

Article

Black Rails in Baja California

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Simple Summary

The California black rail (*Laterallus jamaicensis coturniculus*) is the western subspecies of the smallest North American rail. It is non-migratory, cryptic, poorly known, and federally endangered. We compiled historical records from the last 120 years (1905–2025) of its presence in Baja California and report data from surveys conducted from 2000–2025 in western Baja California and the Colorado River Delta wetlands, where suitable habitats exist. The number of records has increased with more biologists in the field, eBird, and the North American Marsh Bird Protocol. The 35 historical records in Baja California include a minimum reported count of 56 California black rails. In the Colorado River Delta, 22 years of surveys reported 20 detections across nine survey events. In 2023, surveys in suitable rail habitat yielded the first records of this bird in Estero de Punta Banda with a maximum monthly count of 15 detections, and 31 at Bahía de San Quintín, both in western Baja California. The scant records of the California black rail in northwestern México's wetlands suggest that the bird is rare and any efforts to increase numbers will likely require explicit conservation measures that expand and improve its habitat.



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Abstract

Summarizing records from 1905 to 2025, we document the presence and distribution of the California black rail (*Laterallus jamaicensis coturniculus*) in northwestern México, particularly Baja California and the Colorado River Delta. This subspecies has a restricted distribution in the western U.S. and northwestern México. We found few records over the past century: sparse detections in the early 1900s and an increase in reported records after 2000. Over 120 years, we compiled 35 documented records of California black rail occurrence in Baja California with a minimum reported count of 56 rails. Our call-broadcast survey methods reconfirmed previously occupied sites and documented the species at a previously

unreported site. Surveys in the Baja California portion of the Colorado River Delta yielded 20 detections across nine survey events between 2000 and 2022. In April 2003, standardized surveys detected 12 California black rails: 7 in Bahía de San Quintín, 3 in Arroyo San Telmo, and 2 in Arroyo El Rosario. Our recent survey work (2022–2025) recorded maximum monthly counts of 31 detections at Bahía de San Quintín and 15 detections at Estero de Punta Banda, the latter representing a previously undocumented location for the subspecies. These surveys also yielded the first photographic and acoustic documentation of California black rail in México. The contribution of spatial and temporal data provided by citizen science platforms increased our understanding of the subspecies' distribution. Enforceable protection of this subspecies' habitat is needed to safeguard its persistence.

Keywords: Northwestern Mexico; endangered species; habitat loss; call-broadcast surveys; marshbirds; waterbirds

1. Introduction

The black rail (*Laterallus jamaicensis*) is the smallest North American rail. Five subspecies are recognized; the two occurring in North America are the eastern black rail (*L. j. jamaicensis*) and the California black rail (*L. j. coturniculus*). The eastern subspecies is listed as federally threatened in the U.S. [1] and has both migratory and resident populations occurring along the Atlantic and Gulf Coasts of the U.S. and the Caribbean, with inland populations in Kansas and Colorado [2]. The eastern black rail prefers marshes with infrequent tidal inundation [2,3]. California black rails are state-listed as threatened in California [4,5], and federally endangered in México under NOM-059-SEMARNAT-2010 [6,7]. Both subspecies share conservation problems, including habitat loss caused by human development and climate variation [2,3].

Compared to the eastern black rail, the California black rail is smaller, has a brighter plumage, is non-migratory, and tolerates greater flooding in tidal marshes, provided surrounding upland vegetation is available for escape during extreme high tides [8,9].

The California black rail inhabits both tidal and freshwater wetlands, preferring shallow-water wetlands (0–5 cm) and stable water levels, with short emergent vegetation [2,10,11]. These habitat features are associated with tidal elevation and are influenced by freshwater presence at our Baja California study sites [12,13]. The California black rail has declined throughout its range, existing today in a series of non-contiguous populations within remnant tidal marshes on the western coasts and inland sites of the U.S. and México [2,9,14]. The California black rail is arguably rarer than its eastern counterpart [15]. We know relatively little about the bird's distribution and remaining core habitat in northwestern México, where likely threats include the lack of enforcement of land-use and water-use regulations.

Confirmed records of the California black rail in México are restricted to wetlands in Sonora and Baja California; one unverified record has also been reported from Sinaloa [16–21]. A small Sonoran population occurs in the Ciénega de Santa Clara and El Doctor wetlands [11,19]. Two individuals were detected in 2001 at the Río Hardy and Laguna del Indio, and seven rails were detected in 2010 along the Colorado River [19,20]. Despite these records, systematic surveys have been limited, and the species' current distribution remains poorly documented in North America, especially in northwestern México. Documenting the status and distribution of this bird in Baja California, near the southern limit of the species' distribution, will help determine the most effective conservation measures for protecting this rare species.

Historical records of California black rail in the Bahía de San Quintín area were compiled by [18], and [21] recorded one individual at San Telmo and another at El Rosario, Baja California. Additional observations were reported by [15,22]. Given the rarity of this bird and the lack of information on its status and distribution in Baja California, we: (1) compiled and summarized all records for the California black rail in Baja California, and (2) conducted standardized call-broadcast surveys in potentially suitable wetlands to characterize occurrence patterns, detection frequencies, and detectability to better document current status and distribution in northwestern Baja California, México. We focused surveys within three wetland regions in northwestern México (Figure 1): the Baja California portion of the Colorado River Delta (Humedales del Río Colorado), Estero de Punta Banda, and Bahía de San Quintín.

