WETLANDS, Vol. 27, No. 4, December 2007, pp. 987–998

STATUS AND HABITAT USE OF THE CALIFORNIA BLACK RAIL IN THE SOUTHWESTERN USA

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Abstract: California black rails (*Laterallus jamaicensis coturniculus*) occur in two disjunct regions: the southwestern USA (western Arizona and southern California) and northern California (Sacramento Valley and the San Francisco Bay area). We examined current status of black rails in the southwestern USA by repeating survey efforts first conducted in 1973–1974 and again in 1989, and also examined wetland plant species associated with black rail distribution and abundance. We detected 136 black rails in Arizona and southern California. Black rail numbers detected during past survey efforts were much higher than the numbers detected during our more intensive survey effort, and hence, populations have obviously declined. Plants that were more common at points with black rails included common threesquare (*Schoenoplectus pungens*), arrowweed (*Pluchea sericea*), Fremont cottonwood (*Populus fremontii*), seepwillow (*Baccharis salicifolia*), and mixed shrubs, with common threesquare showing the strongest association with black rail presence. Plant species and non-vegetative communities that were less common at points with black rails included California bulrush (*Schoenoplectus californicus*), southern cattail (*Typha domingensis*), upland vegetation, and open water. Black rails were often present at sites that had some saltcedar (*Tamarix ramosissima*), but were rarely detected in areas dominated by saltcedar. We recommend that a standardized black rail survey effort be repeated annually to obtain estimates of black rail population trends. Management of existing emergent marshes with black rails is needed to maintain stands of common threesquare in early successional stages. Moreover, wetland restoration efforts that produce diverse wetland vegetation including common threesquare should be implemented to ensure that black rail populations persist in the southwestern USA.

Key Words: Arizona, California, common threesquare, habitat use, *Laterallus jamaicensis*, lower Colorado River, population status, *Schoenoplectus pungen*

INTRODUCTION

Freshwater and saltwater emergent wetlands are extremely productive ecosystems that support diverse and unique communities of plants and animals (Mitsch and Gosselink 2000). However, emergent wetlands continue to be eradicated in the conterminous United States. Acreage of emergent wetlands declined 21% between 1950 and 2004 (Dahl 2006). Continued losses of freshwater emergent marshes were due primarily to conversion to agriculture and losses of saltwater emergent marshes were due primarily to transition to open water (Dahl 2006). Loss of emergent marshes in North America may be having adverse effects on the animals that depend on these unique ecosystems (Greenberg et al. 2006).

A good example of a species that may be negatively affected by loss of emergent marshes is the black rail (*Laterallus jamaicensis* Gmelin). Black rails do not occur outside of saltwater and freshwater emergent marshes, and two subspecies are recognized in North America: California black rails (*L. j. coturniculus*) and Eastern black rails (*L. j. jamaicensis*) (Eddleman et al. 1994). California black rails were much more common in the early 1900s (Allen 1900) than they are today and nearly all populations of black rails are thought to have declined dramatically during the past century (Eddleman et al. 1994). Because of wetland loss and perceived population declines, California black rails are listed as federally endangered in Mexico (Diario Oficial de la Federacion 2002), threatened in California (California Department of Fish and Game 2006), and a species of special concern in Arizona (Arizona Game and Fish Department 1996). Consequently, California black rails are one of the 10 highest priorities for conservation action among birds in Arizona (Latta et al. 1999). Black rail populations have also declined in the eastern United States (Kerlinger and Wiedner 1991). Hence, black rails are considered a species of national conservation concern in the USA (U.S. Fish and Wildlife Service 2002), and were previously a Category 1 "candidate" species for federal listing under the Endangered Species Act (U.S. Department of Interior 1989).

Remaining California black rails in the USA occur in two disjunct regions: the Southwest (including western Arizona and southern California) and northern California (including Sacramento Valley and the San Francisco Bay area) (Evens et al. 1991, Tecklin 1999). The status of California black rails in Mexico is unknown, but large populations probably do not exist (Wilbur 1987, Russell and Monson 1998). A region-wide survey effort of black rails in northern California in 2000–2001 suggested stable populations (Spautz and Nur 2002). In contrast, current status and distribution in the southwestern USA is still poorly known (Flores and Eddleman 1991). Two widespread survey efforts of black rails using similar survey methods have occurred in the southwestern USA: 1973–1974 (Repking and Ohmart 1977) and 1989 (Evens et al. 1991). Comparison of numbers detected during these survey efforts suggest a 30% decline in black rails between 1974 and 1989. California black rail populations along the lower Colorado River were thought to be declining in 1977 because of wetland destruction (Repking and Ohmart 1977, Edwards 1979), and several marshes in the region have been altered or destroyed since the last region-wide survey effort in 1989 (Evens et al. 1991). Hence, information on current distribution and abundance of black rails in the southwestern USA is not available and is considered a priority conservation need (Gustafson 1987, Evens et al. 1991, Flores and Eddleman 1991).

Information on habitat associations of California black rails in the southwestern USA is also needed. Protection of existing habitat and restoration of marshes that historically had breeding rails is needed to maintain black rail populations in the southwestern USA (Evens et al. 1991). California black rails are one of 20 priority species in the Lower Colorado River Multi-species Conservation Plan (U.S. Bureau of Reclamation 2006), which requires the U.S. Bureau of Reclamation to create 52 ha of additional black rail habitat (and maintenance of all existing occupied habitat) along the lower Colorado River. The plan includes no provisions that the newly created habitat be occupied by black rails. Hence, regulatory and land-management agencies need information on optimal black rail habitat in the region to help design effective wetland restoration efforts required by the Multi-species Conservation Plan.

To meet these needs, we implemented a standardized, range-wide survey effort for California black rails throughout all marshes in the southwestern USA (western Arizona and southern California). We conducted point-count surveys within marshes included in 10 previous survey efforts (the two region-wide survey efforts plus eight local survey efforts conducted from 1975–1988; see Conway et al. 2002 for details) to determine current status of California black rails in the region. We also surveyed all other emergent marshes in the region that were not included in previous survey efforts. Habitat loss is considered the main factor causing past population declines and limiting population recovery of black rails (Evens et al. 1991, Eddleman et al. 1994), so we also examined the plant species within wetlands that were correlated with presence of breeding black rails.

