOs experienced the highest overall parasitism in 2006, each with a 33 percent rate. BEVI nest parasitism rates increased from 0 percent during the trapping years to 24 percent post-trapping; YBCH nests also increased from 0 percent during trapping years to 13.3 percent in the post trapping years. None of the 11 SWFL nests were parasitized. When comparing parasitism rates of the four pooled species during the trapping years (1999- 2001) to parasitism rates during the post-trapping years (2002-2006), there was no difference in parasitism rates between the two periods ($\chi^2 = 3.60$, $P = 0.058$).

Nest predation also increased from 0 percent during trapping to a high of 33 percent in 2002 during the post trapping years. One SWFL nest was predated in 2006. Predation rates for BEVIs increased from 22 percent in 2002 to 25 percent in both 2004 and 2005, and 33 percent in 2006 compared to 0 percent during trapping years; rates for YBCH increased from 0 percent during trapping years to an average of 24.4 percent during post trapping years. Predation was found to be significantly higher during the post-trapping years ($\chi^2 = 6.32$, $P = 0.012$).

[3] SWFL nests monitored by SBCM and SWCA contractors.

Table 2. Nest monitoring results for four species (ABTO, BEVI, SWFL, and YBCH) at Bill Williams NWR (1999-2006).

1999 Results:

Species	# Nests	Parasitzed	Predated	Abandoned/Other	Successful
ABTO	1	0	0	0	1
BEVI	4	0	0	1	3
YBCH	No data	No data	No data	No data	No data
SWFL	1	0	0	0	1
TOTAL	6	0	0	1 (17%)	5 (83%)

2000 Results:

Species	# Nests	Parasitzed	Predated	Abandoned/Other	Successful
ABTO	No data	No data	No data	No data	No data
BEVI	4	0	0	2	2
YBCH	1	0	0	0	1
SWFL	1	0	0	0	1
TOTAL	6	0	0	2 (33%)	4 (67%)

2001 Results:

Species	# Nests	Parasitzed	Predated	Abandoned/Other	Successful
ABTO	No data	No data	No data	No data	No data
BEVI	No data	No data	No data	No data	No data
YBCH	8	0	0	0	8
SWFL	2	0	0	0	2
TOTAL	10	0	0	0	10 (100%)

2002 Results:

Species	# Nests	Parasitzed	Predated	Abandoned/Other	Successful
ABTO	No data	No data	No data	No data	No data
BEVI	9	2	2	0	7
SWFL	4	0	0	2	2
YBCH	8	0	5	0	3
TOTAL	21	2 (10%)	7 (33%)	2 (10%)	12 (57%)

2003 Results:

Species	# Nests	Parasitzed	Predated	Abandoned/Other	Successful
ABTO	1	0	0	0	1
BEVI	2	1	0	1	1
YBCH	5	1	1	1	4
SWFL	2	0	0	0	2
TOTAL	10	2 (20%)	11%)	2 (20%)	7 (70%)

2004 Results:

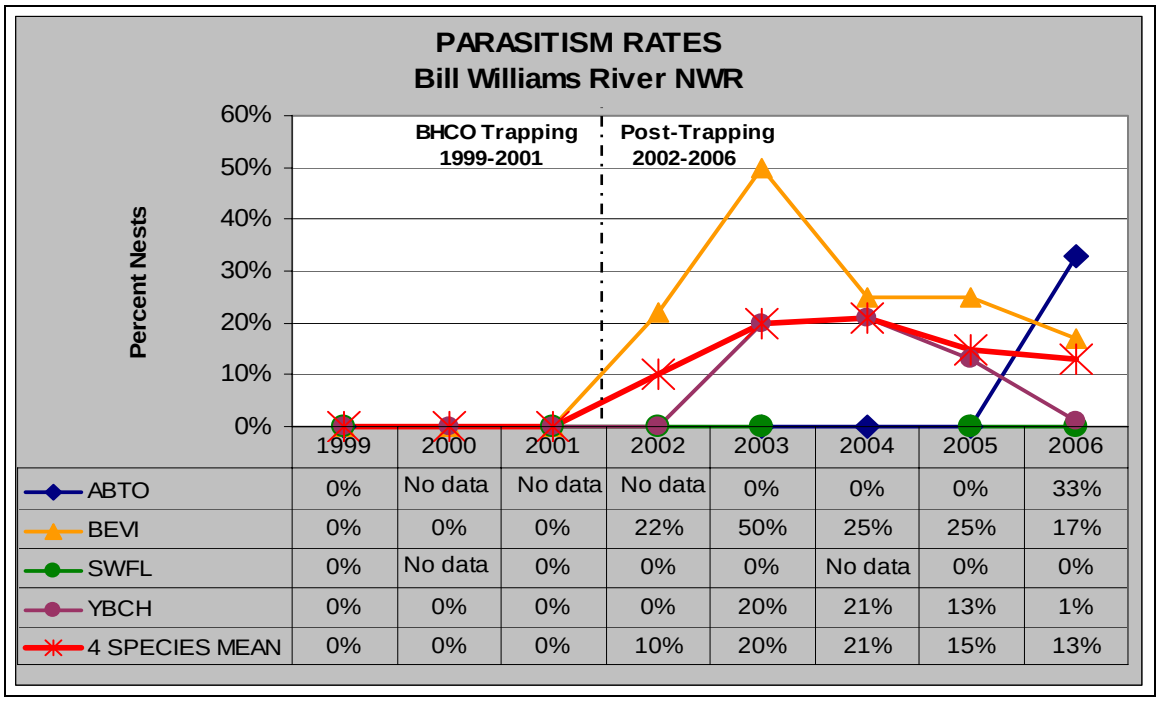
Species	# Nests	Parasitzed	Predated	Abandoned/Other	Successful
ABTO	1	0	0	0	1
BEVI	4	1	1	0	3
YBCH	14	3	3	2	9
SWFL	No data	No data	No data	No data	No data
TOTAL	19	4 (21%)	4 (21%)	2 (11%)	13 (68%)