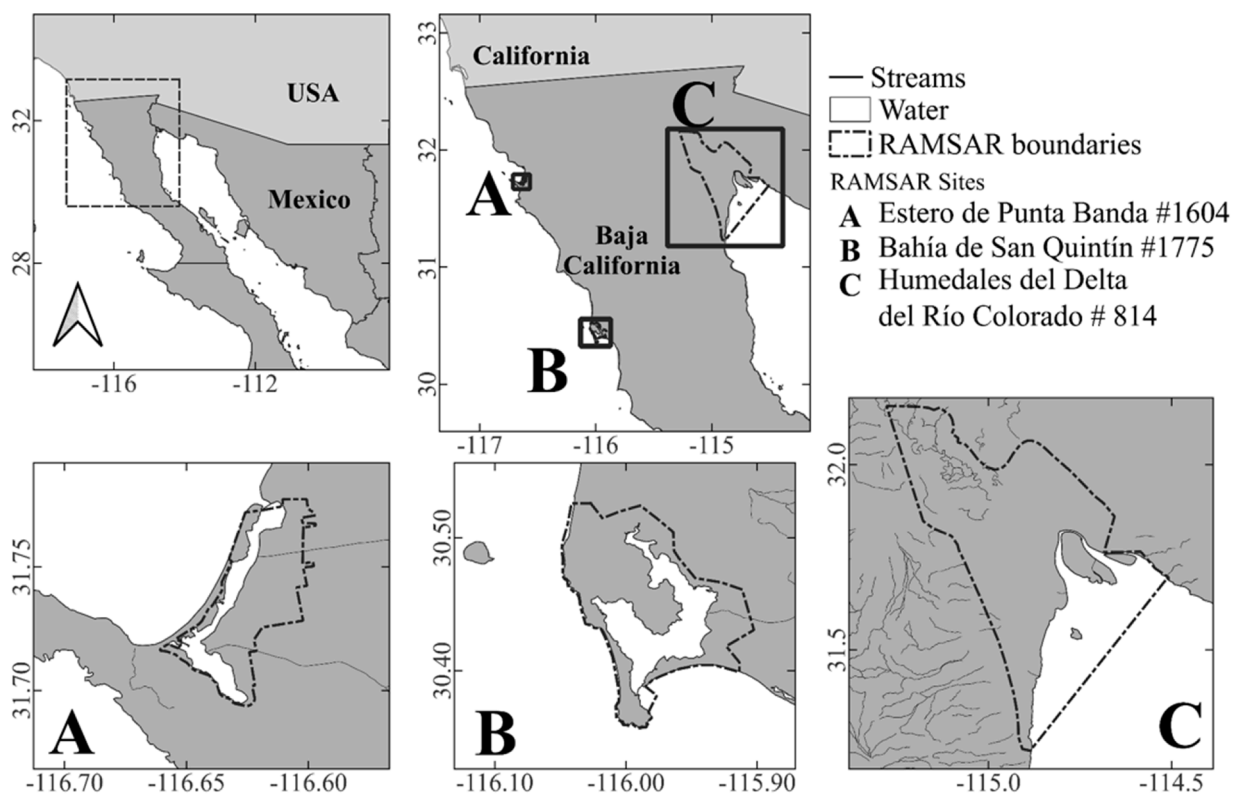


Figure 1. Location of the three study areas in northwestern México and their Ramsar site numbers: (A) Estero de Punta Banda #1604; (B) Bahía de San Quintín #1775; (C) Humedales del Delta del Río Colorado #814.

2. Materials and Methods

2.1. Historical Records

To compile and summarize records of California black rail in Baja California, we conducted a comprehensive literature review spanning both published and unpublished sources. Our review included early 20th-century ornithological reports and historical field notes, as well as more recent studies from the Museum of Vertebrate Zoology, USGS Alaska Science Center, and North American Birds. Key references [16–18,23] provided context and validated our findings. We accessed museum and archival records, including specimen data from expeditions led by [24–26], and cross-validated these records against published catalogues and monographs. We expanded our dataset by incorporating contemporary observations from the citizen science platform eBird [15], filtering records based on observer, geographic accuracy, and data reliability. All records were summarized by locality, year, source type, and detection method to describe the historical distribution of the species in

Baja California. A record is data obtained from museums, literature, unpublished sources, or citizen science. A detection occurs when a rail is seen or heard during a formal survey. Repeated sightings do not equate to distinct individuals, and non-quantitative data only confirm that the species was present, without indicating its number.

2.2. Study Areas

The Colorado River Delta is Ramsar site No. 814 [27], located on the western coast of Sonora and the northeast coast of Baja California, México (250,000 ha, 31°49' N 114°58' W). The site is integrated into the Pacific Coast Shorebird Conservation Strategy (Site No. 87) and endorsed by the Western Hemisphere Shorebird Reserve Network [28]. This area includes most of the habitat for the Yuma Ridgway's rail (*Rallus obsoletus yumanensis*) [11,20,29,30], featuring riparian zones maintained by flooding, lagoons, and mudflats influenced by the Gulf of California tides, and marshes fed by run-off and springs. Dominant vegetation includes southern cattail (*Typha domingensis*), Palmer's saltgrass (*Distichlis palmeri*), the native Fremont cottonwood (*Populus fremontii*)—Goodding's willow (*Salix gooddingii*) association, and introduced salt cedar (*Tamarix ramosissima*).

