Lower Colorado River Multi-Species Conservation Program

Balancing Resource Use and Conservation

Marsh Bird Water Depth Analysis

2016 Progress Report

September 2017

Work conducted under LCR MSCP Work Task C66

Lower Colorado River Multi-Species Conservation Program Steering Committee Members

Federal Participant Group

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

Arizona Participant Group

Arizona Department of Water Resources
Arizona Electric Power Cooperative, Inc.
Arizona Game and Fish Department
Arizona Power Authority
Central Arizona Water Conservation District
Cibola Valley Irrigation and Drainage District
City of Bullhead City
City of Lake Havasu City
City of Mesa
City of Somerton
City of Yuma
Electrical District No. 3, Pinal County, Arizona
Golden Shores Water Conservation District
Mohave County Water Authority
Mohave Valley Irrigation and Drainage District
Mohave Water Conservation District
North Gila Valley Irrigation and Drainage District
Town of Fredonia
Town of Thatcher
Town of Wickenburg
Salt River Project Agricultural Improvement and Power District
Unit "B" Irrigation and Drainage District
Wellton-Mohawk Irrigation and Drainage District
Yuma County Water Users' Association
Yuma Irrigation District
Yuma Mesa Irrigation and Drainage District

Other Interested Parties Participant Group

QuadState Local Governments Authority
Desert Wildlife Unlimited

California Participant Group

California Department of Fish and Wildlife
City of Needles
Coachella Valley Water District
Colorado River Board of California
Bard Water District
Imperial Irrigation District
Los Angeles Department of Water and Power
Palo Verde Irrigation District
San Diego County Water Authority
Southern California Edison Company
Southern California Public Power Authority
The Metropolitan Water District of Southern California

Nevada Participant Group

Colorado River Commission of Nevada
Nevada Department of Wildlife
Southern Nevada Water Authority
Colorado River Commission Power Users
Basic Water Company

Native American Participant Group

Hualapai Tribe
Colorado River Indian Tribes
Chemehuevi Indian Tribe

Conservation Participant Group

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

Lower Colorado River
Multi-Species Conservation Program

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September 2017

Dodge, C. and N. Rudd. 2017. Marsh Bird Water Depth Analysis, 2016 Progress Report. Annual report prepared by the Lower Colorado Multi-Species Conservation Program, Bureau of Reclamation, Boulder City, Nevada.

ACRONYMS AND ABBREVIATIONS

AIC	Akaike's information criterion value
AIC_c	small sample size corrected AIC
eps	probability of extinction
ER	evidence ratio
gamma	probability of colonization
K	number of parameters
LCR	lower Colorado River
LCR MSCP	Lower Colorado River Multi-Species Conservation Program
n	number of samples
p	detection probability
psi	probability of occupancy
Reclamation	Bureau of Reclamation
SW	sum of model weights

Symbols

=	equal to
<	less than
%	percent

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INTRODUCTION

The Yuma clapper rail (*Rallus longirostrus yumanensis*), also known as the Ridgway's Rail (*R. obsoletus yumanensis*), is listed as federally endangered and as a covered species under the Lower Colorado River Multi-Species Conservation Program (LCR MSCP). The name for this species was changed from Yuma clapper rail to Ridgway's Rail in 2014. Throughout this report, the bird referred to is the Yuma clapper rail, as the name has not officially changed neither on the Endangered Species List nor on the LCR MSCP permit documents.

The LCR MSCP has been tasked with creating 512 acres of marsh habitat to provide habitat for the Yuma clapper rail (Habitat Conservation Plan 5.7.1.2 CLRA1). According to the Habitat Conservation Plan, the marsh habitat created by the LCR MSCP must maintain water levels at appropriate depths for this species, which is defined as no more than 12 inches. The LCR MSCP has interpreted this to mean that water levels at created marsh habitat will be maintained between 0 and 12 inches at all times.

Water fluctuations and water depths on the lower Colorado River (LCR) are often greater than 12 inches at breeding Yuma clapper rail habitat. This has led to speculation that it may be possible to allow a greater range of water depths at created marsh habitats and still provide suitable breeding habitat for Yuma clapper rails. The LCR MSCP created the Work Task C66 in order to investigate water levels in Yuma clapper rail habitat. The purpose of this work task is to (1) gather the current information available on Yuma clapper rail breeding and water depth fluctuations and (2) take existing data on the LCR and analyze if water fluctuations show an effect on the presence of Yuma clapper rails during the breeding season.