METHODS

General Methods

We conducted point-count surveys in all marshes that were included in any of the previous black rail survey efforts conducted in the southwestern USA. We also surveyed all other emergent marshes in the region (those that lacked previous black rail records). Hence, we conducted point-count surveys in all marshes: 1) along the lower Colorado River (Grand Canyon south to the Gila River confluence), 2) at Morro Bay (San Luis Obispo County, California), 3) at Big Morongo Canyon Preserve (San Bernardino County, California), 4) throughout the Imperial Valley of California (including areas along the All-American and Coachella Canals, the New River west of Seeley, Fig Lagoon, and around the Salton Sea), and 5) along the lower Gila River and lower Bill Williams River in Arizona (Figure 1). All point-count surveys were conducted from March 1 to July 28 (Morro Bay, Fig Lagoon, the New River, and marshes near Blythe, California in 2001 and all other areas in 2000) to coincide with seasonal timing (March through August) of most of the previous survey efforts in the region (Todd 1970, Repking and Ohmart 1977, Eddleman et al. 1994). In contrast, Evens et al. (1991) conducted all their point-count surveys during a narrower time period (late March through late April). However, we conducted point-count surveys at eight of these 11 areas during a similar timeframe (March 4 to April 24; Figure 2). We conducted point-count surveys at the other three sites in June, but doing so did not

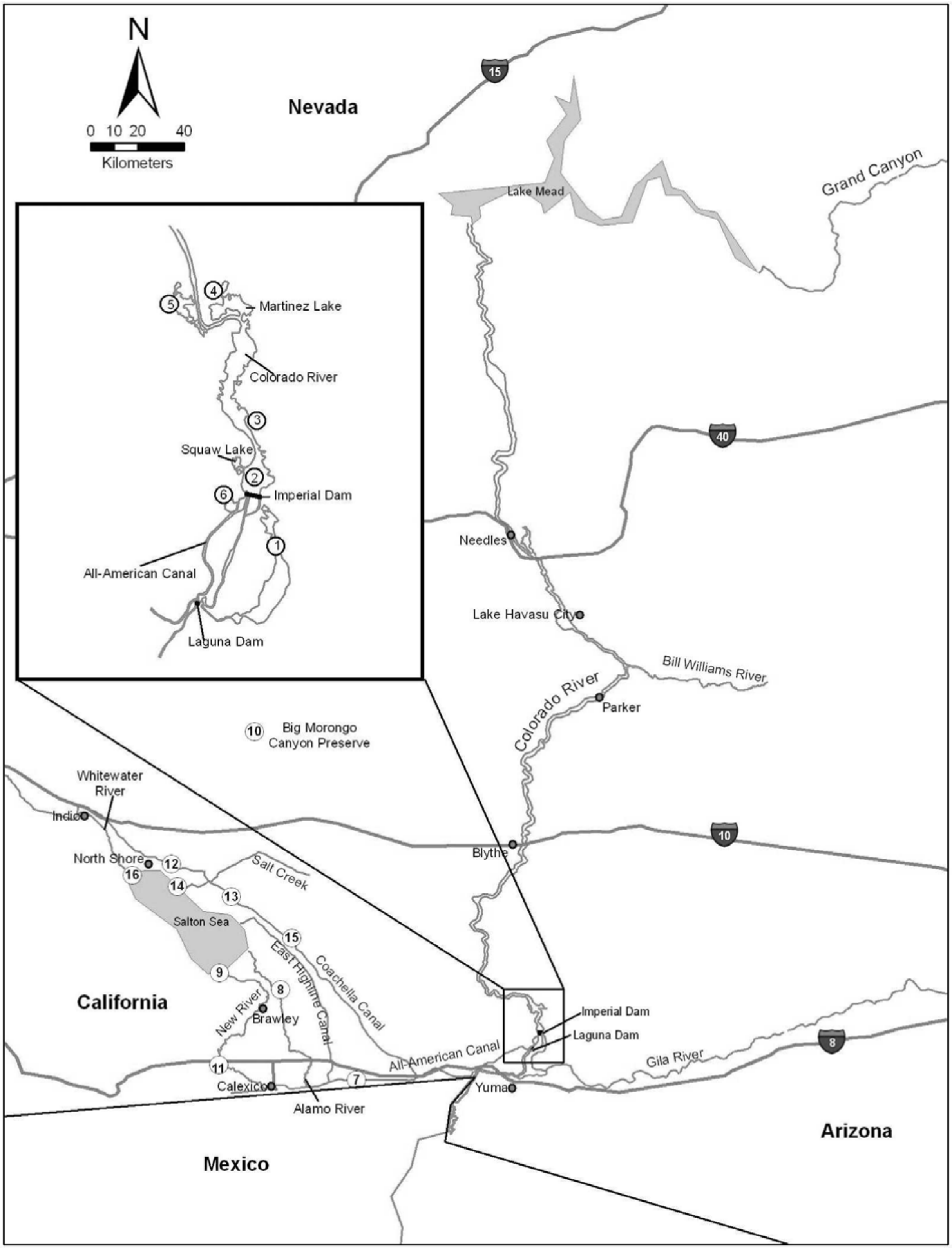

Figure 1. Location of areas surveyed (March to July, 2000–2001) for California black rails throughout the southwestern USA: 1) Mittry Lake, 2) Imperial Reservoir, 3) Arizona Channel, 4) Imperial National Wildlife Refuge, 5) Ferguson Lake, 6) West Pond, 7) All-American Canal seepage marshes, 8) Finney and Ramer Lakes, 9) New River delta, 10) Big Morongo Canyon Preserve, 11) Fig Lagoon, 12) Coachella Canal at Desert Aire Road, 13) Coachella Canal below station 19, 14) Salt Creek delta, 15) seep marshes along south Coachella Canal, and 16) Whitewater River delta.