Estero de Punta Banda (EPB) is in the municipality of Ensenada, Baja California, México (2393 ha, 31°44' N, 116°37' W; Figure 1) and is Ramsar site No. 1604 [31], but it lacks federal, state, or municipal government conservation protection. EPB includes tidal channels, mudflats, and pools that bisect the tidal marsh vegetation. These marshes cover 326 ha [31] and receive freshwater from winter rains (200 to 400 mm annually [12,13]). Rainfall drains into two hydrological basins, the San Carlos and Las Ánimas Streams, supporting seasonal riparian vegetation and rail habitat [32]. EPB is undergoing development pressures through urbanization and agriculture in adjacent upland areas that could threaten its persistence and biological integrity [31]. The Antonio Perisky Private Reserve protects over 70 ha.

Bahía de San Quintín (BSQ) is 200 km south of Estero de Punta Banda in the Municipality of San Quintín, Baja California, México (24,622 ha; 30°25'34" N, 115°59'4" W; Figure 1B), and is Ramsar site No. 1775 [33]. The area is used for oyster farming [34–36], and the coastal lagoon is divided into two subunits: Bahía de San Quintín and Bahía Falsa. The lagoon has mudflats exposed during low tides, 805 ha of salt marsh vegetation, and tide-driven seawater input. The lagoon is protected to the west and south by sandbars and receives freshwater via winter rain (200 to 500 mm annually [37]). The state of Baja California manages a 201-ha upland reserve in BSQ. Two private conservation areas established by Terra Peninsular and a private landowner protect the marsh from development.

The dominant plants at EPB and BSQ are pickleweed (*Salicornia pacifica* and *S. bigelovii*) and California cordgrass (*Spartina foliosa*) [38]. The higher areas within the coastal lagoon are characterized by Parish's glasswort (*Arthrocnemum subterminale*).

2.3. Surveys

Survey sites were randomly selected within suitable habitat for general marsh bird surveys and California black rail surveys at BSQ and EPB; sites were selected based on confirmed presence or potentially suitable habitat.

Hinojosa et al. [19] performed comprehensive surveys in the Baja California portion of the Colorado River Delta, between 2000 and 2022, to ascertain the presence of the California black rail and other marsh birds. The surveys were conducted during the species' presumed breeding season, using methods based on [39], and incorporating regional methodologies [19]. At each survey station, observers recorded all waterbird species detected within a 200 m radius. Pre-recorded vocalizations for the target species were played sequentially. To capture peak vocal activity, surveys were performed during optimal

time windows, starting at sunrise and continuing until no later than 10:30 a.m. Transects and mini-route locations were selected non-randomly to maximize coverage of the various zones and wetland environments across the delta. The route's design was determined by habitat suitability, focusing on areas with marsh vegetation, salt cedar, native riparian plants, and surface water. Fifteen transects comprising 305 survey points were established across multiple areas in the Baja California portion of the Colorado River Delta: Río Hardy, Laguna del Indio, Andrade Mesa Wetlands, Colorado River, and Las Arenitas wetland. The survey points were separated by a minimum distance of 200 m to ensure independent waterbird detections (black rail calls are seldom audible beyond 150 m [39–42]). Transects were strategically located along the ecotones between marsh and upland or between marsh and open water.

We conducted standardized surveys in April 2003 following [39], using randomized survey points in BSQ and the lower parts of Arroyo San Telmo and Arroyo El Rosario, near the coast, to detect California black rails. Arroyos San Telmo and El Rosario originate in the Sierra de San Pedro Mártir and are riparian wetlands with historical black rail records, especially Arroyo San Telmo [25].

In 2022, we conducted call-broadcast surveys for the California black rail at EPB and BSQ during their presumed breeding season, March to August. A survey was defined as a single visit to a set of sampling points grouped together in survey routes within a site, and methods followed the standardized North American Marsh Bird survey protocols of [39,40]. In 2022, we used a multi-species call-broadcast sequence that included calls for California black rail, Virginia rail (*Rallus limicola*), and light-footed Ridgway's rail (*Rallus obsoletus levipes*). We conducted surveys during both morning (0.5 h before sunrise to 1 h after sunrise) and evening (1 h before sunset to 0.5 h after sunset) survey windows, as per [40]. Our surveys included 24 survey routes with 112 survey points, with ≥ 200 m between points and 300 m between routes. During May, June, and July 2023–2025, we conducted additional surveys at EPB and BSQ in areas where we had detected California black rail on the initial surveys, or where we found the suitable habitat described by [2,10]. For security reasons, all surveys conducted during 2023–2025 were restricted to the morning survey window. Based on suitable habitat continuity at each location, we established a combination of survey routes and points along each route, as described in [41,42]. We established one survey route with three survey points at EPB and one survey route with six survey points at BSQ. All survey points were along the vegetated marsh uplands or edges at the upper reaches of the high-tide water line in areas with suitable habitat that might contain California black rail. We do not show maps of our survey routes to protect both fragile habitats and endangered species from unnecessary visits. Surveys were only performed when conditions provided the best conditions for the highest detection probability for rails: no rain and wind speeds ≤ 25 km/h [39–43]. At each survey point, we conducted a 6-min point-count survey consisting of a 3-min passive period followed by a 3-min call-broadcast period. All surveys were conducted during low tides, with a mean air temperature of 17 °C (range: 15–22 °C). During each survey, all California black rails heard or seen were recorded, noting the direction, type of call response, and distance from the surveyor; a Forestry Pro II rangefinder (Nikon, Tokyo, Japan) with an accuracy of 0.3 m was used to estimate the distance to each rail detected. Additionally, we recorded birds that we detected while moving between survey points, but if a bird was suspected of having been previously recorded at an earlier point, only its initial detection was included to avoid duplicate records.

