



Inventory of Eastern Black Rail (*Laterallus jamaicensis*) to Inform Padre Island National Seashore Prescribed Fire Management



Cover photo: Padre Island National Seashore young Eastern Black Rail.

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Inventory of eastern black rail (*Laterallus jamaicensis*) to inform Padre Island National Seashore prescribed fire management

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Christopher J. Butler ¹, Tabitha W. Olsen ^{1, 2}

¹ Department of Biology
Texas A&M University
3258 TAMU
College Station, TX 77843

² Department of Ecology and Evolutionary Biology
Texas A&M University
3258 TAMU
College Station, TX 77843

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Abstract

The Eastern Black Rail (*Laterallus jamaicensis jamaicensis*) is an elusive, federally threatened marsh bird with declining populations, making effective monitoring and habitat management critical. This study investigated Black Rail occupancy and habitat characteristics at Padre Island National Seashore (PAIS) using a combination of call-playback surveys, passive acoustic monitoring, trail cameras, and vegetation sampling. Over a survey season from March to July 2024, call-playback surveys detected Black Rails at eight locations, primarily in Upper Bird Island Basin, although Eastern Black Rails were also detected at Bird Island Basin and the North Shooting Range units. Both detectability and occupancy were low, with a detection probability of only 8.8% and with only 10.6% of apparently suitable habitat occupied. Passive acoustic monitoring and trail cameras proved less effective at documenting Eastern Black Rail presence than call-playback surveys, with only one Black Rail detection via autonomous recording units (ARUs) and no detections using trail cameras. Vegetation sampling revealed that survey points were dominated by emergent vegetation, with limited coverage by shrubs, saltgrass (*Distichlis spicata*), and cordgrass (*Spartina* spp.). The above-ground biomass (AGB) of grassy and herbaceous vegetation has been positively correlated with occupancy at other sites and the relatively low AGB observed at sites on Padre Island National Seashore may help explain the limited occupancy (only 10.6% of apparently suitable habitat) observed in this study. Black Rails typically avoid areas of extensive woody vegetation, and prescribed fire can be very effective at reducing woody vegetation encroachment. Consequently, prescribed fire is likely an effective way to manage units for continued Black Rail persistence. However, adjusting the interval between burns may be required to allow AGB to increase to a higher level in order to increase occupancy.

Acknowledgements

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Introduction

Rail species throughout the world are declining due to habitat loss and alteration (Taylor 1996). In the United States, for example, many of the nine species of rails are declining due to the disappearance of wetlands (Eddleman et al. 1988). Systematic wetland conversion in the conterminous United States from the 1600s to mid-1980s accounted for the loss of 48 million ha of wetland area, or about 53% of the original total (Dahl and Allford 1996). Legal protection has stabilized the overall rate of wetland loss in the 21st century, but coastal wetland area still declined by 1.4% between 2004 and 2009 (Dahl 2011). These coastal (estuarine) wetlands are vital breeding and wintering habitat for multiple rail species.

One species that may be affected by wetland loss is the rare and elusive Black Rail (*Laterallus jamaicensis*). This species is the smallest of the North American rails and one of the most difficult to observe breeding bird species on the continent (Eddleman et al. 2020). The nominate subspecies (*L. j. jamaicensis*) occurs along the Atlantic and Gulf Coasts from Connecticut to southern Alabama with a disjunct population in southeastern Texas (Eddleman et al. 2020) and Louisiana (Johnson and Lehman 2021) although it should be noted that surveys for Black Rails along coastal Alabama failed to find any during 2004 (Soehren et al. 2009). Eastern black rails are also located in southcentral Kansas and in eastern Colorado within the Arkansas River Valley during the breeding season. The International Union for the Conservation of Nature considers Black Rails to be “Endangered” (IUCN 2024). Few baseline data exist to estimate populations of Black Rails, but qualitative observations note a drastic population decrease between the 1920s and 1970s (Eddleman et al. 2020), and remaining populations in some areas suffered annualized declines of up to 6.5% since the 1990s (Watts et al. 2021). In October 2020, the US Fish & Wildlife Service listed the Eastern Black Rail as a Threatened species (FWS-R4-ES-2018–0057).