2005 Results:

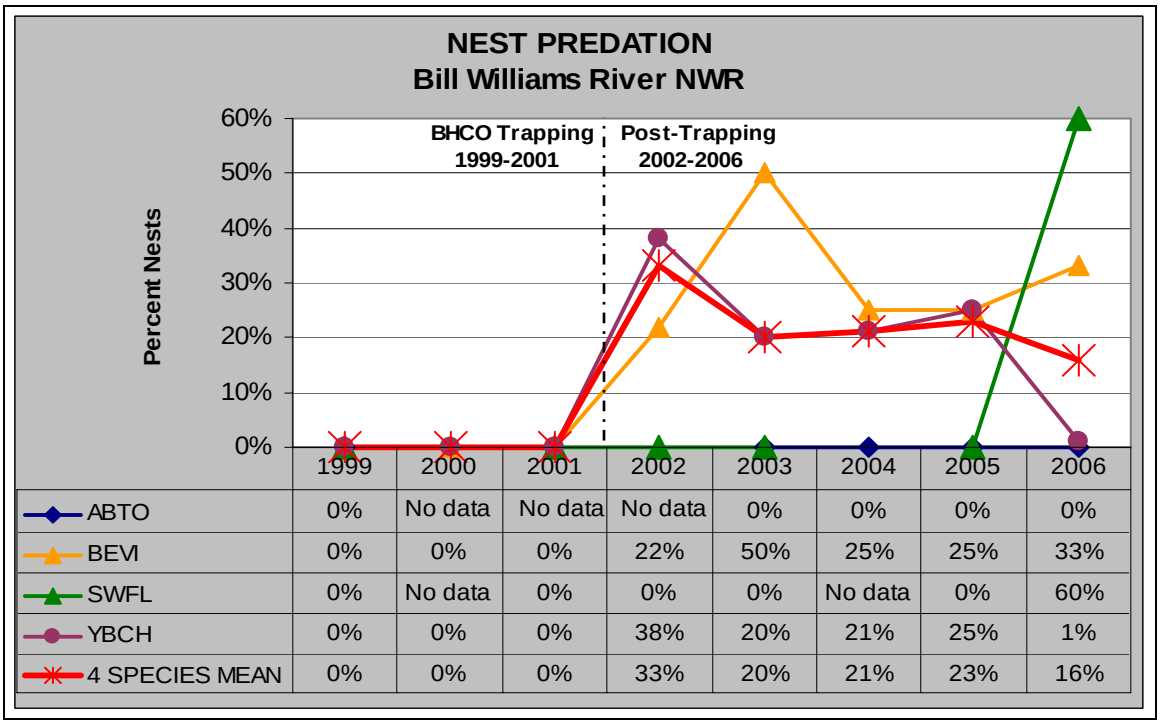
Species	# Nests	Parasitzed	Predated	Abandoned/Other	Successful
ABTO	1	0	0	0	1
BEVI	4	1	1	0	3
YBCH	8	1	2	1	5
SWFL	2	0	0	0	2
TOTAL	15	2 (15%)	3 (23%)	1(7%)	11 (73%)

2006 Results:

Species	# Nests	Parasitzed	Predated	Abandoned/Other	Successful
ABTO	4	1	0	1	3
BEVI	6	1	2	1	3
YBCH	10	1	1	1	8
SWFL	5	0	3	1	1
TOTAL	25	3 (12%)	6 (24%)	4 (16%)	15 (60%)



	1999	2000	2001	2002	2003	2004	2005	2006
ABTO	0%	No data	No data	No data	0%	0%	0%	33%
BEVI	0%	0%	0%	22%	50%	25%	25%	17%
SWFL	0%	No data	0%	0%	0%	No data	0%	0%
YBCH	0%	0%	0%	0%	20%	21%	13%	1%
4 SPECIES MEAN	0%	0%	0%	10%	20%	21%	15%	13%



	1999	2000	2001	2002	2003	2004	2005	2006
ABTO	0%	No data	No data	No data	0%	0%	0%	0%
BEVI	0%	0%	0%	22%	50%	25%	25%	33%
SWFL	0%	No data	0%	0%	0%	No data	0%	60%
YBCH	0%	0%	0%	38%	20%	21%	25%	1%
4 SPECIES MEAN	0%	0%	0%	33%	20%	21%	23%	16%

Figure 19. Parasitism and nest predation observed at Bill Williams River NWR for four host species.