BACKGROUND

There is published data on Yuma clapper rail breeding success and water fluctuations. Much of the information comes from investigations of coastal areas where clapper rails breed within tidal marshes that experience daily fluctuations in water levels due to the ebb and flow of the tides. Limited information has also been obtained from investigation of the LCR. Much of the information available is observational, although a few studies have tried to indirectly quantify the effects of fluctuating water levels on Yuma clapper rails and other subspecies.

One of the earliest and most extensive studies of Yuma clapper rails on the Colorado River was conducted at two sites on the LCR from 1985 to 1987 (Edelman 1989). Research was conducted on various aspects of Yuma clapper rail breeding and habitat, including measuring water levels and using radio telemetry. The research was conducted at two sites: one at Crystal Beach at the south end of Topock Gorge on the Arizona side of the Colorado River and the other at the northeast corner of the Mittry Lake Wildlife Management Area outside of Yuma, Arizona. Mittry Lake experienced very little changes in water level during the period of the study, but the site at Crystal Beach experienced a 1.1-meter (3.608 feet) water level change during the entire period of study. The site at Crystal Beach experienced a rapid rise and fall of water levels, and Edelman reports that the birds moved to higher areas during periods of high water. He also reports that the birds use a variety of habitats, including near shore, shallow water, and deep water of over 1 meter (3.28 feet) in depth. Edelman states that Yuma clapper rails are able to persist even with variation in water levels if marsh vegetation remains undisturbed, water is consistently present, substrate depth varies gradually, and slightly higher sites or upland are close by. He hypothesizes that a gradual increase of water depth during the breeding season is important for Yuma clapper rails to have the ability to adapt their nests and persist in an area; however, the data collected during this study did not lead directly to this conclusion.

Courtney Conway conducted research along the LCR on Yuma clapper rails using radio telemetry (Conway et al. 1993) to learn about the vegetation characteristics of their habitat and to determine detection rates at sites where birds were present to improve calculations of population estimates. The study found that most birds did not respond to call-playback surveys; there was a response rate of 40% in the period of early breeding, 20% in the late breeding period, 7% in the post-breeding period, and 10% in winter. Conway hypothesizes that prior to the construction of dams and water control structures on the LCR, water levels likely varied greatly, and variable water depths within marshlands provided the habitat Yuma clapper rails needed for both breeding and wintering. Another study (Nadeau et al. 2011) at the created Field 16 and Field 18 marsh cells on the Imperial National Wildlife Refuge found that Yuma clapper rails were most likely to occupy areas with low densities of river bulrush (*Scirpus fluviatilis*), moderate densities of cattail (*Typha domingensis*), and 0 to 65 millimeters of water depth. However, they hypothesize that the shallow water depths from their study were a result of the lack of vegetation in deeper waters in the areas studied. They also found that Yuma clapper rails were most abundant when water depths varied greatly.

Other authors have also hypothesized that prior to the construction of dams, LCR water levels varied greatly, and wildlife on the river were likely adapted to these type of variations (Ohmart et al. 1975; Sykes 1937). While many observations have led to hypotheses about the tolerance of Yuma clapper rails for varying water depths, nothing has been based on empirical data collected on the LCR.

As previously mentioned, there is published information about varying water levels and clapper rail populations in other parts of their range, including coastal tidal areas. Rush et al. (2010, 2012) report overall nest success to be high (only 16 lost out of a total of 76 nests) for clapper rails in these tidal areas with good habitat. The contrary was published by Zembal and Massey (1983); in southern California, 9 of 15 light-footed clapper rail (*R.l. levipes*) nests monitored were destroyed by tidal flooding. Further studies in central California found that only 2 nests were lost to flooding, while 42 were lost to predation in an area where tidal effects would not be a factor (Schwarzbach et al. 2001). A study in the San Francisco Bay marshes reported that flooding had little effect on the survival of eggs of clapper rails and that predation and contamination play a much greater role in nest success. Only severe tidal flooding of over 2 meters (6.56 feet) posed a threat to the birds as seen when two nests were lost during an El Niño year with high tidal flooding (Schwarzbach et al. 2006).

Clapper rails may be able to respond to high flood levels by adapting their nests and also by renesting. Clapper rails will build their nests above the mean water level and will also build a ramp to the nest that allows them access in times of lower water levels (Jackson 1983; Duhse 1988). Clapper rails will also build up their nests higher or move them to higher locations in times of high water or flooding (Rush et al. 2012; Jackson 1983; Edleman 1989; Massey et al. 1984). A majority of the published information on clapper rails, as discussed above, is similar to the information published on the LCR in that no quantitative analysis of the bird's tolerance for a fluctuation in water levels has been conducted.