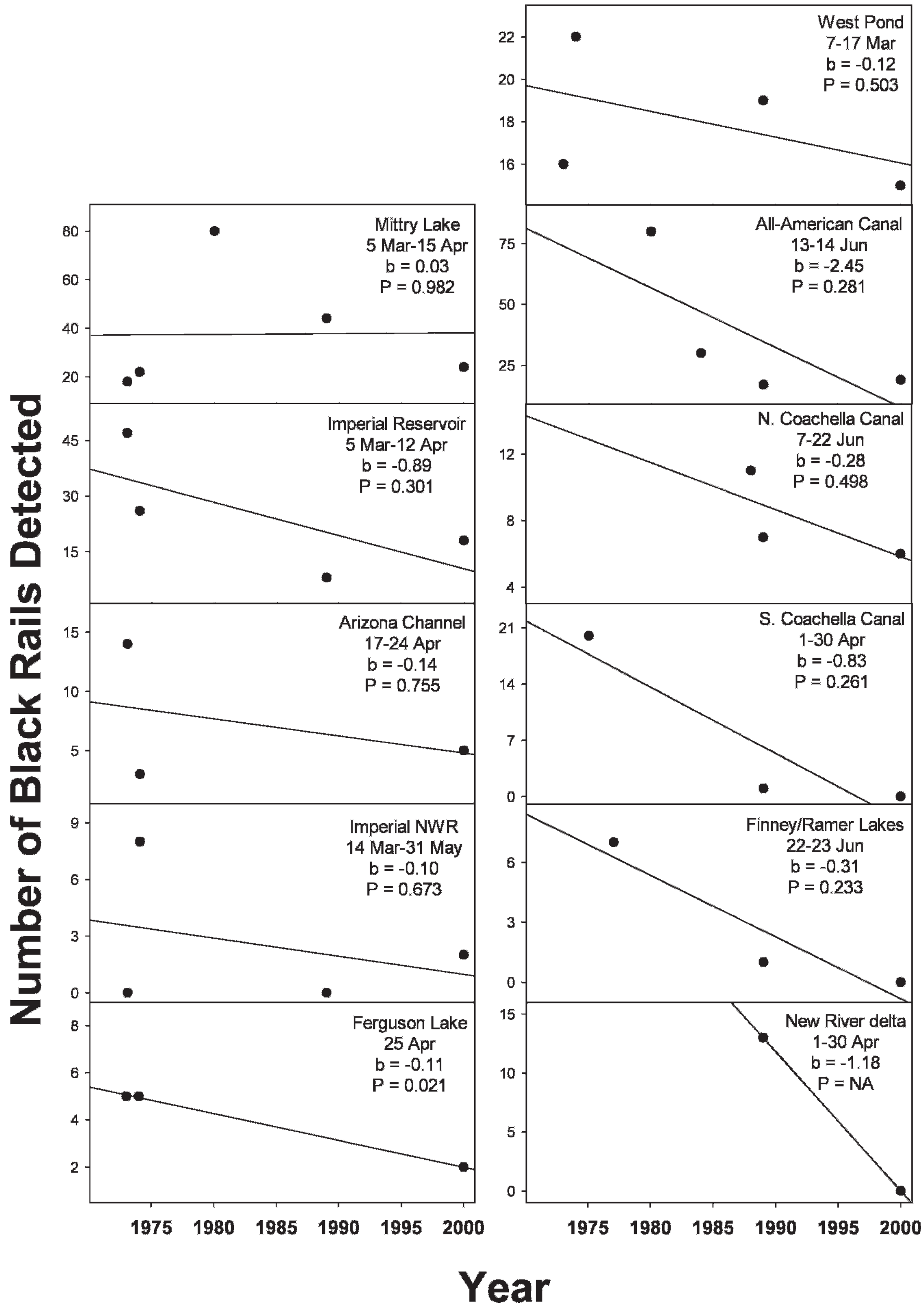

Figure 2. Changes in number of black rails detected at 11 locations in Arizona and southern California, 1973–2000. Lines (b = slope) represent simple linear least-squares regression of number of black rails detected versus year for each location. Dates surveyed in 2000 are provided for each location. North Coachella Canal includes seepage marshes near Desert Aire Road, Desert Hot Springs, Dos Palmas, and below siphon 19.

lead to lower detection probability. We previously conducted 7–11 replicate point-count surveys from March to July at a subset of six of our sites with black rails, including five of the sites surveyed by Evens et al. (1991), and peak response was highest in June or July at all six sites (Conway et al. 2004). Spear et al. (1999) also failed to find any changes in detection probability of California black rails throughout the breeding season. Hence, we have ample evidence to suggest that detection probability during the March to April survey window used by Evens et al. (1991) should be similar to that during the wider survey window (March to July) used during the other two region-wide survey efforts (Repking and Ohmart 1974 and this study). We conducted point-count surveys in additional marshes (those not included in previous survey efforts), which were identified by looking for emergent vegetation on aerial photos of the Colorado River taken in 1997 (the most recent photos available at the time of the study). Most point-count surveys ($n = 1,653$ of the 1,722) were conducted in the morning from 0.5 h before sunrise until 1000 PST to coincide with the timing used in previous black rail survey efforts in the region (Repking and Ohmart 1974, Todd 1980, Evens et al. 1991, Flores and Eddleman 1991). The remainder of the point-count surveys ($n = 69$ of the 1,722) were conducted in the evening (4 hr before sunset until 0.5 hr after sunset), but three previous studies (including one in these same wetlands) have presented data suggesting that detection probability during evening counts was similar to (or even slightly higher than) that during morning counts (Spear et al. 1999, Tecklin 1999, Conway et al. 2004). Evens et al. (1991) also conducted both morning and evening counts.

We established survey points along upland and open water edges of all emergent marshes that we thought might contain black rails based on our examination of aerial photographs, information from previous survey efforts, conversations with local biologists and recreational birders, and reconnaissance visits. We attempted to conduct point-count surveys in all areas with emergent marsh vegetation and shallow ($<$ 10 cm) water. The distance between adjacent survey points was approximately 50 m at sites where black rails were discovered during past survey efforts and 100–150 m at sites with no previous black rail records. This allowed us to thoroughly survey areas (with 50 m point spacing) that had been surveyed during past survey efforts. We used 100–150 m point spacing at marshes that had no previous black rail records so that we could survey a larger number of marshes with the available time. We located survey routes in the same locations as previous studies (Todd 1980, Repking 1975, Evens et al. 1991). To ensure that we replicated past survey efforts precisely, we obtained the following items from the previous survey efforts: 1) unpublished annual and final reports, 2) detailed maps of survey routes, and 3) copies of the original field notes from two of the lead authors. In the few instances where we did not know the exact location of each survey point from past survey efforts, we overcompensated by surveying the entire marsh thoroughly. Hence, we always ended up with the same or more survey points in a particular marsh than previous survey efforts. This approach ensured that any declines observed were not because our survey route was in a different part of a particular marsh because we surveyed each marsh equally or more thoroughly than previous efforts. We recorded the location of each survey point using a Garmin eMap GPS receiver, and plotted the location of each survey point onto aerial photographs or topographic maps to allow standardized replication in future years.