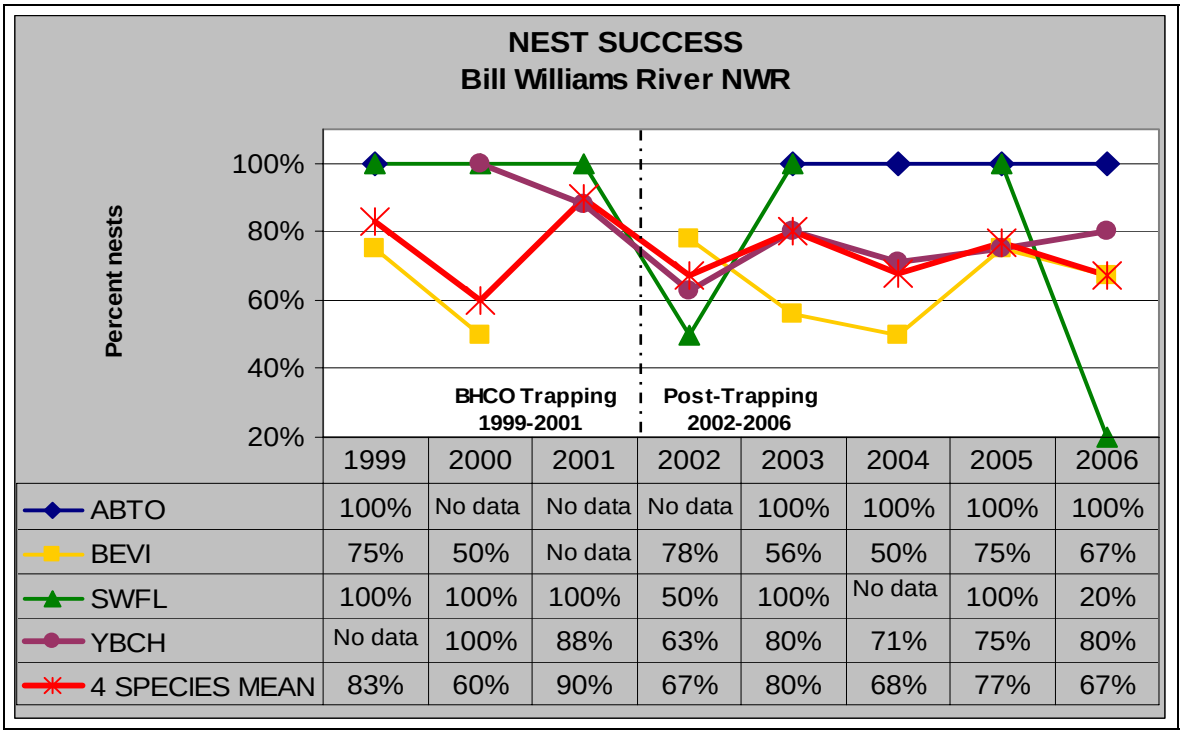
Nest success was as high as 100% in 2001 during trapping and dropped to a low of 57% in 2002, a pattern inversely related to predation (Figure 20). Nest success was also significantly lower during the post-trapping years ($\chi^2 = 3.95$, $P = 0.047$). Although nest success was found to be related to trapping, modified Mayfield indices for combined four species means (ABTO, BEVI, YBCH and SWFL) were not significantly different between the trapping years and the post-trapping years (W = -917.0, $P = 0.088$). There was also no difference when comparing Mayfield indices between individual years (test stat = 7.23, $P = 0.405$). When examining each of the four species individually, there were no significant differences in Mayfield success between years.

Discussion

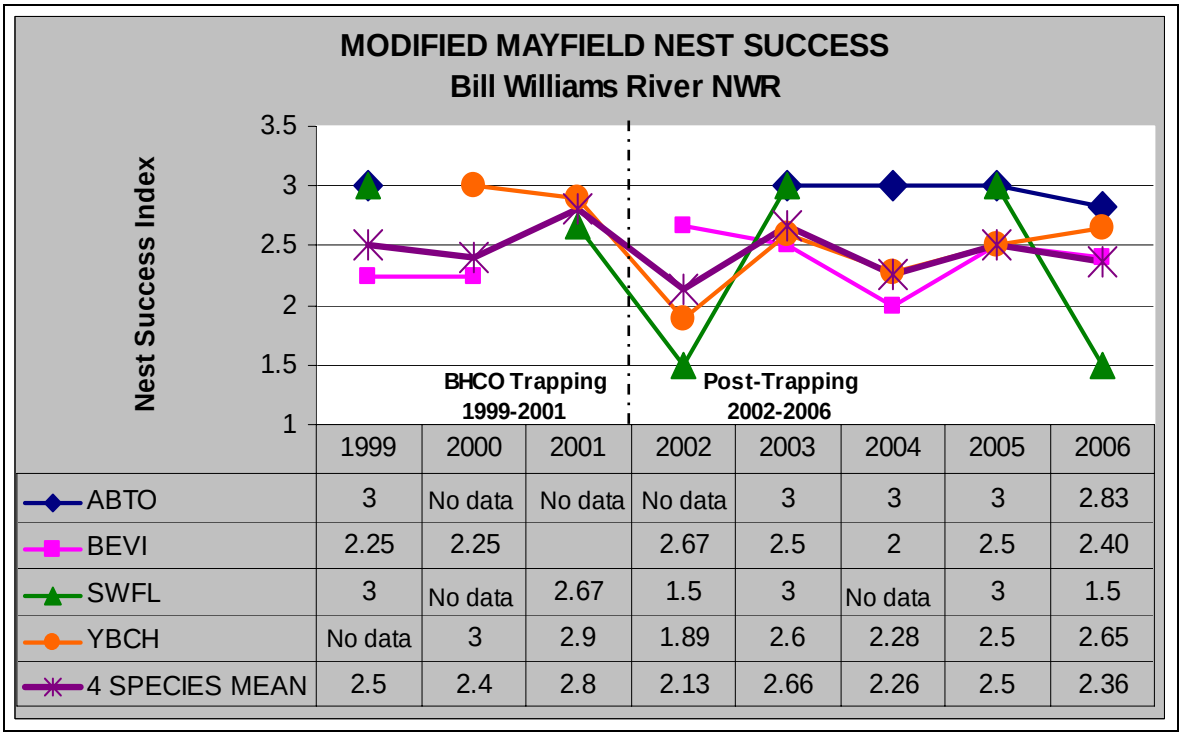
BHCO Abundance

Compared to sites on the mainstem Colorado River, BHCO numbers have remained relatively low during and following trapping at the Alamo Lake SWA and the Bill Williams River NWR. The number of cowbirds observed during our point counts at the Alamo Lake SWA and Bill Williams River NWR during 1999-2006 is less than 30 percent of what had been observed along the mainstem lower Colorado River in previous years. During our study, annual mean BHCO abundance ranged from a low of 0.01 in 2001(trapping year) to a high of 0.58 in 2006 (post-trapping year) at Alamo Lake and a low of 0.06 in 1999 (trapping year) to a high of 0.38 in 2006 (post-trapping year) at Bill Williams River. In contrast, point counts conducted by Averill (1996) in 1994 and 1995 found that BHCO abundance averaged 1.24 BHCOs per point along the lower Colorado River.