METHODOLOGY FOR MARSH BIRD SURVEYS AND WATER DEPTH ANALYSIS

Marsh Bird Surveys

Bureau of Reclamation (Reclamation) personnel have conducted surveys for marsh birds, including the Yuma clapper rail, in the Topock Gorge area of the Colorado River since 1996. Topock Gorge lies between Lake Havasu and Interstate 40 south of Needles, California. The area has consistently had a large number of detections of Yuma clapper rails. The surveys in Topock Gorge are well suited for analysis of Yuma clapper rail populations due to the consistency in survey personnel and the methodology.

This study analyzed data from 2006 to 2014 using the Standardized North American Survey Protocol (Conway 2011). All surveys were conducted by boat, starting before dawn and concluding no later than 10 a.m., when marsh birds generally cease calling. Surveys ceased when the windspeed was greater than 12 miles per hour (20 kilometers per hour) because, at this windspeed, the detection of birds was impaired by noise from rustling vegetation. Surveys were not conducted during periods of sustained rain or heavy fog (Conway 2011). A total of 52 points were surveyed during 3 separate survey periods. The location of the survey points was the same each year (figure 1). Reclamation conducted marsh bird surveys from March 15 to March 31 for period 1, from April 1 to

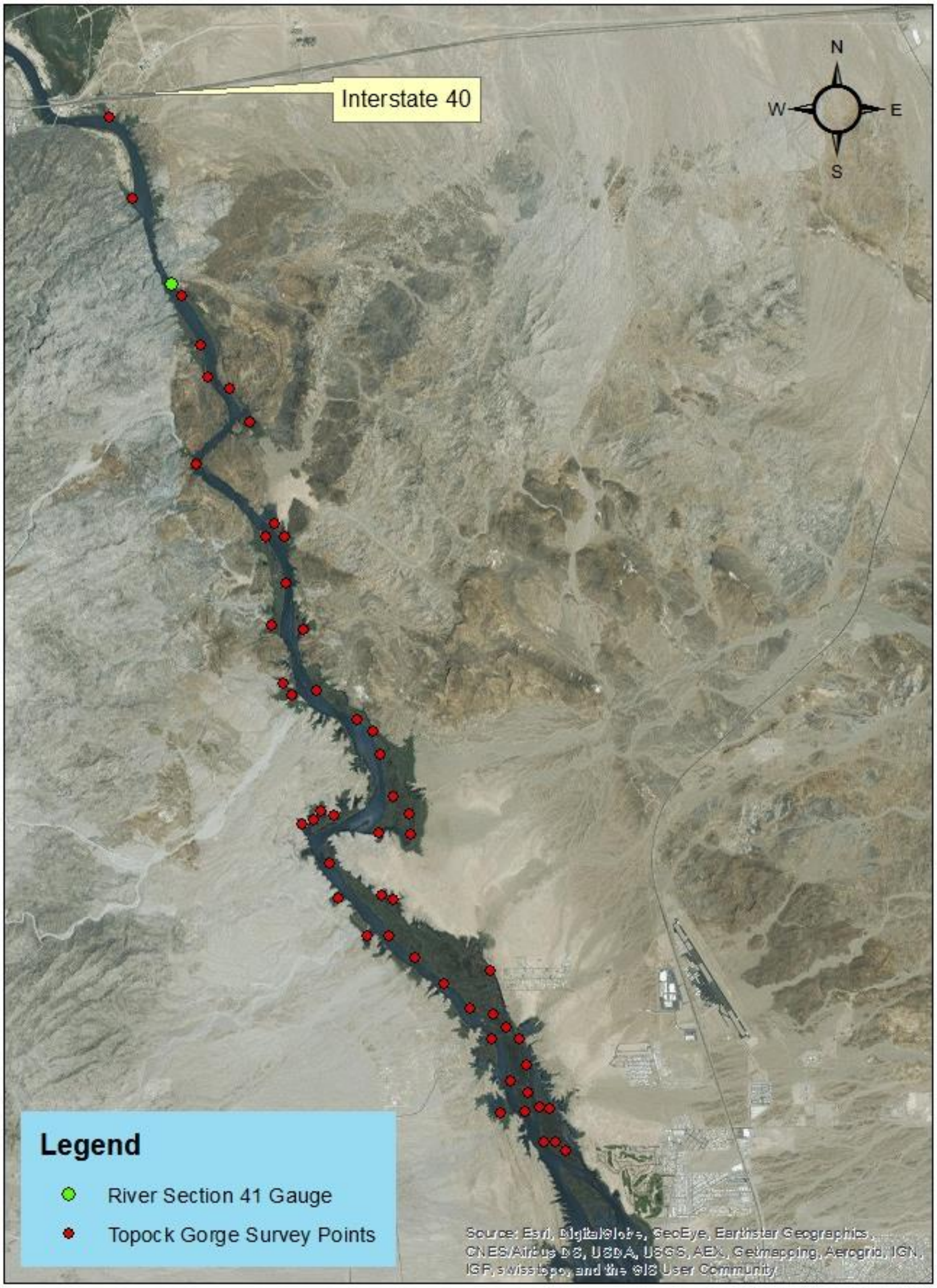

Figure 1.—Location of survey points and the gauging station at Topock Marsh.