For the 2023–2025 surveys, we used a call-broadcast sequence that only included California black rail calls. A complete survey sequence comprised:

3 min of silence,

45 s of California black rail calls:

3 s of black rail *kicky-doo* calls
 5 s of silence
 6 s of black rail *kicky-doo* calls
 5 s of silence
 4 s of black rail *grrr* calls
 10 s of silence
 12 s of black rail *Ink-ink-ink-ink* and growl calls
 45 s of silence
 45 s of California black rail calls (same as above)
 45 s of silence

The playback calls were obtained from the recordings of [40,44]; the sound transcriptions were taken from [2,16]. We used an MP3 file to broadcast calls at a volume of 89 dB at 1 m from the speaker [39], using a wireless speaker (VOBCOM IPX7 Waterproof 40 W Bluetooth 5.0 model, Houl Zalee, Meidi Electronics Inc., Shenzhen, China), linked to a mobile phone (Apple iPhone 11, Apple Inc., Cupertino, CA, USA). Vocalizations and video/photo documentation were obtained during surveys in the field using GoPro 10 and GoPro 13 cameras (GoPro, San Mateo, CA, USA). Spectrograms were generated using SoX version 14.4.2 (Sound eXchange; The SoX Team, 2015; <https://sourceforge.net/projects/sox/>, accessed on 23 June 2026) with the default spectrogram settings (Kaiser window, 512-point FFT). Spectrograms displayed frequencies from 0 to 11 kHz and amplitudes ranging from +3 to −97 dBFS. Temporal scales varied according to the vocalization shown, ranging from 0–7 s to 0–14 s.

2.4. Distance Sampling and Estimates

Descriptive statistical analyses were then performed to quantify temporal and spatial patterns across decades, including the detection frequency and the methods used. Annual detection metrics were summarized by site and year. For each site–year combination, we recorded the total number of detections, the number of survey points, and the number of visits per point. Detections per point were calculated as total detections divided by the number of survey points surveyed, whereas detections per point-visit were calculated as total detections divided by the product of survey points and visits. Detection metrics were treated as indices of detection frequency rather than an estimate of abundance, because repeated detections of a single individual across visits cannot be ruled out. All detection events were tallied through the end of the playback period.

Detection models within Distance software version 8.0 were selected primarily based on biological plausibility, parameter stability, and coefficient of variation while considering Akaike's information criterion (AIC), with the retained model selected for each site–year combination [2,45].

Detection functions were fitted using conventional distance sampling (CDS) with right truncation at 80 m. Reported parameters include: number of detections (N), model, Akaike's information criterion (AIC), effective detection radius (EDR), average detection probability within the truncation distance (p), density estimate (D), associated 95% confidence intervals, and coefficient of variation (CV). Parameter constraints were applied to ensure monotonic detection functions due to small N. When candidate models had similar support, biological plausibility, parameter stability, and coefficient of variation were also considered in model selection. Goodness-of-fit was evaluated using the chi-square and Kolmogorov–Smirnov tests provided by Distance Software. Kolmogorov–Smirnov tests were included because analyses were based on exact distances, whereas chi-square results

were affected by the distance intervals and pooling applied by the program. Goodness-of-fit statistics are presented in Table S1.

3. Results

3.1. Records

We compiled 35 documented historical records and survey detections between 1905 and 2025 (120 years), with a minimum reported count of 56 California black rails (Tables 1 and 2). The species was rare throughout this study period in Baja California. Both type of accounts reveal prolonged periods of scarcity followed by an increase in reported detection events after 2000. Bird presence accounts were distributed unevenly through time. Only eight historical records were documented between 1905 and 1999, whereas 27 detection events (77.1% of all compiled accounts) were documented since 2000.

Table 1. Summary of historical records and survey accounts of the California black rail in Baja California and the Colorado River Delta. Detection type: HO = Heard Only, OI = Overheard Incidentally, P = Pair, S = Sighting, SC = Specimen Collected, SI = Single Individual, UP = Unquantified Presence.

Authors, Date	Detection	Location	References
Nelson & Goldman, 31 August 1905	1 SC	Bahía de San Quintín, San Simón River	[16,23,24]
Museum of Vertebrate Zoology, 3 & 6 April 1925	2 SC	San Telmo	[16,23]
Huey, 6 June 1925	1 SC	San Ramón	[16,25]
Bent, December 1926	1 HO	Bahía de San Quintín	[23,46]
Huey, June 1927	1 HO	Sangre de Cristo	[16,25,26]
Jensen, 11 April 1979	1 S	Bahía de San Quintín, Punta Mazo	[15]
Hamilton & Erickson, April 1991	1 HO	Bahía de San Quintín, Punta Azufre	[18]
Tibbits et al., December 1998	1 S	Bahía de San Quintín, Punta Azufre	[47]
Anderson & Bautista, April 2000	UP	Bahía de San Quintín, Punta Azufre	[47]
San Miguel, 18 July 2001	1 HO	San Telmo	[15]
San Miguel, 19 July 2001	5 HO	San Telmo	[15]
Hinojosa et al., 25 & 30 May 2001	2 HO	Laguna del Indio & El Mayor	[19,48]
Ruiz et al., February–December 2002	UP	San Telmo	[21]
Ruiz et al., February–December 2002	UP	El Rosario	[21]
USGS Alaska Science Center, 1 March 2002	UP	Bahía de San Quintín, Punta Mazo	[47]
Erickson & Hamilton, 21 April 2002	2 HO	Lower San Telmo	[49]
Erickson & Hamilton, 21 April 2002	1 P + 1 SI HO	Bahía de San Quintín, Punta Azufre	[49]
Palacios & Hinojosa, 21–23 April 2002	4 HO	Bahía de San Quintín	[49]
Hamilton et al., 21 April 2002	1 HO	Lower San Telmo	[49]
Palacios & Hinojosa, 22 April 2002	1 HO	Lower Río El Rosario	[49]
Patten, 4–5 May 2002	1 HO	San Telmo	[49]
Erickson et al., 31 May 2002	1 HO	Lower San Telmo	[15]
Iliff, 12 July 2003	1 HO + 1 OI	Lower San Telmo	[15]
USGS Alaska Science Center, February 2005	UP	Bahía de San Quintín, Punta Azufre	[47]