Point-count surveys were conducted on foot (marsh vegetation-upland interface) or from a boat (marsh vegetation-open water interface). We recorded all black rails seen or heard during the 6-min survey period as well as all those detected while moving between survey points (either before or after the 6-min survey period at each point). Like Repking and Ohmart (1977) and most of the other previous survey efforts, we recorded all birds detected (regardless of distance from surveyor), but excluded birds that we thought might have been detected at a previous survey point. In contrast, Evens et al. (1991) only recorded birds detected within 30 m of the surveyor. This approach differed from ours and from all the previous black rail survey efforts (see Discussion section for potential ramifications of this difference). Point-count surveys were not conducted when wind speed consistently exceeded 25 km/hr or during periods of heavy rain.

Our 6-min point-count survey consisted of a 3-min passive period followed by a 3-min period of call broadcast (Conway et al. 2004). During both of the 3-min periods, we recorded all black rails seen or heard calling, and whether each individual bird was detected previously that day (i.e., at a previous survey point). We used a cassette tape of recorded black rail calls broadcast at a volume of 90 decibels (1 m from the speaker) using a cassette tape player (Optimus model SCP-88 or model SCP-104) attached to a pair of amplified speakers (Optimus model AMX-4). Speakers were taped together and placed on the ground at the marsh edge facing the marsh. The 3-min broadcast sequence consisted of three 1-min segments of 30 s of black rail calls (15 s of "*kik-kik-kerr*" calls and 15 s of "*grr*" calls) followed by 30 s of silence.

Population Status

We conducted point-count surveys at 11 marshes that had been the subject of previous black rail survey efforts. Repking (1975) and Repking and Ohmart (1977) surveyed all suitable emergent marshes along the lower Colorado River from Yuma, Arizona north to Needles, California in both 1973 and 1974 (March 21 to August 14). Evens et al. (1991) and Laymon et al. (1990) replicated Repking's (1975) survey effort along the lower Colorado River and also surveyed marshes along the All-American and Coachella Canals and throughout the Imperial Valley of southern California (March 23 to April 23, 1989). Eight other survey efforts were focused on restricted areas known to harbor black rails (Figure 1). Jurek (1975) surveyed all of the seep marshes between Highline and Coachella Canals from the All-American Canal north to Niland in the Imperial Valley, California (May 12–16). Garrett and Dunn (1981) report black rails detected at Finney and Ramer Lakes in California and along the Bill Williams River in Arizona. Todd (1980) surveyed all suitable emergent marshes between Imperial Dam south to the Gila River on the Arizona side of the lower Colorado River (May 8–17). McCaskie (in Evens et al. 1991) reported black rails detected along the All-American Canal in 1980. Kasprzyk et al. (1987) surveyed the All-American Canal seepage marshes on April 9–13 and again May 14–18, 1984. Conway and Eddleman (unpubl. data) surveyed north Mittry Lake, Arizona 1985–1987. Flores and Eddleman (1991) surveyed areas near north Mittry Lake 1987–1988. Jackson (1988) surveyed the Coachella Canal and adjacent wetlands between Niland and North Shore, California, March 29–30 and April 19–21, 1988. Using survey methods similar to those used during the two previous region-wide survey efforts (Repking and Ohmart 1974, 1977; Laymon et al. 1990; Evens et al. 1991), we examined current status of black rail populations in the southwestern USA.

Habitat Correlates of Black Rail Distribution

We visually estimated the percent coverage of each of nine plant species and three mixed-species or non-vegetative communities (mixed shrubs, upland vegetation, and open water) within a 50-m-radius semi-circle (0.4 ha) at each survey point. The nine emergent plant species were: common threesquare (*Schoenoplectus pungens*), arrowweed (*Pluchea sericea*), Fremont cottonwood (*Populus fremontii*), seepwillow (*Baccharis salicifolia*), California bulrush (*Schoenoplectus californicus*), southern cattail (*Typha domingensis*), saltcedar (*Tamarix ramosissima*), common reed (*Phragmites australis*), and salt grass (*Distichlis stricta*). Upland vegetation was usually Sonoran or Mojave desert lowland. Percent coverage across all 12 plant species and non-vegetative communities summed to 100% at each survey point. Most of these wetland plant species grow in monotypic stands in the region, making visual estimation of percent coverage straightforward. We used a semi-circle because our survey points were on the marsh-upland or marsh-water interface. Some semi-circles included upland vegetation or open water because the interface between marsh vegetation and either upland or open water was not always a straight line (and because pools of open water were sometimes interspersed within marsh vegetation). Points along an upland-marsh interface typically provided a sufficient viewpoint to look down over the vegetation within the semi-circle and easily estimate percent coverage by each plant species. For points along an open water-marsh interface, we stood up in the bow of the boat to see the plant species with the 50-m semi-circle. We did not measure vegetation height or density, because doing so would have required walking out into the interior of the marsh, which would have disturbed nesting birds and trampled emergent vegetation (vegetation was so dense that extensive trampling or modification of the vegetation would have been necessary to walk out into the marsh).

Statistical Analysis

To examine the current status of black rails in the region, we used two approaches. First, we used a linear mixed-model using data for the 11 sites for which ≥ 5 birds were detected during at least one year. The number of black rails detected was the response variable, site was a random effect, and year was a repeated fixed effect and linear covariate in the model. We used a heterogeneous first-order autoregressive variance structure for the year effect and a heterogeneous diagonal variance structure for the random effect. Second, we used simple linear regression to regress number of black rails detected against year for each of the 11 sites separately, and then used these 11 separate slopes in a one-sample t-test to examine whether the population change in black rails over the past 25 years was significantly different from zero.

We used three approaches to identify the wetland plant species associated with black rail presence.