BHCO abundance declined from 1999 to 2001 at the Alamo Lake SWA while trapping was conducted. This trend may represent BHCO population reduction during the trapping years and correlates with the decrease in numbers of trapped BHCOs each year from 1999-2001. After trapping was terminated, there was an increase in BHCO abundance from 2002 to 2004, followed by a slight decrease in 2005, and then another increase in 2006. The numbers of BHCOs detected from 2004 through 2006 were the highest of our eight year study, indicating that BHCO numbers are returning to pre-trapping levels five years after the termination of trapping. No data on BHCO abundance prior to the start of BHCO control are available. The gradual increase in BHCO numbers following trapping may indicate a relatively slow immigration rate of BHCOs into an area isolated from a major BHCO population center, agricultural area, and migration corridor such as the Colorado River.



	1999	2000	2001	2002	2003	2004	2005	2006
ABTO	100%	No data	No data	No data	100%	100%	100%	100%
BEVI	75%	50%	No data	78%	56%	50%	75%	67%
SWFL	100%	100%	100%	50%	100%	No data	100%	20%
YBCH	No data	100%	88%	63%	80%	71%	75%	80%
4 SPECIES MEAN	83%	60%	90%	67%	80%	68%	77%	67%



	1999	2000	2001	2002	2003	2004	2005	2006
ABTO	3	No data	No data	No data	3	3	3	2.83
BEVI	2.25	2.25		2.67	2.5	2	2.5	2.40
SWFL	3	No data	2.67	1.5	3	No data	3	1.5
YBCH	No data	3	2.9	1.89	2.6	2.28	2.5	2.65
4 SPECIES MEAN	2.5	2.4	2.8	2.13	2.66	2.26	2.5	2.36

Figure 20. Nest success observed at Bill Williams River NWR for four host species (1999-2006).

At the Bill Williams River NWR, mean BHCO values actually increased during the 1999 to 2001 trapping period. The first year of trapping (1999) resulted in the lowest BHCO abundance. Except for the decrease observed in 2003, BHCO numbers continued to increase after trapping, and the 2006

abundance exceeded all other years including 1999. Similar to what occurred at Alamo Lake, BHCO abundance dropped slightly in 2005, and increased again in 2006. There was significantly lower BHCO abundance at Bill Williams during the first year of trapping in 1999 compared to Alamo Lake ($t = 3.18$, $P < 0.001$). This may reflect a reduction of BHCOs from the 1996-1998 trapping effort at the Bill Williams River NWR, which occurred prior to our study. Morrison and Averill-Murray (2002) found that the earlier trapping efforts from 1996 to 1998 and a decrease in local irrigated agriculture probably resulted in reduced cowbird abundance along the lower Bill Williams River. The closer proximity of the Bill Williams site to the mainstem Colorado River compared to Alamo Lake may result in faster recruitment of BHCOs and BHCO numbers may more accurately reflect the region-wide trends of BHCO abundance.

Higher BHCO numbers were documented at the Havasu NWR throughout the study period. However, unlike the Bill Williams and Alamo Lake sites, annual BHCO point count detections actually decreased from 1999 to 2006. In 1999, 2001, and 2002, and before trapping started for the season in 2003 and 2004, BHCO abundance ranged from 0.6 to 1.9 per point along our host species point count route at the Havasu NWR. In mid-June 2003 and 2004, following the start of trapping, the abundance dropped to 0.5. In 2006 the 3 survey average was 0.3, a slight increase from 2005, but still much lower than 1999-2004.

Compared to the Alamo Lake SWA and the Bill Williams River NWR, much higher BHCO abundance was observed at the Havasu NWR during host species point counts from 1999 to 2004. However, except for a spike in May 2004, BHCO overall abundance decreased after 2002 which may be the result of trapping starting in 2003.

The decrease in abundance of BHCOs at the Alamo Lake SWA following trapping is similar to a cowbird control program in California which showed significant decline in the number of BHCOs captured from year to year over a 5-year period (Whitfield et al. 1999). However, Reclamation's BHCO control program on the mainstem Rio Grande in New Mexico showed a relatively constant capture rate from 1996 to 2001 (Ahlers and Tisdale-Hein 2001). These contrasting results could indicate that (1) a constant annual immigration of BHCOs occurs along major north-south oriented continuous migration corridors such as the Rio Grande and Colorado River and (2) lower BHCO immigration occurs in certain riparian areas off the mainstem of such rivers. Ongoing and future BHCO control programs along the mainstem Colorado River could further test this hypothesis.

Host Species Abundance and BHCO Ratios

Our point counts at the Alamo Lake SWA, Bill Williams River NWR, and Havasu NWR documented

the continued occurrence of a diverse population of late spring migrants and breeding songbirds including potential BHCO host species, riparian obligates, and neotropical migrants. The abundance of several species of songbirds, especially neotropical migrants and riparian obligates, experienced declines in 2002 at Alamo Lake SWA, Bill Williams River NWR, and Havasu NWR. By 2003 or 2004, abundances for many species were increasing toward 2001 levels. Overall, the pooled means of all birds, neotropical migrants, and riparian obligates were higher in all three areas in 2004 compared with 2002. Many species such as YBCH approached or exceeded 2001 levels, while others such as Blue Grosbeak (*Guiraca caerulea*) and YEWA continued declines at some or all of our study sites. In 2005 and 2006, the abundance of neotropical migrants and riparian obligates indicated a continued increase at Alamo Lake while numbers dropped slightly at Bill Williams River and Havasu NWR. The most dramatic change occurred in YBCH abundance, which was the most abundant riparian obligate at all three sites.

BHCO abundance followed a different pattern than neotropical migrants and riparian obligates. BHCO abundance decreased to low values in 2001 at Alamo Lake SWA and began a steady increase in 2002, reaching its highest level of the study in 2006. Due to habitat destruction, we were unable to conduct the point counts at Brown's Crossing in 2006. At Bill Williams River NWR, BHCO abundance increased through 2002, decreased in 2003, then increased each year from 2004 through 2006, reaching the highest level at Bill Williams in 2006. At Havasu, mid-June BHCO abundance was relatively high in 2002, then decreased from 2003 through 2005, and increased slightly in 2006. Therefore, we cannot necessarily correlate the decrease in BHCO abundances with the decrease in overall avian abundances.