Table 1. *Cont.*

Authors, Date	Detection	Location	References
Eldemire, 18 February 2005	1 HO	Bahía de San Quintín, Chapala	[15]
Eldemire, 25 February 2005	1 S	Bahía de San Quintín, Punta Azufre	[15]
Zamora, 6 April 2007	2 HO	Bahía de San Quintín, Casona Vieja	[15]
González Bernal, March–April 2008	8 HO	Bahía de San Quintín	[50]
Vargas & Andrade, 2–3 June 2017	3 HO	Bahía de San Quintín, Chapala	[15]
Hoffman et al., 7–8 February 2024	1 S	Bahía de San Quintín, Chapala	[15]
Trinchan Guerra & Montejó, 21 February 2024	1 S	Bahía de San Quintín, Chapala	[15]
McAndrews & Montejó, 15 July 2024	1 HO	Bahía de San Quintín, Estero NW	[15]
Mena Páramo & Hernández Álvarez, 16 November 2025	1 HO	Bahía de San Quintín	[15]
Rademaker & Rademaker, 20 November 2025	3 S	Bahía de San Quintín, Cielito Lindo	[15]
Kahle et al., 5 December 2025	2 HO	Bahía de San Quintín	[15]

Table 2. California black rail detections registered during systematic surveys in the Baja California portion of the Colorado River Delta, México, 2000–2022.

Site	Survey Points	Date	Number of Black Rails
Hardy River	168	22 March 2000	1
Laguna del Indio	11	23 March 2000	1
Andrade Mesa Wetlands	6	20 March 2004	2
		25 March 2009	5
		22 May 2009	2
Colorado River	106	9 March 2010	1
		10 March 2010	6
		16 April 2017	1
Las Arenitas Wetlands	14	1 March 2022	1
Total	305		20

Table 1 shows the California black rail historical records and survey accounts in Baja California. Heard-only detections represented the most common category in recent detection events, whereas specimen historical records predominated in the early twentieth century.

San Telmo and Sangre de Cristo are inland locations with riparian vegetation, while San Ramón is a coastal location. Wilbur [17] reported that no suitable black rail habitat existed at San Telmo, but the species has been detected there repeatedly in recent years [15]. BSQ accounted for most of the historical records.

Additional detections in the Colorado River Delta and the lower Río El Rosario document occurrences at geographically separated localities across the region.

3.2. Field Surveys

Between 2000 and 2022, surveys were conducted at 305 points in the Baja California portion of the Colorado River Delta yielded 20 California black rail survey detections

across nine survey events (Table 2). The available surveys yielded the highest numbers of California black rail detections at Andrade Mesa and along the Colorado River.

In April 2003, we detected 12 California black rails across three sites: seven birds in BSQ, three in Arroyo San Telmo, and two in Arroyo El Rosario. Surveys conducted in 2022 produced no detections in the morning or evening sampling periods, despite extensive coverage of 24 routes and 112 survey points. In contrast to the 2022 surveys, we detected California black rails at both study sites in 2023; detection records varied by year and site (Table 3). A photograph taken at EPB on 27 May 2023 (Figure 2) is the first photographic record of California black rail in México. *Kicky-doo* and *grrr* vocalizations [2,16] from both sites, along with corresponding spectrograms, are included as Supplementary Materials (Audios S1 and S2; Figures S1 and S2) and constitute the first acoustic record of the subspecies in México.

Table 3. Annual survey detection indices for California black rail for Estero de Punta Banda (EPB) and Bahía de San Quintín (BSQ). Baja California, México, between 2023 and 2025.

Site	Year	Points Surveyed	Visits per Point	Detections	Detections per Point	Detections per Point-Visit
EPB	2023	3	3	41	13.67	4.56
	2024	3	3	19	6.33	2.11
	2025	3	3	9	3.00	1
BSQ	2023	6	3	63	10.50	3.50
	2024	6	3	65	10.83	3.61
	2025	6	3	67	11.17	3.72

Note: Detection rates are presented as indices of detection frequency and do not represent the number of unique individuals, as repeated detections across visits cannot be ruled out.



Figure 2. California black rail (*Laterallus jamaicensis coturniculus*) photographed at Estero de Punta Banda, Baja California, 27 May 2023, by Hiram Moreno and Héctor Sánchez.