First, we used stepwise logistic regression to examine the extent to which plant species were associated with black rail distribution. Whether or not black rails were detected at a point was the response variable, and the percent coverage of each of the 12 plant species or non-vegetative communities were the explanatory variables in the logistic model. Second, we used a univariate approach to compare the percent coverage by each plant species or non-vegetative community between points at which we detected black rails ($n = 243$ of 1,722) and those lacking black rails ($n = 1{,}380$ of 1,722; we did not record habitat data at 99 of the 1,722 survey points) using independent samples t-tests. We conducted t-tests using: 1) all survey data, and 2) only data from survey routes along which at least one black rail was detected sometime during the season. Third, we examined the proportion of survey points at which we detected black rails for each of four categories for each plant species: 0%, 1%–33%, 34%–66%, and 67%–100% coverage. We calculated these four percentages for each of the nine plant species and the three mixed-species or non-vegetative communities. We excluded percentages for plant cover categories that were represented by < 15 survey points. We used Chi-square contingency tests to determine whether the percentage of survey points at which black rails were detected differed depending on the percent coverage of each plant species or non-vegetative community.

RESULTS

General Results

We conducted point-count surveys at 1,722 survey points and detected 136 black rails (some of which were detected at > 1 survey point). All of the black rails were detected aurally. The majority (76%) of the black rails detected were along the lower Colorado River, and 21 were detected at three marshes along the All-American Canal, California (Figure 1). Most (84%) of the 100 black rails detected along the lower Colorado River were found in marshes between Laguna Dam north to Ferguson and Martinez Lakes (Figure 1; see Conway et al. 2002 for additional details on location of all black rails detected).

Population Status

Based on the parameter estimate for the main effect of year in the mixed-model analysis, the numbers of California black rails in the southwestern USA has declined 22.5% annually ($b = -0.225$, $F = 40.9$, $P < 0.0001$). A reduction in numbers was noticeable at 10 of the 11 locations where rails are (or were) most abundant (Figure 2). The mean slope from the 11 linear regression analyses (which can be used to estimate percent annual population change) was -0.58 ± 0.22 ($t = -2.62$, df = 10, $P = 0.026$). When we weighted sites by the inverse of the standard error of their slope, the result was even more significant ($t = -15.9$, $P < 0.001$).

Past survey efforts in the Bill Williams River have been inadequate to allow meaningful comparisons with our numbers (Conway et al. 2002). We detected only four black rails at Morro Bay, California. Previous survey efforts at Morro Bay detected seven black rails in 1977 (Manolis 1978) and six black rails in 1986–1987 (Evens et al. 1991). We failed to detect black rails in many marshes that had incidental black rail records in recent years and we did not detect rails at any sites lacking previous black rail records (see Conway et al. 2002 for location of all survey routes).

Habitat Correlates of Black Rail Distribution

Points at which black rails were detected differed in vegetative composition compared to points at which we failed to detect black rails (Tables 1–3). Our results were similar whether we limited our analysis to include only survey routes that had ≥ 1 black rail or we analyzed all 1,623 points (we did not record vegetative composition at 99 of the 1,722 points) (Table 2). Percentage of the survey points at which we detected black rails differed depending on the percent coverage of each plant species within a 50-m radius semi-circle of each survey point (Table 3). Plants that were more common at points with black rails included common threesquare, arrowweed, Fremont cottonwood, seepwillow, and mixed shrubs. Plants that were less common at points with black rails included California bulrush and southern cattail. Upland and open water were also less common at points with black rails. Saltcedar and common reed had positive odds ratios in the stepwise logistic regression model (Table 1), but areas dominated by these two plant species were less likely to have black rails than areas lacking these species (Table 3). Most survey points where we detected black rails were not in areas dominated by one plant species but rather had low ($< 33\%$) percent coverage for ≥ 3 different wetland plant species (typically common threesquare with some combination of cattail, saltcedar, arrowweed, or seep willow). These transitional plant communities were most common in areas where wetland transitioned into upland with water depths ranging

Table 1. Results of stepwise logistic regression analysis showing association between presence/absence of black rails and percent coverage of nine plant species and three mixed-species or non-vegetative communities at 1,623 survey points in the southwestern USA, March to July 2000–2001. Plant species and non-vegetative communities removed during the stepwise process included open water, *Distichlis stricta*, *Schoenoplectus californicus*, and *Typha domingensis*.

	Coefficient		Odds Ratio			
Plant species	b	SE	Exp b	95% CI	Wald χ^2	P
Schoenoplectus pungens	0.047	0.005	1.048	1.038–1.057	97.1	< 0.001
Pluchea sericea	0.043	0.008	1.044	1.027–1.061	27.6	< 0.001
Tamarix ramosissima	0.018	0.005	1.018	1.009–1.028	15.2	< 0.001
Populus fremontii	0.053	0.016	1.055	1.022–1.088	11.2	0.001
Baccharis salicifolia	0.020	0.007	1.020	1.007–1.034	8.5	0.004
Phragmites australis	0.008	0.003	1.008	1.001–1.014	5.6	0.018
Mixed-shrub community	0.060	0.026	1.062	1.010–1.117	5.5	0.019
Upland vegetation	−0.033	0.012	0.968	0.944–0.991	7.0	0.008

from moist soil to 2 cm. Common threesquare showed the most obvious association; we detected black rails at 61.2% of the survey points with > 33% common threesquare but at only 9.9% of the survey points with 0% common threesquare (Table 3).

DISCUSSION

Population Status

The number of black rails in the southwestern USA has declined. Although we detected 14 more black rails (136 birds) in the region compared to the 1989 survey effort (116 birds), we surveyed almost twice the number of survey points (1,722 points in 2000–2001 vs. 939 points in 1989) and we recorded all birds detected at each point rather than the number within 30 m of each point (Evens et al. 1991). Hence, we surveyed ~676 ha (based on a 50-m effective survey radius; Conway et al. 2004) compared to ~133 ha surveyed in 1989. In contrast, populations of California black rails have been stable in San Francisco Bay tidal marshes (Spautz and Nur 2002). We failed to detect any black rails in marshes associated with the Salton Sea of California. A survey effort in 1999 in the Salton Sea area also failed to detect any black rails (Shuford et al. 2000). Habitat at Finney Lake, Whitewater River delta, and the New River delta that once supported breeding black rails has been completely altered or destroyed and has not supported black rails in many years (Conway et al. 2002). Several observers have recently reported black rails in marshes associated with the Colorado River delta in Mexico (Hinojosa-

Table 2. Results of independent sample t-tests comparing % ground coverage (± 1 SE) between survey points at which California black rails (BLRAs) were and were not detected at wetlands in Arizona and southern California during 2000–2001.