to April 20 for period 2, and from April 21 to May 20 for period 3 (table 1). The timing of the survey periods deviated from that described in the official protocol in order to maintain consistency with surveys conducted previous to 2006. The dates for each survey period generally fell within these dates, but in a few cases they did not (when surveys were cancelled and then rescheduled at a later date due to reasons such as inclement weather). At each survey point, a series of calls of four focal marsh bird species, California black rails (*Laterallus jamaicensis coturniculus*), western least bitterns (*Ixobrychus exilis hesperis*), Virginia rails (*Rallis limicola*), and Yuma clapper rails were broadcast. If a response was heard, it was recorded onto a data sheet and used as an indication of the presence of the species.

Table 1.—Dates of each survey period from 2006 to 2014

Year	Analysis period	Date range
2006	Period 1	March 1 to March 21
	Period 2	March 22 to April 25
	Period 3	April 26 to May 16
2007	Period 1	March 1 to March 20
	Period 2	March 21 to April 25
	Period 3	April 26 to May 22
2008	Period 1	March 1 to March 25
	Period 2	March 26 to April 15
	Period 3	April 16 to May 22
2009	Period 1	March 1 to March 17
	Period 2	March 18 to April 14
	Period 3	April 15 to May 19
2010	Period 1	March 1 to March 23
	Period 2	March 24 to April 20
	Period 3	April 20 to May 18
2011	Period 1	March 1 to March 22
	Period 2	March 23 to April 19
	Period 3	April 20 to May 10
2012	Period 1	March 1 to March 20
	Period 2	March 21 to April 17
	Period 3	April 18 to May 19
2013	Period 1	March 1 to March 20
	Period 2	March 21 to April 17
	Period 3	April 18 to May 19
2014	Period 1	March 1 to March 18
	Period 2	March 19 to April 8
	Period 3	April 9 to May 20

Portable audio players with amplified speakers were used to broadcast calls of California black rails, western least bitterns, Virginia rails, and Yuma clapper rails. The recordings consisted of 5 minutes of silence followed by 30 seconds of selected calls and 30 seconds of silence for each of the species. The specific calls used were “kicky-doo” and “grr” for California black rails, “coo” and “kak” for western least bitterns, “grunt,” “ticket,” and “kicker” for Virginia rails, and “clatter,” “kek,” and “kek-burr” for Yuma clapper rails. The calls were played at a volume of 80–90 decibels measured 1 meter from the speakers.

Water Depth Data Collection

Reclamation maintains the River Section 41 gauging station in Topock Gorge just south of where Interstate 40 crosses the river (figure 1) to measure the water levels. Reclamation collected daily water levels for the period between 2006 and 2014 and calculated the fluctuation in water levels as the difference between the maximum and minimum daily water level for each survey period. The data used in the analysis of water levels began on March 1 each year to include water data collected before the first marsh bird surveys were started.

Methodology for Occupancy Modeling

The analysis did not use the number of birds detected at each survey point. The number of birds detected cannot be used as an estimate of abundance without a detection probability, and the use of the number of detections as an index of use is not a reliable method to evaluate sites (MacKenzie 2005). Instead, the survey results were converted to a format usable by Program Presence to show presence at each survey site.

Reclamation modeled data from marsh bird surveys using occupancy modeling techniques in Program Presence (Version 9.0) to determine whether the presence of Yuma clapper rails was influenced by observed water level fluctuations in each survey period. They converted the detection data from the number of detections at each survey point to a detection or non-detection of a clapper rail at each survey point. A detection confirms presence at a survey site. The data were then entered into Program Presence, and models were run to describe the characteristics of the Yuma clapper rail population in Topock Gorge. Reclamation used a simple multi-season model to estimate four separate probabilities that drive population dynamics over time. The first is Psi (occupancy), which is the probability of a site being occupied. The second is gamma (colonization), or the probability that a site unoccupied in one year is then occupied in a subsequent year. The third is epsilon (eps) (extinction), or the probability that a site occupied in one year is then unoccupied in a subsequent year. It is important to note that in this case extinction only refers to the probability that a site is unoccupied for any reason and does not necessarily refer to mortality, as that would only be one possible cause of a site becoming unoccupied. The final probability is p (detection), or the detection probability. Detection probability is important because it provides unbiased estimates of occupancy, colonization, and extinction when $p < 1$ (i.e., when birds that are present go undetected, which is always the case when marsh bird monitoring). Multi-season models assume that (1) there are no false detections, (2) detections are independent at each site, (3) there is no unmodeled heterogeneity in occupancy or detection, (4) there is no colonization or extinction between repeated samples within a season, and (5) there is no unmodeled heterogeneity in colonization or extinction between seasons. These model assumptions are reasonable for Yuma clapper rail data, as false detections are unlikely due to their distinct vocalizations, the distance between sites allows for site detections to be independent, there is no evidence for heterogeneity in occupancy or detection, and there is no evidence for unmodeled colonization or extinction between seasons.