Monthly detection surveys by year are shown in Table 4. EPB showed a marked decline in detection frequency, whereas BSQ had higher and more consistent detection frequencies. Annual detection indices diverged sharply between the two sites (Table 3): detection records at EPB declined by roughly 78% between 2023 and 2025, while BSQ sustained consistent numbers throughout the three years. By 2025, BSQ detections were more than sevenfold those recorded at EPB. These patterns represent differences in detection frequency and should not be interpreted as population trajectories or abundance trends.

Table 4. California black rail (*Laterallus jamaicensis coturniculus*) survey detections by month and year totals for Estero de Punta Banda (EPB) and Bahía de San Quintín (BSQ), Baja California, México, during the 2023–2025 breeding seasons. Monthly values represent the total number of detection records obtained during each survey. Highest detections per month are in bold numbers. Annual totals are the sum of all detection records across the three survey visits.

Site	Year	May	June	July	Annual Total
EPB	2023	15	13	13	41
	2024	6	6	7	19
	2025	2	5	2	9
BSQ	2023	12	20	31	63
	2024	15	19	31	65
	2025	18	22	27	67

3.3. Distance Sampling and Estimates

Sample sizes for distance sampling analyses ranged from 9 (EPB, 2025) to 67 detections (BSQ, 2025). Half-normal, hazard-rate, and uniform models were evaluated; retained models are shown in Table 5. In EPB 2025, the uniform model produced a degenerate solution and was excluded from biological interpretation.

Table 5. Detection parameters and distance sampling model selection for California black rail surveys at Estero de Punta Banda (EPB) and Bahía de San Quintín (BSQ), 2023–2025. Half-Normal + cosine = HN + C, Hazard Rate + cosine = HR + C, Uniform + cosine = U + C, Akaike Information Criterion = AIC, Effective Detection Radius = EDR, Confidence Interval = CI, Coefficient of Variation = CV, Detection Probability = DP. Selected model and AIC in bold. Monotonicity constrained = *, N = Total number of detection events within each site–year combination.

Site	Year	N	Model	AIC	EDR (m)	EDR 95% CI	Detection Probability (p)	p 95% CI	CV (p)	Density (ind./ha)	D 95% CI
EPB	2023	41	HN + C	319.42	35.86	30.55–42.10	0.20	0.15–0.28	0.16	11.76	7.22–19.16
			HR + C	320.45	35.97	27.47–47.09	0.20	0.12–0.34	0.27	11.69	6.21–22.01
			U + C	321.65	35.94	30.55–42.28	0.20	0.15–0.28	0.16	11.71	7.17–19.12
	2024	19	HN + C	156.79	50.77	37.86–68.08	0.40	0.23–0.72	0.28	2.47	1.28–4.75
			HR + C	158.15	46.49	23.12–93.47	0.34	0.09–1.00	0.68	2.95	0.78–11.07
			U + C	156.54	50.66	40.53–63.32	0.40	0.26–0.62	0.21	2.48	1.44–4.28
	2025	9	HN + C	75.95	74.97	32.6–172.42	0.88	0.19–1.00	0.75	0.73	0.16–3.39
			HR + C	76.99	73.36	55.41–97.12	0.84	0.48–1.00	0.24	0.76	0.42–1.38
			U + C	74.01	80.00	80.00–80.00	1.00	1.00–1.00	0.00	0.64	0.45–0.91
BSQ	2023	63	HN + C	513.74	24.08	21.21–27.33	0.09	0.07–0.12	0.13	18.92	10.87–32.93
			HR + C	509.15	23.59	18.18–30.60	0.09	0.05–0.15	0.26	19.71	9.84–39.49
			U + C *	512.36	20.30	17.18–23.99	0.06	0.05–0.09	0.17	26.60	14.77–47.90
	2024	65	HN + C	542.70	24.44	19.94–29.97	0.10	0.06–0.14	0.20	19.24	10.39–35.62
			HR + C	543.67	28.09	21.66–36.42	0.12	0.07–0.21	0.26	14.57	7.35–28.91
			U + C	544.97	25.82	21.21–31.44	0.10	0.07–0.15	0.20	17.24	9.39–31.67
	2025	67	HN + C	547.77	28.44	23.85–33.91	0.13	0.09–0.18	0.18	14.21	9.39–21.51
			HR + C	545.21	29.81	23.08–38.51	0.14	0.08–0.23	0.26	12.94	7.46–22.42
			U + C	547.90	30.5	25.96–35.83	0.15	0.11–0.20	0.16	12.36	8.36–18.26

Detection parameters differed between sites, and detection distances ranged between 2 and 150 m; most birds were detected within 50 m (Table 5). At EPB, estimated detection probability increased from 0.20 in 2023 to 0.40 in 2024 and 0.88 in 2025, while the effective detection radius increased from 35.9 m to 50.8 m and 75.0 m, respectively. However, coefficients of variation also rose sharply as the sample size fell, reaching 0.75 in 2025. These results should be interpreted cautiously, are unsuitable for strong biological inference, and should not be considered evidence of biological changes in detectability. At BSQ, detection probability ranged from 0.09 to 0.14, effective detection radius ranged from 23.6 to 29.8 m, and CV ranged from 0.20 to 0.26. Density estimates varied markedly between sites (Table 5).

Goodness-of-fit diagnostics for all candidate detection-function models are presented in Table S1. Kolmogorov–Smirnov tests did not indicate significant lack of fit for any model, although some chi-square tests produced significant or near-significant results and were sensitive to the distance intervals and pooling procedure (Table S1).