Plant species	Points with BLRAs $n = 243$[c]	Points[a] lacking BLRAs $n = 380$	t	P	Points[b] lacking BLRAs $n = 1380$	t	P
Schoenoplectus pungens	13.1 ± 1.3	1.9 ± 0.4	10.1	< 0.001	2.2 ± 0.3	13.2	< 0.001
Pluchea sericea	5.7 ± 0.7	2.1 ± 0.4	5.0	< 0.001	1.6 ± 0.2	8.4	< 0.001
Populus fremontii	1.8 ± 0.4	0.5 ± 0.2	3.4	0.001	0.4 ± 0.1	5.5	< 0.001
Tamarix ramosissima	13.9 ± 1.0	10.3 ± 0.7	3.1	0.002	9.6 ± 0.4	4.4	< 0.001
Baccharis salicifolia	5.8 ± 0.6	3.4 ± 0.4	3.3	0.001	3.0 ± 0.2	4.4	< 0.001
Mixed-shrub community	0.9 ± 0.2	0.4 ± 0.1	2.0	0.049	0.3 ± 0.1	4.1	< 0.001
Distichlis stricta	0.6 ± 0.2	0.1 ± 0.1	3.5	< 0.001	0.2 ± 0.1	2.7	0.007
Typha domingensis	35.5 ± 1.9	38.8 ± 1.6	1.3	0.196	52.1 ± 0.9	7.2	< 0.001
Phragmites australis	11.2 ± 1.4	25.9 ± 1.5	6.6	< 0.001	11.4 ± 0.6	0.1	0.919
Schoenoplectus californicus	4.4 ± 0.9	6.8 ± 0.8	1.9	0.058	5.7 ± 0.4	1.2	0.247
Upland vegetation	1.7 ± 0.3	3.7 ± 0.5	2.9	0.004	3.4 ± 0.3	2.7	0.007
Open water	4.0 ± 0.6	5.6 ± 0.6	1.9	0.060	6.6 ± 0.4	3.0	0.003

[a] Restricted to survey points along survey routes that had at least one black rail detected.
[b] All survey points included.
[c] Only 136 black rails were detected but some were detected at ≥ 2 adjacent survey points.

Table 3. Percent of survey points in the southwestern USA at which we detected black rails based on percent coverage of nine plant species and three mixed-species or non-vegetative communities. Overall, we detected black rails at 15% of the 1,623 survey points, so percentages in the table that are > 15% for the three categories with that plant species present (1%–33%, 34%–66%, or 67%–100% coverage) suggest preference for that plant species, and percentages in the table that are > 15% for the 0% category suggest avoidance of that plant species. Plant categories lacking numbers had fewer than 15 points (i.e., we had no points with > 34% coverage by *Populus fremontii*).

	Percent coverage by plant species					
Plant species	0%	1%–33%	34%–66%	67%–100%	χ^2	P
Populus fremontii S. Wats.	14.0	35.4			22.6	< 0.001
Distichlis stricta (L.) Greene	14.4	37.8			15.7	< 0.001
Phragmites australis (Cav.) Trin.	14.7	15.9	16.8	13.3	0.8	0.860
Baccharis salicifolia (Ruiz and Pavon) Pers.	11.5	29.5	17.2		62.7	< 0.001
Schoenoplectus californicus (C.A. Mey.) Palla	15.3	13.5	15.5	8.3	1.7	0.650
Schoenoplectus pungens (Vahl) Palla	9.9	43.3	61.2		228.0	< 0.001
Mixed-shrub community	14.1	36.7			23.2	< 0.001
Tamarix ramosissima Ledeb.	8.0	18.8	28.2	6.3	49.7	< 0.001
Pluchea sericea (Nutt.) Coville	11.6	34.6	43.5		90.4	< 0.001
Typha domingensis Pers.	20.0	23.2	16.2	7.2	53.2	< 0.001
Upland vegetation	15.7	13.1	0		8.2	0.018
Open water	16.6	12.5	5.6		9.4	0.009

Huerta et al. 2001), but a more standardized survey effort is needed throughout this region and in Baja California to determine distribution and abundance.

Habitat Correlates of Black Rail Distribution

The plants that we found associated with black rail presence were those associated with shallow water or moist soil along the upland/wetland interface (e.g., common threesquare, seepwillow, arrowweed, Fremont cottonwood). In contrast, plants that were more common at points lacking black rails were those associated with comparatively deeper water (e.g., southern cattail, California bulrush). Similar to our results, Repking and Ohmart (1974) reported that common threesquare, salt grass, and arrowweed were more common in areas where they detected black rails. And Flores and Eddleman (1995) reported that black rails selected common threesquare and avoided southern cattail. But in contrast to our results, Repking and Ohmart (1974) reported that common reed and southern cattail were also more common in areas where they detected black rails. And Flores and Eddleman (1995) reported that black rails selected California bulrush and avoided the mixed-shrub community.

Black rails used areas with saltcedar as long as other plant species were present (areas with < 67% coverage by saltcedar), but they were infrequently detected in more contiguous stands of saltcedar (Table 3). Wetlands with a small amount of saltcedar on the periphery of the marsh appear to be suitable for black rails, but habitat suitability for black rails declines rapidly when marshes become dominated by saltcedar. Saltcedar is increasing in abundance in the southwestern USA (Turner and Karpiscak 1980, Busch and Smith 1995) and often establishes dense monotypic stands in the region (C. Conway, personal observation). Unless efforts are implemented to prevent wetlands from being overtaken by saltcedar, habitat suitability for black rails may continue to decline.

Black rails in the southwestern USA prefer very shallow water or moist soil conditions and are thought to avoid marshes with large daily fluctuations in water level (Repking 1975, Flores and Eddleman 1995). Common threesquare is most common in shallow or saturated soil situations where there is a gradual transition from upland to wetland with a gentle slope (Repking and Ohmart 1977). Hence, the association between black rails and common threesquare may simply reflect similar requirements for moist soil conditions. Indeed, the majority of sites (73%) at which black rails were detected in interior areas of northern California were areas with water depths ≤ 3 cm (Tecklin 1999) and black rails were more likely to use areas with < 3 cm of water in Arizona (Flores and Eddleman 1995). Moreover, all five nests located in Arizona were in areas with < 2.5 cm of water (Flores and Eddleman 1993). Some plants associated with black rail presence (e.g., Fremont cottonwood) have declined in the region (Ohmart et al.1977) and some plants associated with black rail absence (e.g., dense saltcedar) have increased in the region. These changes in plant associations may help explain declines in black rail populations in the region. We know little about regional trends in abundance of common threesquare.