Reclamation examined the influence of water fluctuations on occupancy, colonization, and extinction by comparing models with and without the water depth fluctuation covariate. Since the water data only come from one point in Topock Gorge, only one value for the water fluctuation was available per survey period. Several models were run with some of the probabilities changed within each model. The models included psi, one or both of gamma and epsilon, and detection probability, and the first three probabilities were assumed constant, allowed to vary by year, or modeled as a function of water fluctuation. The detection probability was either held constant or allowed to vary by survey period, survey year, or both.

Reclamation compared models using Akaike's information criterion (AIC), with lower values reflecting more support or a better fit to the data. The small sample correction of AIC, AIC_c, is recommended when the ratio of samples to model parameters (n/K) is < 40 (Burnham and Anderson 2010). However, the effective sample size for occupancy models is difficult to define, as it may be considered as the number of sampled sites or the number of detections. The analysis examined the effect of small sample correction by comparing results without a sample size correction with those assuming effective sample sizes of 52 (the number of survey points) and 538 (the number of detections recorded throughout the entirety of the data collection process).

Reclamation calculated evidence ratios (ERs) for water fluctuation effects in order to determine the support for the fluctuation in water levels affecting colonization, extinction, occupancy, period, and year effects on Yuma clapper rail detection within the models. The ERs were developed for each factor of interest by summing the AIC weights from every model that had the factor of interest (SW) and dividing that by the sum of weights from every model without the factor of interest (ER = SW/(1-SW). Thus, ERs indicate the relative support for the effect of a given factor on a model parameter, with strong support indicated when ER is much greater than 1. These ERs are tabulated for each hypothesized effect of water fluctuation on colonization, extinction, and occupancy as well as for the effect of period and year on detection rates. ERs are an easy and intuitive way to demonstrate relative support for different models or parameters.

RESULTS

Results of Marsh Bird Surveys and Water Depth

The river at Topock Gorge experienced fluctuations in water levels over every survey period. The smallest fluctuation was 0.41 meter (1.36 feet) in period 2 of 2014, and the largest fluctuation was 1.6 meters (5.36 feet) recorded for period 1 of 2010. The changes in water level per period are shown on figure 2.

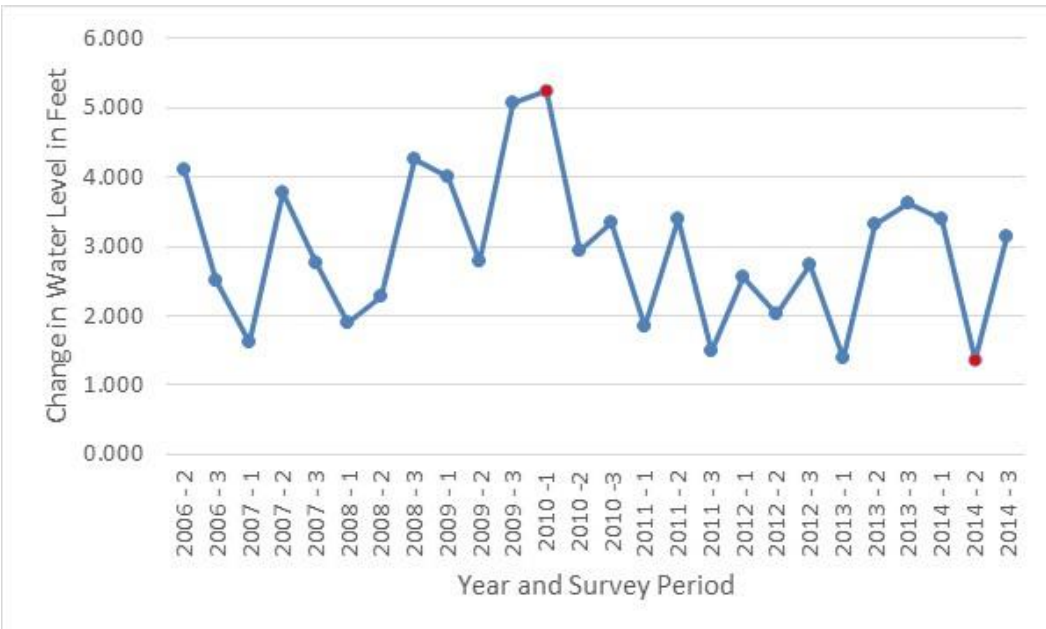

Figure 2.—Change in daily water levels per period, from 2006 to 2014.
The maximum and minimum points are colored in red.