4. Discussion

California black rails are rare throughout their range, with intermittent records in northwestern México. Published data from historical records and standardized surveys are also scant. Our study provides the most comprehensive synthesis to date of historical records and standardized surveys of California black rails in México and documents several wetlands used by this rare bird in northwestern México. Our surveys confirm the presence of this subspecies at multiple key sites, including EPB, BSQ, and various locations within the Colorado River Delta, with concentrations of detections occurring in an arid landscape with limited freshwater marshes. Our results highlight the value of periodic, systematic, and the intensive monitoring of rare species, as well as the utility of citizen science platforms, e.g., eBird, to complement formal surveys and generate suitable data [51,52]. Together, these data sources provide the most comprehensive summary of the current status and distribution of a rail subspecies.

All previous historical records of California black rail in México consisted of physical specimens, heard-only detections, or unverified sightings (Table 1). The photographic and acoustic records obtained in 2023 therefore represent a first in the documentation of this subspecies in the country, nearly a century since the last specimen was collected in Baja California in 1925 [16,25]. Some published records claiming to be of California black rails in BSQ are likely to be light-footed Ridgway's rail chicks (*Rallus obsoletus levipes*), as the latter are small and black. The confusion between Ridgway's rail chicks and the 'sighting' descriptions at Bahía de San Quintín in eBird is most likely the result of the misidentification of a quickly moving bird in an impenetrable environment; caution should be taken when quoting unverified records. For eBird and unpublished records from the last 10 years, we included only records from academics, academic institutions, or experienced birders. Over more than a century, historical records and detection events of the California black rail in Baja California have varied noticeably. In the early decades of the 20th century, sightings were few and sporadic, reflecting both the species' rarity and the limited monitoring effort. However, the notable surge in detections since 2000 correlates with enhanced survey methods and the growing contribution of citizen science, rather than a documented increase in population size.

The presence and patchiness of California black rail habitat across multiple sites within the Colorado River Delta from 2000 to 2022 highlight the importance of maintaining wetland connectivity and habitat availability to support this elusive species; the fluctuating detection rates across years and sites may reflect variation in wetland conditions, survey effort, and the species' inherent rarity in the Colorado River Delta region. Our 2003 records show the need to continue comprehensive and systematic survey efforts at recognized historical sites and new potential locations.

We documented California black rails at EPB, a wetland with no prior records. We detected several rails in proximity, and believe that at least one pair was present during our first survey at BSQ. The *ink-ink-ink* call, which we heard, is given by females at nests [2], suggesting a possible pair with a nest; however, the breeding activity or nest was not confirmed. The California black rails detected at BSQ were on ZOFEMAT lands managed by Terra Peninsular for conservation. This area of ZOFEMAT land is a federally owned land strip along the coast reaching 20 m above the high tide line. Continued presence at BSQ was further confirmed by audiovisual documentation obtained in 2026 (Supplementary Video S1

taken by Hiram Moreno and Héctor Sánchez). This record was not included in quantitative analyses. Additional surveys and focused research on California black rails at these sites in Baja California would help explain their presence and habitat associations, characterize population trends, and identify the most important threats to their conservation.

The California black rail has strict habitat requirements [2,42,43]; we carried out our surveys at sites with known or potentially suitable habitat. We failed to detect California black rails in 2022 but detected several rails in 2023. Six possible explanations for these results include the following. (1) We conducted our 2022 surveys in wetlands where California black rails may have been absent or were not detected; subsequent surveys focused on more suitable rail habitat and documented their presence. (2) Annual variation in occupancy and habitat suitability could be associated with variation in rainfall periodicity, flooding, food, and other habitat conditions. (3) Annual variation in breeding phenology: rails might stop responding to call broadcast once a pair has been established, or if predators are present [43]. (4) Annual variation in microsite use: rails could move locally in response to food, tides, and other habitat conditions [53–56]. (5) Surveyor skill, training, and experience likely varies. (6) The protocol used in 2022 was the [40] multi-species protocol, whereas the protocol used in 2023 was a California black rail-only protocol. California black rails might take longer to respond and hence go undetected when other, larger species' calls are broadcast [55]. The potential inhibitory effect of call playback from other species inherent to the multi-species protocol was not evaluated, and should be further investigated. Because of low and highly variable detection probability, as many as 15 replicate surveys are needed to attain an overall detection probability >90% for California black rails [41].

Estimated detection probabilities differed markedly between sites, with values at EPB increasing from 0.20 in 2023 to 0.88 in 2025, while BSQ remained consistently low (0.09–0.14) across the same time frame. However, the high detection probabilities estimated at EPB in later years coincided with the smallest sample sizes and unstable parameter estimates, suggesting that these values reflect parameter instability rather than genuine differences in detectability and do not represent a decline in abundance. The low and relatively stable detection probabilities estimated for BSQ were based on larger sample sizes and more stable detection functions. However, site-specific differences in detectability should be interpreted cautiously because many other factors known to influence detection were not explicitly evaluated. Although detection probability was evaluated using distance sampling methods, detection indices were not adjusted using estimated detection functions due to limited sample sizes for some years and the exploratory nature of the analysis. Consequently, comparisons among site-years should be interpreted as relative measures of detection frequency.