Conservation Implications

California black rails are relatively rare outside of San Francisco Bay; 608 birds were detected in San Francisco Bay (Evens et al. 1991), 184 birds were detected in marshes along the Sacramento River (Tecklin 1999), and we detected 136 birds in marshes throughout western Arizona and southern California. Aside from a few black rails detected in northwestern Mexico, these represent the only known populations of California black rails in North America. The long-term viability of populations outside of the San Francisco Bay region is undoubtedly low if frequent immigration does not sustain populations in the southwestern USA.

Our data suggest that degradation and elimination of suitable emergent marshes over the past 25–30 years has caused significant reduction in black rail distribution in southern California and Arizona (also see Wilbur 1974, Garrett and Dunn 1981, Gustafson 1987, Jackson 1988). Declines have been most dramatic in the Imperial Valley of California where marshes that once supported breeding black rails have been altered or destroyed. Abundance of saltcedar has increased in the southwestern USA, and these changes in wetland plant communities have led to reduced habitat suitability for black rails. Observed declines in eastern black rail populations are also the result of elimination and degradation of wetland habitat (Kerlinger and Wiedner 1991).

Laymon et al. (1990) believed that the outlook for maintaining California black rails in the southwestern USA was bleak. They suggested that insufficient habitat was available to maintain the species in perpetuity and that any further habitat loss could lead to local extinction. Since 1989, several marshes with past breeding records have been destroyed and populations have declined. Hence, land managers need to manage existing marshes to maintain conditions suitable for black rails and to restore previously-suitable areas immediately. Indeed, restoration of degraded marshes has been a management priority for conservation of California black rails for many years (Gustafson 1987), but little has been done to benefit the birds. Recovery of black rail populations through habitat restoration may be possible; black rails will use constructed or restored wetlands (Tecklin 1999). The Lower Colorado River Multi-species Conservation Program provides a unique opportunity to use adaptive management to design and compare different methods for creating wetlands suitable for breeding black rails.

RECOMMENDATIONS

Possible methods for restoring or creating black rail habitat have not been evaluated. Prescribed fire is one management tool that has been suggested to benefit black rails, but needs to be evaluated, especially in marshes where saltcedar is taking over. Creation of new wetlands with a gradually-sloping transition between wetland and upland may increase black rail populations in the region. Wetland restoration efforts should focus on establishing stands of common threesquare with moist soil conditions and eliminating wetland plants that are less suitable for black rails (California bulrush, southern cattail, and monotypic stands of saltcedar). We recommend that a standardized survey effort be repeated annually in marshes throughout the southwestern USA so that better population data can be obtained and managers can more closely monitor status and trends of black rails, and black rail habitat, in the region. Moreover, we recommend that areas with potential black rail habitat be restored and standardized point-count surveys be conducted in restored wetlands to learn more about how to restore wetlands to benefit black rails.

ACKNOWLEDGMENTS

Funding was provided by the Arizona Game and Fish Department Heritage Program (IIPAM Grant # I99010), and the California Department of Fish and Game (CDFG) Habitat Conservation Planning Branch. B. Clock and W. Jess provided invaluable field assistance. H. Hundt, J. Bulloch, G. Clune, S. Goodchild, E. Schuldheiss, and J. Kahl helped conduct surveys. The U.S. Fish and Wildlife Service provided logistical support. B. Raulston provided assistance throughout the project. C. Kirkpatrick and W. R. Eddleman commented on an earlier draft.

LITERATURE CITED

Allen, J. A. 1900. The little black rail. The Auk 17:1–8.

Arizona Game and Fish Department. 1996. Wildlife of special concern in Arizona. Nongame and Endangered Wildlife Program. Arizona Game and Fish Department, Phoenix, AZ, USA.

Busch, D. E. and S. D. Smith. 1995. Mechanisms associated with decline of woody species in riparian ecosystems of the southwestern US. Ecological Monographs 65:347–70.

California Department of Fish and Game. 2006. State and federally listed endangered and threatened animals of California. Biogeographic Data Branch, California Department of Fish and Game, Sacramento, CA, USA.

Conway, C. J., C. Sulzman, and B. E. Raulston. 2002. Population trends, distribution, and monitoring protocols for the California black rail. Technical Report (Heritage Program IIPAM Grant # I99010), Arizona Game and Fish Department, Phoenix, AZ, USA.

Conway, C. J., C. Sulzman, and B. E. Raulston. 2004. Factors affecting detection probability of California black rails. Journal of Wildlife Management 68:360–70.

Dahl, T. E. 2006. Status and trends of wetlands in the conterminous United States 1998 to 2004. U.S. Department of the Interior, Fish and Wildlife Service, Washington, DC, USA.

Diario Oficial de la Federacion. 2002. Norma Oficial Mexicana NOM-059-ECOL-2001, Proteccion ambiental-Especies nativas de Mexico de flora y fauna silvestres-Categoriosde riesgo y especificaciones para su inclusion, exclusion o cambio-Lista de especies en riesgo. Secretaria de Medio Ambiente y Recursos Naturales, 6 Marzo 2002.

Eddleman, W. R., R. E. Flores, and M. L. Legare. 1994. Black rail (*Laterallus jamaicensis*). *In* A. Poole and F. Gill (eds.) The Birds of North America, no. 123. The Academy of Natural Sciences, Philadelphia, PA, USA.

Edwards, C. 1979. A report on the distribution, abundance, population trends and habitat requirements for the California black rail on the lower Colorado River. Technical Report, Nongame Wildlife Branch, Arizona Game and Fish Department, Phoenix, AZ, USA.

Evens, J. G., G. W. Page, S. A. Laymon, and R. W. Stallcup. 1991. Distribution, relative abundance and status of the California black rail in western North America. The Condor 93:952–66.

Flores, R. E. and W. R. Eddleman. 1991. Ecology of the California black rail in southwestern Arizona. Final Technical Report, Arizona Game and Fish Department, Phoenix, AZ, USA.

Flores, R. E. and W. R. Eddleman. 1993. Nesting biology of the California black rail in southwestern Arizona. Western Birds 24:81–88.

Flores, R. E. and W. R. Eddleman. 1995. California black rail use of habitat in southwestern Arizona. Journal of Wildlife Management 59:357–63.