Although Black Rails can be found during the non-breeding season along the upper and central Texas coast (Lockwood and Freeman 2004), the 1987–1992 Breeding Bird Atlas found only one probable and one possible breeding location for this species. More recently, reasonable numbers of birds have been found in Aransas NWR and the mid-Coast NWR complex (Tolliver et al. 2019, Butler et al. 2023). High-quality coastal habitat for Black Rails in Texas appears to extend from the border of Louisiana south to Nueces County (Stevens and Conway 2020), and Black Rails have been detected in Mustang Island during surveys in 2022 and 2023 (Butler, unpubl. data). Insufficient numbers of Black Rails are found during Breeding Bird Surveys to track trends, and for the period of 1966–2011, an average of only 21 Black Rails were detected on Christmas Bird Counts (Butler et al. 2023) in Texas. Due to difficulties in surveying this species, the numbers of individuals breeding in Texas is uncertain, although there are tentatively estimated to be 100–500 breeding pairs in the state (Watts 2016).

Park Resource Management Issues

Padre Island National Seashore (PAIS) conducts prescribed fire operations in the Malaquite Beach Fire Management Unit. Documenting presence/absence of Black Rail during the breeding season, or probabilities of occupancy for different habitat types during the breeding season, would enable the

park to optimize burn planning to increase benefits to habitat while avoiding negative impacts to Black Rail. The park's prescribed fire program is currently limited in the frequency and amount of acreage that can be burned due to the presence of potential Black Rail breeding habitat.

Project Goals

The goal of the project is to determine if Black Rails are present on PAIS during the breeding season. If Black Rails are present, the goal is to identify the probability of occupancy for different habitat types during the breeding season to inform the park's prescribed fire program.

Methods

Study Area

Padre Island National Seashore (hereafter, PAIS) is a barrier island located southeast of Corpus Christi, Texas within Kleberg, Willacy, and Kennedy counties. PAIS represents the longest stretch of undeveloped barrier island in North America and consists of 130,434 acres (~52,784 ha) of coastal prairie, tidal flats, and hypersaline lagoons (e.g., Laguna Madre). Of the total area, ~78,000 acres (~31,565 ha) are comprised of wetland ecotypes, including emergent wetland, algal flats, and various freshwater ponds. Annual rainfall for this region is approximately 81 cm. PAIS is open to the public, although individuals are restricted from driving or interfering with sensitive ecosystems, such as the sand dunes and various wetlands.

PAIS conducts regular management for various species of concern, including monarch butterflies (*Danaus plexippus*), Red Knot (*Calidris canutus rufa*), and Eastern Black Rail (*Laterallus jamaicensis jamaicensis*). Management on the property also includes flammable fuel reduction through the use of prescribed fire for both wildlife and to protect surrounding properties from uncontrolled high-intensity fires. Prescribed burns tend to be conducted on a 2–4 year interval based on weather conditions and site necessity.

Sampling Design

Black Rails begin pairing up and vocalizing in late winter; we have observed apparent Black Rail pairs in February (Olsen et al. 2024), and a nest of this species has been as early as 19 March in Texas (Haverland et al. 2021). Peak vocalizations for Black Rails appear to be during the second half of April and the first half of May and vocalization rates decline precipitously during June (Butler et al. 2023). Consequently, the primary field season for this research ran from 13 March through 18 July 2024 followed by vegetation and habitat measurements from 25 June–31 July.

A map of potentially suitable Black Rail habitat on the island was provided by PAIS staff that used the park's vegetation map as input and the Fish and Wildlife Service definition of Black Rail habitat (>80% cover) to delineate potential habitat. Additionally, Watts (2022) suggested that topography affects habitat suitability for Black Rails and Enwright et al. (2023) created a map of high salt marsh, illustrating fine scale microtopography. Based on 79 survey points at the Texas mid-Coast National Wildlife Refuge complex where we detected Black Rails during 2022, there is a significant moderate correlation between fine scale microtopography and the number of Black Rail detections over the course of the field season (Spearman's $\rho = 0.40$, $p = 0.0003$), with rails more likely to be detected in high salt marsh habitat.

A map of high salt marsh habitat (Enwright et al. 2023) areas of high suitability for Black Rails was overlaid on PAIS, along with the map provided by park biologists. A fishnet was created with points spaced 400 m apart to avoid recording Black Rails on more than one point. This spacing recommendation was based on a protocol created by Hand et al. (2023). The points were then clipped to the areas where suitability for Black Rails was judged to be high.