However, the increase in the ratio of BHCO females to host birds at Bill Williams NWR beginning in 2002 may be attributable to the decline in abundance of host species in relationship to higher numbers of BHCOs. Our data indicate that the mid-June ratio of female BHCOs to host birds at Alamo Lake and Bill Williams had increased in 2004. The ratios at the Bill Williams River NWR had showed increases that correlated with the increase of parasitism that started in 2002.

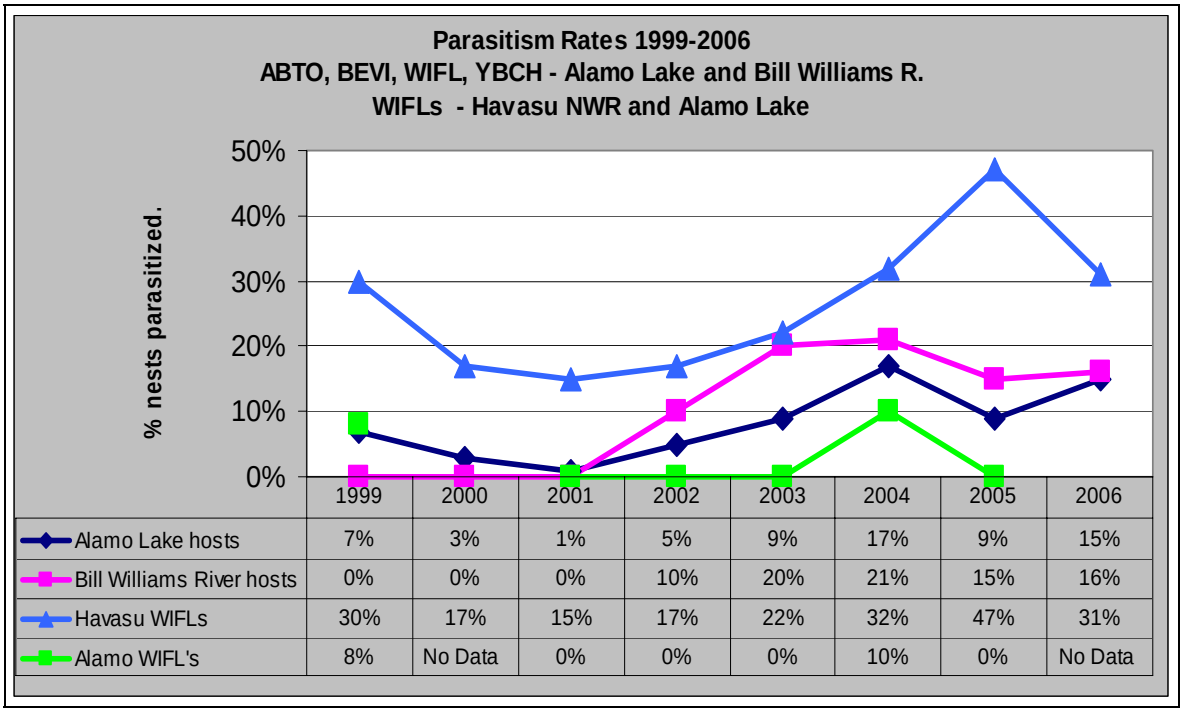
The ratios at Havasu NWR decreased starting in June 2003, but parasitism had continued to increase. The ratio had remained high from 1999 to 2002 at the Havasu NWR which correlates with the much higher parasitism in the SWFL population observed by McKernan and Braden (2002). The decrease in the host ratio from 2003 through 2006 at the Havasu NWR may correlate with the BHCO control that started in June 2003. The 47 percent parasitism rate observed in SWFL nests in 2005 at Havasu NWR is the highest since 1999 and represents an increasing trend. This may be a result of a larger population of BHCOs, greater immigration potential, or it may represent a lag effect of BHCO control.

BHCO Parasitism and Nest Success

By 2004, parasitism rates for the four host species, including SWFLs, increased to the highest rates observed during the three years following BHCO trapping in both nest monitoring study sites. However, parasitism at Alamo Lake dropped to 9 percent in 2005, and then increased again in 2006 to 15 percent. At Bill Williams, the 2005 and 2006 rates leveled off to 15 percent and 16 percent, respectively. The 2002-2006 parasitism rates of 5 percent to 17 percent for four host species exceeded rates observed during the 1999-2001 trapping years at Alamo Lake, as did the rates at Bill Williams, which ranged from 10 percent to 21 percent for the post trapping years (Figure 21). It is possible that the 2002-2004 increase in parasitism is attributable to cessation of trapping, and that the 2005 and 2006 decrease may be a result of inundation of habitat.

It has been estimated that parasitism rates greater than 25 percent could threaten the long-term survival of certain localized populations of host species (Smith 1999). Only 1 of the 54 SWFL nests found at Alamo Lake and Bill Williams sites were parasitized during post-trapping years. During the 1999-2001 BHCO control program, parasitism rates for all host species ranged from 0 percent to 5 percent and from 0 percent to 8 percent for SWFLs. One of the 46 SWFL nests monitored was parasitized during the trapping years at Alamo Lake.

Unfortunately, no pre-trapping parasitism data are available specifically for our study plots at the Alamo Lake SWA or Bill Williams River NWR. However, during the 1997 to 1998 trapping seasons in Bill Williams River NWR, parasitism rates ranged from 11 percent to 27 percent for BEVI and 0 percent to 12 percent for YBCH in other nearby plots (Morrison and Averill-Murray 2002). Averill (1996) found parasitism rates in the Lower Colorado River Valley ranged from 40 percent to 90 percent for three of the same common host species during 1994-1995; the Bill Williams River NWR was included in her study area. If parasitism rates were in that range prior to the start of our trapping, we conclude that trapping may have reduced parasitism during the trapping years extending into the third year after the cessation of trapping.