Yuma clapper rail survey results were converted from the number of detections at each survey point to a detection or non-detection of a Yuma clapper rail at each survey point to show presence at each survey site. Every year between 30 and 38 of the 52 total survey points had at least 1 detection of a Yuma clapper rail. Figure 3 shows the number of sites with at least one detection for every year.

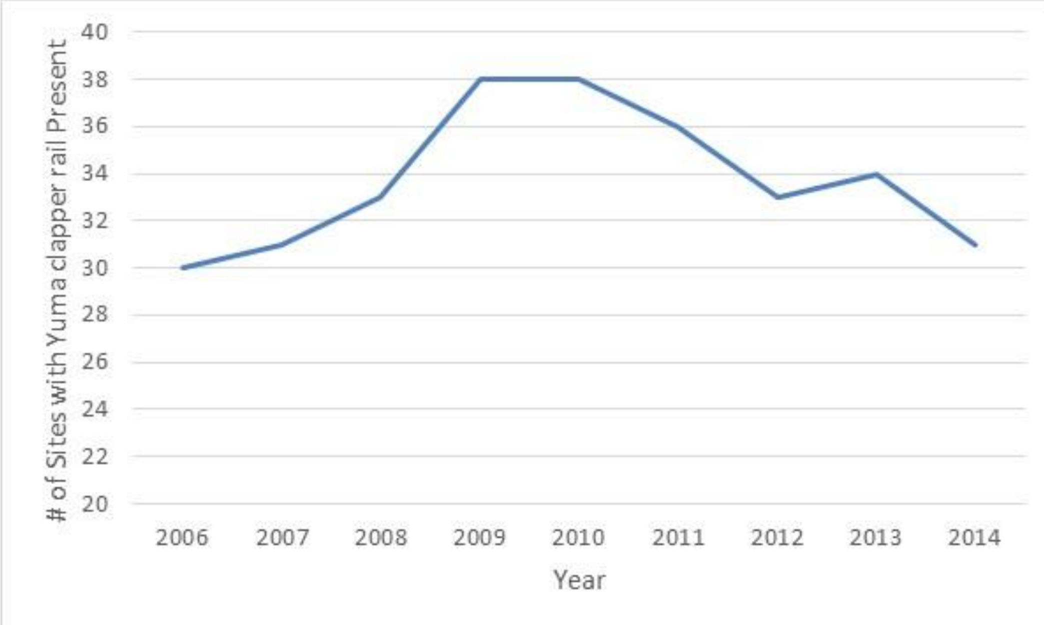

Figure 3.—Number of survey sites with at least one detection of Yuma clapper rails per year.
Total number of survey sites = 52.

RESULTS OF THE OCCUPANCY MODELING

The models and results for each analysis are shown in tables 2, 4, and 6. Each analysis produced ERs for several hypotheses based on the results of the models (tables 3, 5, and 7). The ERs demonstrate the support for each hypothesis based on the modeled data. There was no support for the hypothesized effect of water fluctuation on any model parameter with or without corrections for sample size (i.e., ER < 1). There was very strong support for the combined effects of period and year on the detection probability (p) for the uncorrected model set that assumed an effective sample size based on detections (tables 3 and 7). There was strong support only for the effect of period on detection, but not year, for the more conservative assumption of effective sample size based on the number of sampled sites (table 5).

DISCUSSION

There is strong evidence that detectability of Yuma clapper rail varies by year and survey period. There is essentially no evidence that daily water level fluctuations have an effect on the probability of occupancy, colonization, or extinction of Yuma clapper rails. The ERs clearly show that period and year

Table 2.—Results of models for the Yuma clapper rail population in Topock Gorge with the fluctuation covariate and no correction for small sample size

(psi = occupancy, gamma = colonization, epsilon [eps] = extinction, p = detection, Period = probability is allowed to be different per period, yr = probability is allowed to be different per year, Period*yr = probability varies over both period and year, Fluc_season = seasonal water fluctuation environmental covariate, AIC = Akaike's information criterion value, ΔAIC = AIC differences, and -2*loglike = log likelihood value.)