This resulted in a total of 74 points being selected (Figure 1). Points in potentially suitable habitat were identified in the following burn blocks: Upper Bird Island Basin, Bird Island Basin, Triangle, North Beach, Novillo, Headquarters, Malaquite North, Malaquite South, the North Shooting Range, and the South Shooting Range. Sites were visited at least six times over the course of the field season.

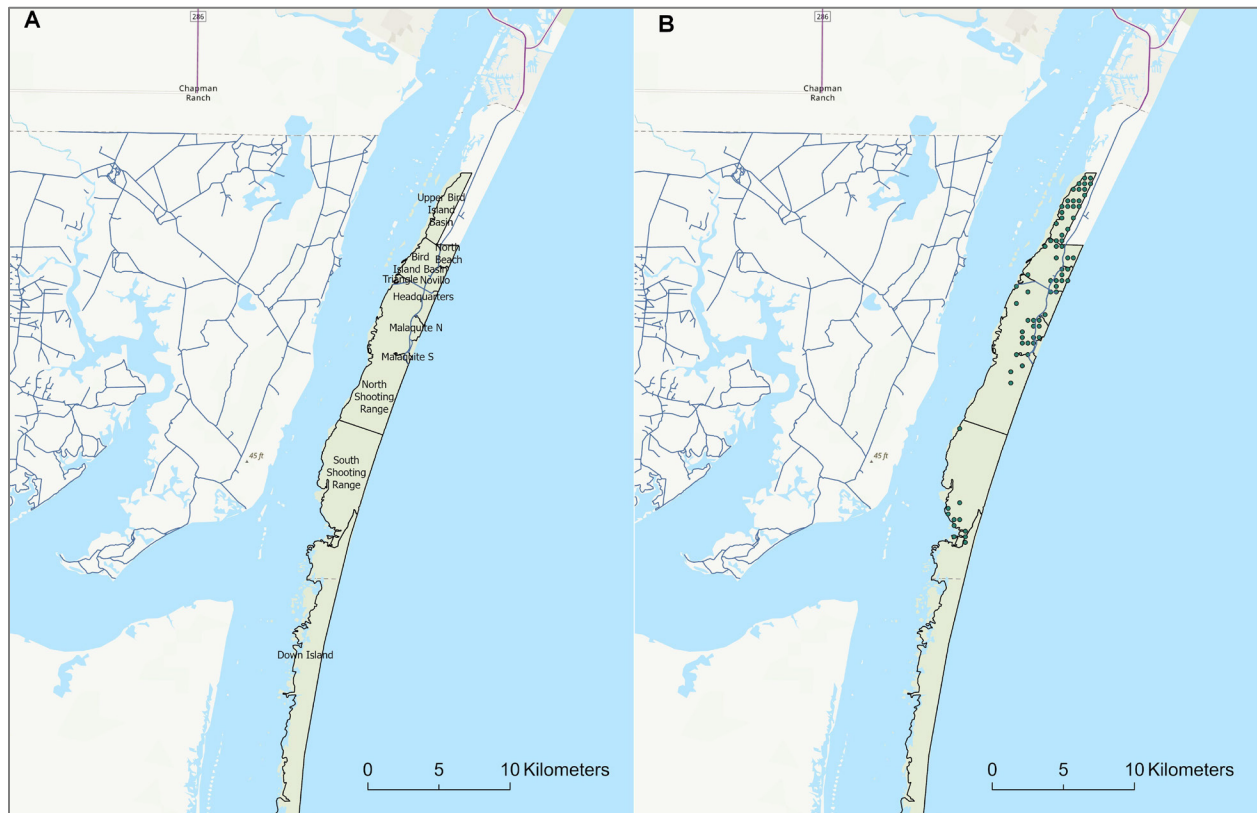


Figure 1. This map shows the fire management units (A) and the survey points (B). We surveyed a total of 74 points over the course of 2024.