	1999	2000	2001	2002	2003	2004	2005	2006
Alamo Lake hosts	7%	3%	1%	5%	9%	17%	9%	15%
Bill Williams River hosts	0%	0%	0%	10%	20%	21%	15%	16%
Havasu WIFLs	30%	17%	15%	17%	22%	32%	47%	31%
Alamo WIFL's	8%	No Data	0%	0%	0%	10%	0%	No Data

Figure 21. Parasitism observed in nest monitoring plots from 1999 to 2006. (Havasu data from McKernan and Braden 2002, SWCA 2005-2006).

At Havasu NWR parasitism increased dramatically from 15 percent in 2001 to 47 percent in 2005 (Figure 21) in spite of extensive BHCO trapping from 2003 to 2005 (SWCA 2005). Cowbird control obviously had not yet reduced parasitism of SWFL nests at Havasu NWR in 2005. A possible explanation could involve a high immigration rate of BHCOs during the breeding season along the mainstem Colorado River coupled with a lag effect where the effect of control would not be observed until after several years of trapping. What is more puzzling is the dramatic reduction of BHCO detections during point counts. We expected that this decrease would correlate with the trapping as it did at Alamo Lake. However, the increase in nest parasitism at Havasu is in contrast with what we observed at Alamo where both BHCO point count detections and parasitism rates decreased during BHCO control. Our speculation is that only a few remaining female BHCOs did most of the parasitism within the SWFL habitat at Havasu in 2005 and/or intensive human activity within nesting territories may have attracted BHCOs.

While parasitism rates were low at the Alamo Lake SWA and the Bill Williams River NWR, the four-species nest success rate increased in 2006 from previous years. Post-trapping nest success at Alamo ranged from a low of 60 percent in 2002 to a high of 79 percent in both 2005 and 2006; at Bill Williams from a low of 50 percent in 2002 to a high of 79 percent in 2006. For comparison, although sample sizes are relatively small, nest success of SWFLs at Havasu NWR decreased from 78 percent in 2003 to

45 percent in 2004, 24 percent in 2005, and 23 percent in 2006 (SWCA 2005). Nest success for SWFLs ranged from 49 percent (2004) to 57 percent (2006) along the Rio Grande in New Mexico from 2002 to 2006 (Moore and Ahlers 2006).

The decreasing trend in nest success for four common host species at Alamo Lake SWA from 2001 to 2004 was the result of both increasing parasitism and nest predation. Combined predation rates increased from 10 percent in 2001 to 23 percent in 2004. However, predation rates for SWFLs increased from 17 percent in 2001 to 33 percent in 2003, and then dropped to 22 percent by 2005. This recent decrease may be attributable to reservoir inundation.

An important finding with our 2005 monitoring was the continued SWFL nesting at Alamo Lake through the 2005 season at essentially the same sites which were inundated by at least 4 m of water throughout the breeding season However, when the water level dropped and all the understory vegetation died in 2006, no SWFLs nested here (Figure 22). We did detect a total of seven individual SWFLs within the same nest plot at Alamo Lake in mid- to late-May of 2006. These birds would likely have established territories at these historic breeding sites had the habitat not degraded.

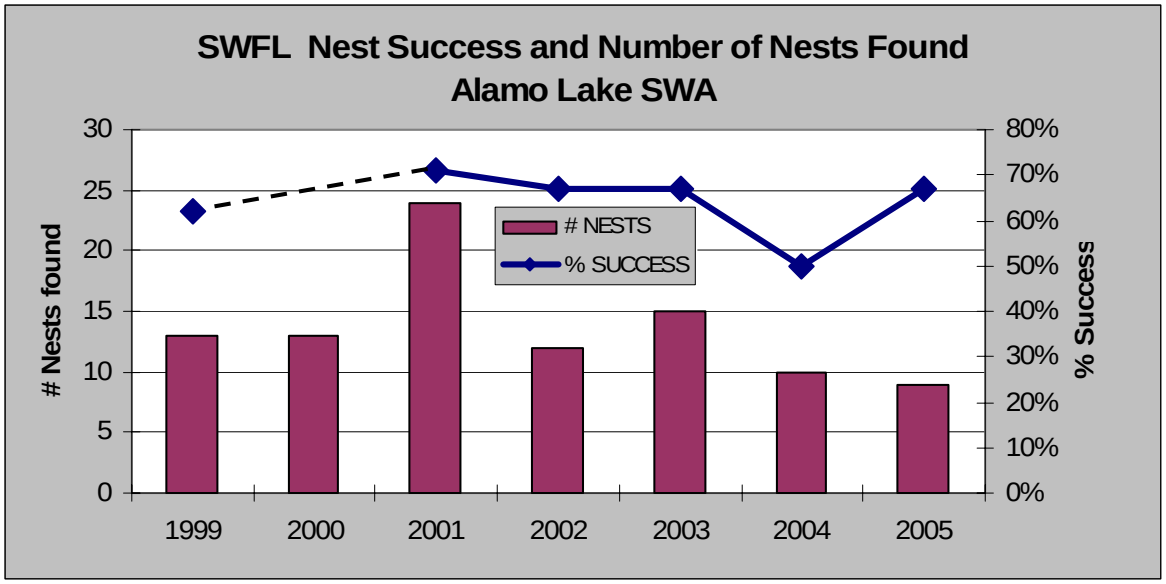


Figure 22. Relation of SWFL nesting success and number of nests at Alamo Lake SWA from 1999 to 2005.

In contrast to our observations of an increase in parasitism in 2004 at Alamo Lake (Ryan and White 2004), there was a decrease in 2005, especially within habitat in the the flooded reservoir pool.

However, BHCO abundance continued to increase along the adjacent Brown's Crossing route, and parasitism rates increased in 2006 at the Santa Maria River nest plot. It is possible that both BHCO numbers and parasitism levels may continue to increase, especially at Alamo Lake SWA. Future monitoring is needed to confirm this, help direct any future management actions, and contribute to the recovery of the SWFL.