Model	AIC	ΔAIC	AIC weight	Model likelihood	Number of parameters	-2*loglike
psi(),eps(),p(Period*yr)	1600.3	0	0.3055	1	29	1542.3
psi(),gamma(),p(Period*yr)	1600.3	0	0.3055	1	29	1542.3
psi,gamma(),eps(),p(Period*yr)	1602.26	1.96	0.1147	0.3753	30	1542.26
psi(Fluc_season),gamma(),p(Period*yr)	1602.28	1.98	0.1135	0.3716	30	1542.28
psi(Fluc_season),gamma(Fluc_season),p(Period*yr)	1603.2	2.9	0.0717	0.2346	31	1541.2
psi(Fluc_season),eps(),p(Period*yr)	1603.42	3.12	0.0642	0.2101	30	1543.42
psi(Fluc_season),eps(Fluc_season),p(Period*yr)	1605.33	5.03	0.0247	0.0809	31	1543.33
psi(),gamma(),p(Period)	1621.03	20.73	0	0	5	1611.03
psi(),eps(),p(Period)	1621.03	20.73	0	0	5	1611.03
psi,gamma(yr),eps(yr),p(Period*yr)	1621.9	21.6	0	0	44	1533.9
psi(yr),eps(yr),p(Period*yr)	1622.98	22.68	0	0	44	1534.98
psi(),eps(),p(yr)	1626.41	26.11	0	0	11	1604.41
psi(),gamma(),p(yr)	1626.41	26.11	0	0	11	1604.41
psi,gamma(),eps(),p()	1638.81	38.51	0	0	4	1630.81
psi(yr),eps(),p(Period*yr)	1672.73	72.43	0	0	37	1598.73
psi,gamma(),eps(Fluc_season),p(Period*yr)	1682.07	81.77	0	0	31	1620.07
psi(.),gam(.),eps=1-gam,p(Period+year)	1694.71	94.41	0	0	29	1636.71
psi(),eps(Fluc_season),p(Period*yr)	1703.77	103.47	0	0	30	1643.77

Table 3.—Summed model weights and evidence ratios for the four hypothesis represented within all the models

Hypotheses	Summed model weights	Evidence ratios
Fluctuation on occupancy	0.2742	0.378
Fluctuation on colonization	0.0717	0.077
Fluctuation on extinction	0.0247	0.025
Period*year on detection	0.9999	9999.000

Table 4.—Results of models for the Yuma clapper rail population in Topock Gorge with the fluctuation covariate and an assumed sample size of 52

(psi = occupancy, gamma = colonization, epsilon [eps] = extinction, p = detection, period = probability is allowed to be different per period, yr = probability is allowed to be different per year, Fluc_season = seasonal water fluctuation environmental covariate, AIC_c = Akaike's information criterion value corrected for sample size, ΔAIC_c = AIC_c differences, and -2*loglike = log likelihood value.)

Model	AIC_c	ΔAIC_c	AIC weight	Model likelihood	Number of parameters	-2*loglike
psi(),gamma(),p(Period)	1622.33	0	0.4976	1	5	1611.03
psi(),eps(),p(Period)	1622.33	0	0.4976	1	5	1611.03
psi(),eps(),p(yr)	1633.01	10.68	0.0024	0.0048	11	1604.41
psi(),gamma(),p(yr)	1633.01	10.68	0.0024	0.0048	11	1604.41
psi,gamma(),eps(),p()	1639.66	17.33	0.0001	0.0002	4	1630.81
psi(),eps(),p(Period*yr)	1679.39	57.06	0	0	29	1542.3
psi(),gamma(),p(Period*yr)	1679.39	57.06	0	0	29	1542.3
psi,gamma(),eps(),p(Period*yr)	1690.83	68.5	0	0	30	1542.26
psi(Fluc_season),gamma(),p(Period*yr)	1690.85	68.52	0	0	30	1542.28
psi(Fluc_season),eps(),p(Period*yr)	1691.99	69.66	0	0	30	1543.42
psi(Fluc_season),gamma(Fluc_season),p(Period*yr)	1702.4	80.07	0	0	31	1541.2
psi(Fluc_season),eps(Fluc_season),p(Period*yr)	1704.53	82.2	0	0	31	1543.33
psi(.),gam(.),eps=1-gam,p(Period+year)	1773.8	151.47	0	0	29	1636.71
psi,gamma(),eps(Fluc_season),p(Period*yr)	1781.27	158.94	0	0	31	1620.07
psi(),eps(Fluc_season),p(Period*yr)	1792.34	170.01	0	0	30	1643.77
psi(yr),eps(),p(Period*yr)	1873.59	251.26	0	0	37	1598.73
psi,gamma(yr),eps(yr),p(Period*yr)	2187.61	565.28	0	0	44	1533.9
psi(yr),eps(yr),p(Period*yr)	2188.69	566.36	0	0	44	1534.98