The implementation of standardized annual California black rail monitoring during the breeding season surveys with repeated surveys at established points to account for imperfect detectability would help provide more precise estimates of abundance and population trends, distribution, and conservation status for this species. Other important areas for marsh birds in northwestern México include the Ciénega de Santa Clara (Ramsar site 814, [27]) in Sonora. Ciénega de Santa Clara is known for its diversity and abundance of marsh birds; this wetland has been identified as one of the most important wetlands for marsh birds in the Lower Colorado River Delta and northwestern México [19,20,57,58]. The California black rail is more abundant in the adjacent El Doctor wetland than in Ciénega de Santa Clara, and both sites have limited amounts of optimal habitat for the California black rail [11]. Economic, recreational, and tourism activities are threats to the already-limited habitat for the rails in these two wetlands, as well as disturbances caused by 4 × 4 vehicle traffic and a lack of environmental awareness by the local community [58,59].

California black rails are also rare and geographically fragmented in the United States, including San Francisco Bay and isolated inland populations [9,42,60]. The dispersed records in northwestern México are consistent with this broader pattern, although current evidence is insufficient to classify the Mexican sites as core populations, refugia, or connectivity elements.

California black rails have been detected breeding in freshwater wetlands associated with riparian foothill vegetation [2,15,41,59–63]. In Baja California, rails have been observed in Sangre de Cristo and the San Telmo and San Ramón arroyos, far from coastal wetlands. The presence of water at these two arroyos and at other inland freshwater wetlands depends on the winter pluvial events associated with the Mediterranean climate of northwestern Baja California [32]. Water presence at the arroyos is reduced by over-exploitation for agricultural use, resulting in a dramatic and continuous alteration of surface waters that are being restricted to isolated ponds [64]. The occurrence of California black rails in inland arroyos suggests that these freshwater habitats may function as intermittent habitat or potential movement corridors between foothills and coastal wetlands. This possibility could contribute to temporal variation in detections, although movement data are not available to confirm this function or explain the difference observed between 2022 and 2023. Given the documentation of California black rails at a previously unreported site and the lack of recent detections at some historically occupied sites, future research would best integrate habitat suitability models and long-term ecological data to elucidate the environmental and anthropogenic factors influencing its movements and distribution.

Conservation efforts that seek to ensure this subspecies' persistence will be most successful if actions focus on reducing habitat isolation and fragmentation, exotic species impacts, and loss of upland habitats by maintaining and formally protecting upland buffer areas adjacent to occupied marsh habitat to reduce the impacts from urbanization, vehicle traffic, and habitat fragmentation. Prospective research on California black rail populations in northwestern Baja California, including known and potential upland and inland habitats, will be needed to determine whether the observed variation reflects actual population fluctuations and to identify factors driving these patterns. Future research could include the integration of GPS tracking to assess habitat use throughout all seasons, expanding the work of [65], who used VHF tags to estimate mean home-range size (0.59 ha), mean core-area size (0.14 ha), and behavioral differences between sexes of California black rails in the San Francisco Bay area.

5. Conclusions

Despite federal legal regulations in México to protect the California black rail [6,7], no strategic national or binational plan guides recovery efforts or management actions. A plan and conservation instruments in addition to conventional protected-area designations including land-management agreements, conservation easements, and other site-specific legal mechanisms to strengthen coordination among federal, state, municipal, academic, conservation, landowner, and community stakeholders must be implemented. A major finding of this study was the documentation of California black rails at EPB, a wetland where the species had not previously been reported despite decades of ornithological research there. BSQ and EPB have adjacent uplands with risks of future urban development. In both BSQ and EPB, the marshes are ZOFEMAT lands, with no enforceable rules. The conservation stakeholders should develop enforceable management provisions for ZOFEMAT areas supporting black rails, particularly restrictions on vehicle access, habitat alteration, and activities affecting marsh hydrology. Both areas would benefit from becoming State or National natural protected areas because this status would provide enforceable conservation policies. The development and agricultural threats are not unique to BSQ and EPB

marshes. However, the Colorado River Delta is a Federal Protected Natural Area, offering more restrictions on anthropogenic changes to the wetlands [66]. Marshes provide some of the most valuable ecosystem services, more so than many other natural ecosystems [67]. A protection plan in Baja California, involving local groups and agencies from México and the U.S., could improve conditions for endangered species like the California black rail; a broad education program on marsh and marsh bird monitoring will improve California black rail conservation; conserving wetland environments is crucial for maintaining populations of rails and other wetland species [68]. There is a need to maintain freshwater inputs and hydrological conditions in wetlands and associated arroyos affected by agricultural extraction. Adaptations to climate variation that address hydrological and sedimentation dynamics to keep marsh areas intact and above mean sea level will most likely help this rare bird persist. Our review indicated that habitat loss and human disturbance are the primary threats to key remaining California black rail sites, and efforts to restrict further development and vehicular activity at these sites would benefit the conservation of this imperiled bird.

Although the use of citizen science data has become more common, these data should be used cautiously, as not all records can be validated by experts, and photographic or acoustic evidence may not be available to corroborate a sighting. This is especially true of cryptic species like the California black rail and Ridgway's rail in the area.

Supplementary Materials: The following supporting information can be downloaded at: <https://www.mdpi.com/article/10.3390/birds7030051/s1>, Audio S1: *grrr* audio; Audio S2: *kicky-doo* audio; Table S1: Goodness-of-fit statistics for the detection-function models in Table 5. Figure S1: Spectrogram of the “*grrr*” vocalization; Figure S2: Spectrogram of the “*kicky-doo*” vocalization; Video S1: Audiovisual documentation of a California black rail at Bahía de San Quintín in 2026.

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Abbreviations

The following abbreviations are used in this manuscript:

BSQ	Bahía de San Quintín
EPB	Estero de Punta Banda
ZOFEMAT	Zona Federal Marítimo Terrestre

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