Conclusions and Recommendations

Our study at the Alamo Lake SWA and Bill Williams River NWR indicates that the BHCO control effort did reduce BHCO abundance, and consequently parasitism rates, on a local level. Following the cessation of trapping in 2001, there was an increase in BHCO abundance and parasitism through 2006. Simple nest success of the four most common host species including the SWFL, based on whether or not host young fledged from a nest, was also improved during BHCO trapping. However, modified Mayfield indices showed no significant difference when comparing trapping years and non-trapping years. Thus, BHCO trapping can be effective at reducing the impacts of parasitism on nesting neotropical migrants in certain instances. BHCO trapping can be considered an option if it can be documented that parasitism is the primary threat to an individual species. However, as documented by this study, other factors such as predation and habitat degradation or loss can be serious issues.

Recommendations

- Any future BHCO control programs at new sites should be preceded by pre-trapping baseline studies, including study designs that would determine the effectiveness of trapping on the long-term reproductive success and population trends of the SWFL and other host species (Siegle and Ahlers 2004). Limiting factors such as habitat availability and predation should also be assessed.
- Ongoing studies at Havasu NWR should investigate the factors that have caused a dramatic increase of nest parasitism at Havasu in spite of three seasons of BHCO control. In addition, a study could be set up to determine the recent inverse relationship between BHCO point count results and parasitism rates at Havasu NWR.
- Regenerating vegetation at Alamo Lake SWA and Bill Williams River NWR should be periodically monitored to determine its suitability for breeding SWFLs.

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Attachment

Nest Monitoring Data – Alamo Lake SWA and Bill Williams River NWR 1999 - 2006

Attachment

Nest Monitoring Results 1999-2006 Alamo Lake SWA

1999 Results:

Species	Total Nests	Parasitized	Predated	Abandoned/Other	Successful
Abert's Towhee	2	0	0	0	2
Bell's Vireo	5	0	0	0	5
Common Yellowthroat	2	0	0	0	2
Mourning Dove	4	0	0	3	1
Song Sparrow	8	0	1	0	7
S.W. Willow Flycatcher	13	1	1	3	9
Yellow-breasted Chat	8	1	0	3	4
TOTAL	**42**	**2 (5%)**	**2 (5%)**	**9 (21%)**	**30 (71%)**

2000 Results:

Species	Total Nests	Parasitized	Predated	Abandoned/Other	Successful
Abert's Towhee	4	1	0	1	3
Bell's Vireo	3	0	0	0	3
Blue Grosbeak	3	0	0	0	3
Common Yellowthroat	1	0	0	0	1
Mourning Dove	1	0	0	0	1
Pyrrhuloxia	1	0	0	1	0
Song Sparrow	5	0	1	0	4
Yellow-breasted Chat	27	0	2	4	21
Yellow Warbler	1	1	0	0	0
TOTAL	**46**	**2 (4%)**	**3 (7%)**	**6 (13%)**	**36 (78%)**

2001 Results:

Species	Total Nests	Parasitized	Predated	Abandoned/Other	Successful
Abert's Towhee	8	0	1	0	7
Bell's Vireo	9	1	1	0	7
Black-tailed Gnatcatcher	1	0	0	0	1
Blue Grosbeak	2	0	0	0	2
Common Yellowthroat	10	0	1	1	8
Mourning Dove	4	0	0	0	4
Song Sparrow	5	0	1	0	4
S.W. Willow Flycatcher	24	0	4	3	17
Yellow-breasted Chat	28	0	1	1	26
Unidentified songbirds	5	0	4	1	0
TOTAL	**96**	**1 (1%)**	**13 (13%)**	**6 (6%)**	**76 (79%)**

Nest Monitoring Results 1999-2006 Alamo Lake SWA

2002 Results:

Species	Total Nests	Parasitized	Predated	Abandoned/Other	Successful
Abert's Towhee	4	0	2	1	1
Bell's Vireo	10	1	4	1	4
Mourning Dove	2	0	0	0	2
Song Sparrow	2	1	1	0	0
Summer Tanager	1	0	0	0	1
Verdin	5	0	0	0	5
S.W. Willow Flycatcher	12	0	3	1	8
Yellow-breasted Chat	17	1	4	0	13
Yellow Warbler	2	1	1	0	1
Unidentified songbirds	1	0	1	0	0
TOTAL	**56**	**4 (7%)**	**15 (27%)**	**3 (5%)**	**35 (63%)**

2003 Results:

Species	Total Nests	Parasitized	Predated	Abandoned/Other	Successful
Abert's Towhee	4	1	2	0	2
Bell's Vireo	13	3	2	4	7
Blue Grosbeak	3	0	1	1	1
Common Yellowthroat	11	0	2	0	9
Song Sparrow	4	2	0	2	2
S.W. Willow Flycatcher	15	0	5	0	10
Yellow-breasted Chat	25	1	4	2	19
Unidentified songbirds	2	0	1	0	1
TOTAL	**77**	**7 (9%)**	**17 (22%)**	**9 (12%)**	**51 (66%)**

2004 Results:

Species	Total Nests	Parasitized	Predated	Abandoned/Other	Successful
Abert's Towhee	2	1	0	0	2
Bell's Vireo	14	5	3	1	10
Blue Grosbeak	5	2	1	1	3
Common Yellowthroat	2	0	1	0	1
Mourning Dove	1	0	1	0	0
Song Sparrow	3	1	0	0	3
S.W. Willow Flycatcher	10	1	3	2	5
Yellow-breasted Chat	26	3	4	4	18
Yellow Warbler	2	0	0	0	2
TOTAL	**65**	**13 (20%)**	**13 (20%)**	**8 (12%)**	**44 (62%)**

Attachment

Nest Monitoring Results 1999-2006 Alamo Lake SWA

2005 Results:					
Species	**Total Nests**	**Parasitized**	**Predated**	**Abandoned/Other**	**Successful**
Abert's Towhee	4	1	1	1	2
Ash-throated Flycatcher	1	0	0	0	1
Bell's Vireo	9	1	1	0	8
Blue Grosbeak	2	0	0	0	2
Common Yellowthroat	2	0	0	0	2
Mourning Dove	2	0	1	1	0
Song Sparrow	3	1	2	0	1
S.W. Willow Flycatcher	9	0	2	1	6
Yellow-breasted Chat	12	1	3	0	9
Yellow Warbler	4	0	0	0	4
TOTAL	**48**	**4 (8%)**	**10 (21%)**	**3 (6%)**	**35 (73%)**