Table 5.—Summed model weights and evidence ratios for the four hypothesis represented within all the models with an assumed sample size of 5

Hypotheses	Summed model weights	Evidence ratios
Fluctuation on occupancy	0	0.000
Fluctuation on colonization	0	0.000
Fluctuation on extinction	0	0.000
Period on detection	0.9952	207.333
Year on detection	0.0048	0.005

Table 6.—Results of models for the Yuma clapper rail population in Topock Gorge with the fluctuation covariate and an assumed sample size of 538 (# of detections).

(psi = occupancy, gamma = colonization, epsilon [eps] = extinction, p = detection, period = probability is allowed to be different per period, yr = probability is allowed to be different per year, Fluc_season = seasonal water fluctuation environmental covariate, AIC_c = Akaike's information criterion value corrected for sample size, ΔAIC_c = AIC_c differences, and -2*loglike = log likelihood value.)

Model	AIC_c	ΔAIC_c	AIC weight	Model likelihood	Number of parameters	-2*loglike
psi(),eps(),p(Period*yr)	1603.73	0	0.323	1	29	1542.3
psi(),gamma(),p(Period*yr)	1603.73	0	0.323	1	29	1542.3
psi,gamma(),eps(),p(Period*yr)	1605.93	2.2	0.1075	0.3329	30	1542.26
psi(Fluc_season),gamma(),p(Period*yr)	1605.95	2.22	0.1064	0.3296	30	1542.28
psi(Fluc_season),eps(),p(Period*yr)	1607.09	3.36	0.0602	0.1864	30	1543.42
psi(Fluc_season),gamma(Fluc_season),p(Period*yr)	1607.12	3.39	0.0593	0.1836	31	1541.2
psi(Fluc_season),eps(Fluc_season),p(Period*yr)	1609.25	5.52	0.0204	0.0633	31	1543.33
psi(),gamma(),p(Period)	1621.14	17.41	0.0001	0.0002	5	1611.03
psi(),eps(),p(Period)	1621.14	17.41	0.0001	0.0002	5	1611.03
psi(),eps(),p(yr)	1626.91	23.18	0	0	11	1604.41
psi(),gamma(),p(yr)	1626.91	23.18	0	0	11	1604.41
psi,gamma(yr),eps(yr),p(Period*yr)	1629.93	26.2	0	0	44	1533.9
psi(yr),eps(yr),p(Period*yr)	1631.01	27.28	0	0	44	1534.98
psi,gamma(),eps(),p()	1638.89	35.16	0	0	4	1630.81
psi(yr),eps(),p(Period*yr)	1678.35	74.62	0	0	37	1598.73
psi,gamma(),eps(Fluc_season),p(Period*yr)	1685.99	82.26	0	0	31	1620.07
psi(.),gam(.),eps=1-gam,p(Period+year)	1698.14	94.41	0	0	29	1636.71
psi(),eps(Fluc_season),p(Period*yr)	1707.44	103.71	0	0	30	1643.77

Table 7.—Summed model weights and evidence ratios for the four hypotheses represented within all the models with an assumed sample size of 538 (number of detections)

Hypotheses	Summed model weights	Evidence ratios
Fluctuation on occupancy	0.2463	0.327
Fluctuation on colonization	0.0593	0.063
Fluctuation on extinction	0.0204	0.021
Period*year on detection	0.9998	4999.000
Period on detection	0.0002	2.000E-04

effects on detection probability (p) are the only factors that affected the models. Regardless of whether sample size corrections are considered, the ER for all hypotheses with the fluctuation covariate were less than one (ER < 1). The ER for period and annual effects on detection probability (p) were in the hundreds to thousands in all three cases, indicating very strong support for varying detection by survey year and period. Assuming that individual detections were mostly independent, the sample size correction based on the number of sites (52) is likely too conservative of a correction for assessing model results for the effects of period and year on detection.

The results provide strong evidence that the per-period levels of water fluctuation that were recorded in Topock Gorge (0.41 – 1.6 meters [1.36 – 5.26 feet]) do not affect the presence of Yuma clapper rails. These results are similar to what has been reported in the literature for this species (as described earlier in the "Background" section).

Work Task C66 will continue in fiscal year 2017. Reclamation has started a similar analyses with data from Topock Marsh and Topock Gorge in order to increase the sample size of survey points. In fiscal year 2017, Reclamation will also begin a literature search for the published information on the water depth requirements of California black rails. A similar analysis for California black rails will be conducted if adequate data are available.

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