Garrett, K. and J. Dunn. 1981. Birds Of Southern California: Status And Distribution. Los Angeles Audubon Society, Los Angeles, CA, USA.

Greenberg, R., J. Maldonado, S. Droege, and M. V. McDonald. 2006. Tidal marshes: a global perspective on the evolution and conservation of their terrestrial vertebrates. BioScience 56:675–85.

Grinnell, J. 1928. A distributional summation of the ornithology of lower California. University of California Publications in Zoology 32:1–300.

Gustafson, J. R. 1987. California black rail: five-year status report. Technical Report. Non-game Bird and Mammal Section, California Department of Fish and Game, Sacramento, CA, USA.

Hinojosa-Huerta, O., W. Shaw, and S. DeStefano. 2001. Detections of California black rails in the Colorado River delta, Mexico. Western Birds 32:228–32.

Jackson, J. 1988. Surveys for the Yuma clapper rail and the California black rail along the 38-mile unlined portion of the Coachella canal and adjacent wetlands, Imperial and Riverside counties, California. Administrative Report, U.S. Department of Interior, Bureau of Reclamation, Boulder City, NV, USA.

Jurek, R. M. 1975. Survey of Yuma Clapper Rails and California black rails along Coachella canal, Imperial County, May 1975. Nongame Wildlife Investigation, June 6, 1975. California Department of Fish and Game, Sacramento, CA, USA.

Kasprzyk, M., R. Smith, and R. Bransfield. 1987. Avian species composition and densities of a wetland community along the All-American Canal, Imperial County, California. In All-American Canal relocation study, California, Environmental Appendix, U.S. Bureau of Reclamation, Boulder City, NV, USA.

Kerlinger, P. and D. S. Wiedner. 1991. Vocal behavior and habitat use of black rails in south Jersey. Records of New Jersey Birds 16:58–62.

Latta, M. J., C. J. Beardmore, and T. E. Corman. 1999. Arizona Partners-In-Flight Bird Conservation Plan. Technical Report 142. Arizona Game and Fish Department, Phoenix, AZ, USA.

Laymon, S. A., J. G. Evens, and R. W. Stallcup. 1990. Distribution and abundance of the California black rail in south-eastern California. Technical Report, California Department of Fish and Game, Sacramento, CA, USA.

Manolis, T. D. 1978. Status of the black rail in central California. Western Birds 9:151–58.

Mitsch, W. J. and J. G. Gosselink. 2000. Wetlands, third edition. John Wiley & Sons, Inc., New York, NY, USA.

Ohmart, R. D., W. O. Deason, and C. Burke. 1977. A riparian case history: the Colorado River. p. 35–47. *In* R. R. Johnson and D. A. Jones (tech. coords.) (eds.) Importance, Preservation and Management of Riparian Habitat; A symposium. U.S. Department of Agriculture, Forest Service Technical Report RM-43, Fort Collins, CO, USA.

Repking, C. F. 1975. Distribution and habitat requirements of the black rail (*Laterallus jamaicensis*), along the lower Colorado River. M.S. Thesis. Arizona State University, Tempe, AZ, USA.

Repking, C. F. and R. D. Ohmart. 1974. Completion report on the density and distribution of the black rail (*Laterallus jamaicensis*), along the lower Colorado River (Davis Dam to the Mexican Boundary), 22 February 1974. Technical Report, Contract Number 7625-575-15-8, Arizona Game and Fish Department, Phoenix, AZ, USA.

Repking, C. F. and R. D. Ohmart. 1977. Distribution and density of black rail populations along the lower Colorado River. The Condor 79:486–89.

Russell, S. M. and G. Monson. 1998. The Birds Of Sonora. The University of Arizona Press, Tucson, AZ, USA.

Shuford, W. D., N. Warnock, K. C. Molina, B. Mulrooney, and A. E. Black. 2000. Avifauna of the Salton Sea: abundance, distribution, and annual phenology. Contribution No. 931 of Point Reyes Bird Observatory. Salton Sea Authority, La Quinta, CA, USA.

Spautz, H. and N. Nur. 2002. Distribution and abundance in relation to habitat and landscape features and nest site characteristics of California black rail (*Laterallus jamaicensis coturniculus*) in the San Francisco Bay estuary. Final Report. U.S. Fish and Wildlife Service, Sacramento, CA, USA.

Spear, L. B., S. B. Terrill, C. Lenihan, and P. Delevoryas. 1999. Effects of temporal and environmental factors on the probability of detecting California black rails. Journal of Field Ornithology 70:465–80.

Tecklin, J. 1999. Distribution and abundance of the California black rail (*Laterallus jamaicensis coturniculus*) in the Sacramento valley region with accounts of ecology and call behavior of the subspecies. Technical Report, Contract Nos. FG6154WM and FG6154-1WM. California Department of Fish and Game, Sacramento, CA, USA.

Todd, R. L. 1970. Nongame investigations. Arizona Game and Fish Department, Progress Report, Project W-53-20, Phoenix, AZ, USA.

Todd, R. L. 1980. A breeding season 1980 survey of Clapper Rails and black rails on the Mittry Lake Wildlife Area, Arizona. Technical report, Federal Aid Project W-53-R-30, Work Plan 5, Job 1. Arizona Game and Fish Department, Phoenix, AZ, USA.

Turner, R. M. and M. M. Karpiscak. 1980. Recent vegetation changes along the Colorado River between Glen Canyon Dam and Lake Mead, Arizona. U.S. Geological Survey Professional Paper No. 1132. USGS, Washington, DC, USA.

U.S. Bureau of Reclamation. 2006. Science Strategy for the Lower Colorado River multi-species conservation program, May 11, 2006 Draft. U.S. Department of the Interior, Bureau of Reclamation, Boulder City, NV, USA.

U.S. Department of the Interior. 1989. Endangered and threatened wildlife and plants: annual notice of review. Federal Register 54:554–79.

U.S. Fish and Wildlife Service. 2002. Birds of Conservation Concern 2002. Division of Migratory Bird Management, Arlington, Virginia, USA.

Wilbur, S. R. 1974. The literature of the California black rail. Special scientific report-wildlife, No. 179. Patuxent Wildlife Research Center, U.S. Fish and Wildlife Service, Laurel, MD, USA.

Wilbur, S. R. 1987. Birds of Baja California. University of California Press, Berkeley, CA, USA.

Manuscript received 14 June 2006; accepted 30 June 2007.