2006 Results:					
Species	**Total Nests**	**Parasitized**	**Predated**	**Abandoned/Other**	**Successful**
Abert's Towhee	4	1	1	0	3
Bell's Vireo	11	2	2	0	9
Blue Grosbeak	1	0	0	0	1
Common Yellowthroat	3	1	1	0	1
Mourning Dove	2	0	0	1	1
Song Sparrow	2	0	1	0	1
Yellow-breasted Chat	18	2	4	0	14
Yellow Warbler	2	0	1	0	1
TOTAL	**43**	**6 (14%)**	**10 (23%)**	**1 (2%)**	**31 (72%)**

Nest Monitoring Results 1999-2006 Bill Williams River NWR

1999 Results:

Species	Total Nests	Parasitized	Predated	Abandoned/Other	Successful
Abert's Towhee	1	0	0	0	1
Ash-throated Flycatcher	1	0	0	0	1
Bell's Vireo	4	0	0	1	3
Black Phoebe	2	0	0	0	2
Bewick's Wren	1	0	0	0	1
Mourning Dove	2	0	0	2	0
Vermilion Flycatcher	1	0	0	0	1
Verdin	3	0	0	1	2
S.W. Willow Flycatcher	1	0	0	0	1
TOTAL	**16**	**0**	**0**	**4 (25%)**	**12 (75%)**

2000 Results:

Species	Total Nests	Parasitized	Predated	Abandoned/Other	Successful
Ash-throated Flycatcher	1	0	0	0	1
Bell's Vireo	4	0	0	2	2
Black Phoebe	1	0	0	0	1
Great-tailed Grackle	2	0	1	0	1
Verdin	2	0	0	0	2
White-winged Dove	1	0	0	0	1
Yellow-breasted Chat	1	0	0	0	1
TOTAL	**12**	**0 (0%)**	**1 (8%)**	**2 (17%)**	**9 (75%)**

2001 Results:

Species	Total Nests	Parasitized	Predated	Abandoned/Other	Successful
Black-tailed Gnatchatcher	1	0	0	0	1
Cordilleran Flycatcher	1	0	0	0	1
Common Yellowthroat	1	0	0	0	1
Great-tailed Grackle	12	0	0	0	12
Mourning Dove	8	0	0	0	8
Verdin	2	0	0	0	2
S.W. Willow Flycatcher	2	0	0	0	2
White-winged Dove	3	0	0	0	3
Yellow-breasted Chat	8	0	0	0	0
TOTAL	**39**	**0 (0%)**	**0 (0%)**	**0 (0%)**	**39 (100%)**

Nest Monitoring Results 1999-2006 Bill Williams River NWR

2002 Results:

Species	Total Nests	Parasitized	Predated	Abandoned/Other	Successful
Bell's Vireo	9	2	2	0	5
Blue Grosbeak	1	0	0	0	1
Common Yellowthroat	3	0	1	0	2
Mourning Dove	3	0	1	0	2
Song Sparrow	1	0	0	0	1
Verdin	2	0	0	0	2
S.W. Willow Flycatcher	4	0	0	2	2
Yellow-breasted Chat	8	0	5	0	3
TOTAL	**31**	**2 (6%)**	**9 (29)%**	**2 (6%)**	**18 (58)%**

2003 Results:

Species	Total Nests	Parasitized	Predated	Abandoned/Other	Successful
Abert's Towhee	1	0	0	0	1
Bell's Vireo	2	1	0	1	1
Blue Grosbeak	1	0	0	0	1
Common Yellowthroat	1	0	0	0	1
Mourning Dove	2	0	0	0	2
S.W. Willow Flycatcher	2	0	0	0	2
White-winged Dove	2	0	0	0	2
Yellow-breasted Chat	5	1	0	1	4
TOTAL	**16**	**2 (12%)**	**0 (0%)**	**2 (12%)**	**14 (87%)**

2004 Results:

Species	Total Nests	Parasitized	Predated	Abandoned/Other	Successful
Abert's Towhee	1	0	0	0	1
Bell's Vireo	4	1	1	0	3
Common Yellowthroat	2	0	1	0	1
Mourning Dove	1	0	1	0	0
Song Sparrow	3	0	1	0	2
Verdin	2	0	0	0	2
White-winged Dove	1	0	0	0	1
Yellow-breasted Chat	14	3	3	2	9
Yellow Warbler	1	0	1	0	0
TOTAL	**29**	**4 (14%)**	**8 (27%)**	**2 (7%)**	**19 (66%)**

Nest Monitoring Results 1999-2006 Bill Williams River NWR

2005 Results:					
Species	**Total Nests**	**Parasitized**	**Predated**	**Abandoned/Other**	**Successful**
Abert's Towhee	1	0	0	0	1
Bell's Vireo	4	1	1	0	3
Blue Grosbeak	1	1	0	1	0
Song Sparrow	2	0	1	0	1
S.W. Willow Flycatcher	2	0	0	0	2
Yellow-breasted Chat	8	1	2	0	6
TOTAL	**18**	**3 (17%)**	**4 (22%)**	**1 (6%)**	**13 (72%)**

2006 Results:					
Species	**Total Nests**	**Parasitized**	**Predated**	**Abandoned/Other**	**Successful**
Abert's Towhee	4	1	0	1	3
Bell's Vireo	6	1	2	1	3
Blue Grosbeak	3	1	0	1	3
Common Yellowthroat	2	0	1	0	1
Mourning Dove	1	0	0	0	1
Song Sparrow	4	0	0	0	4
S.W. Willow Flycatcher	5	0	3	1	1
Yellow-breasted Chat	10	1	1	2	7
Yellow Warbler	1	0	0	0	1
TOTAL	**36**	**4 (11%)**	**7 (19%)**	**6 (16%)**	**24 (67%)**