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Avian Survey Methods

Call-playback

Call-playback surveys are in-field surveys utilizing a broadcast speaker uploaded with the appropriate vocalizations for the given target species and an observer trained to detect (and subsequently document) any relevant species responses to the audio elicitation. These call-playback surveys targeting Black Rail were conducted using a FoxPro Patriot (FOXPRO Inc.) with the following 10.5-minute vocalization sequence:

- 15-second preparation period
- 5-minute passive period
- 15- seconds of **Black Rail** “*Kee-kee-JERR*” (song)

- 15-seconds silence
- 15- seconds of **Black Rail** “*Kee-kee-JERR*” (song)
 - 15-seconds silence
- 15-seconds of **Black Rail** “*Churr*” and *growl* (calls)
 - 15-seconds of silence
- 15-seconds of **Black Rail** “*Churr*” and *growl* (calls)
 - 15-seconds of silence
- 15-seconds of **Black Rail** “*Churr*” and “*Kee-kee-JERR*” (song & calls)
 - 15-seconds of silence
- 15-seconds of **Black Rail** “*Churr*” and “*Kee-kee-JERR*” (song & calls)
 - 60-seconds of silence
- 15-seconds of **Clapper Rail** Grunt Series (song)
 - 15-seconds of silence (Transition)
- 15-seconds of **Clapper Rail** “*Kek-churr*” (call)
- 45-seconds of silence

End of Survey (Total time: **10.5** minutes)

We included both conspecific and heterospecific calls (e.g., Clapper Rail [*Rallus crepitans*]), as Black Rails are known to respond to other rail vocalizations and in some instances, this may increase detection probability (Conway and Nadeau 2010). Transition periods of 15-second intervals positioned between songs and calls allowed the observer to listen to potential responses. The transition between Black Rail vocalizations to Clapper Rail vocalizations was longer (60-seconds) to provide a period of rest.

Call-playback surveys followed the Hand et al. protocol (2023) and Olsen (2023), and were conducted in two blocks: 30 minutes prior to sunrise, ceasing 3 hours after sunrise (i.e., morning period); 3 hours prior to sunset, ceasing 30 minutes past sunset (i.e., evening period). Using a handheld GPS unit, surveyors would approach the center of their point and begin the survey by turning the broadcast speaker on to sound level 80dB. The speaker would be placed on the ground at a dry spot and the surveyor would stand ~2 m away from the speaker to reduce the impacts of the volume on their ability to detect any potential rails. Prior to each of the surveys or during the 5-minute passive period, surveyors were instructed to record the following data: the name of the survey point, the background noise (Decibels; RisePro Sound Level Meter), cloud cover (estimated percent), average wind speed (km/h; Kestrel 2000), temperature (°C; Kestrel 2000), and water depth (cm; handheld ruler). During the surveys, if a target rail species (Black Rail) responded, the observer would record the species’ name, if the bird was heard or visually seen, the call-type the bird

responded with, the time of the response/detection, and the bearing of the detection (degrees; handheld compass). If any birds were detected outside of the survey window (e.g., just before or after the survey start, or on their way to their survey point), there was a separate section for the surveyors to record this information. Finally, surveyors recorded the time of both the start and end of their surveys.

Call-playback surveys were not conducted during precipitation events or if constant wind speeds exceeded >15 mph (24 kph). If surveyors were not comfortable surveying due to inability to hear potential birds due to high wind conditions, even if conditions did not meet the 15 mph maximum, surveys would not be conducted. Points were rotated amongst observers for revisits to reduce observer biases at individual points. The survey season lasted from 13 March–31 May 2024.

Autonomous Recording Units (ARUs) and Trail Cameras

AudioMoth (v1.2.0) autonomous recording units (hereafter, ARUs) were placed in waterproof housing and affixed to the top of a 5-ft U-post with wire. These units were coupled with a Reconyx Hyperfire 2 Professional trail camera, affixed to a hand-made wooden mount and wired to the bottom of the U-post. See Figure 2 for an example of the complete set-up. Ten ARUs and Reconyx Hyperfire 2 cameras were used during the field season and rotated throughout points at 14-day intervals. Passive monitoring was conducted from 13 March–18 July 2024.

ARUs were manually configured using the AudioMoth Configuration App so that the recording schedule matched that of the call-playback schedule: 30 minutes prior to sunrise, ceasing 3 hours after sunrise (i.e., morning period); 3 hours prior to sunset, ceasing 30 minutes past sunset (i.e., evening period). Acoustic data were obtained from each of the unit's SanDisk Extreme micro-SD cards and stored in an external hard drive for later analysis.

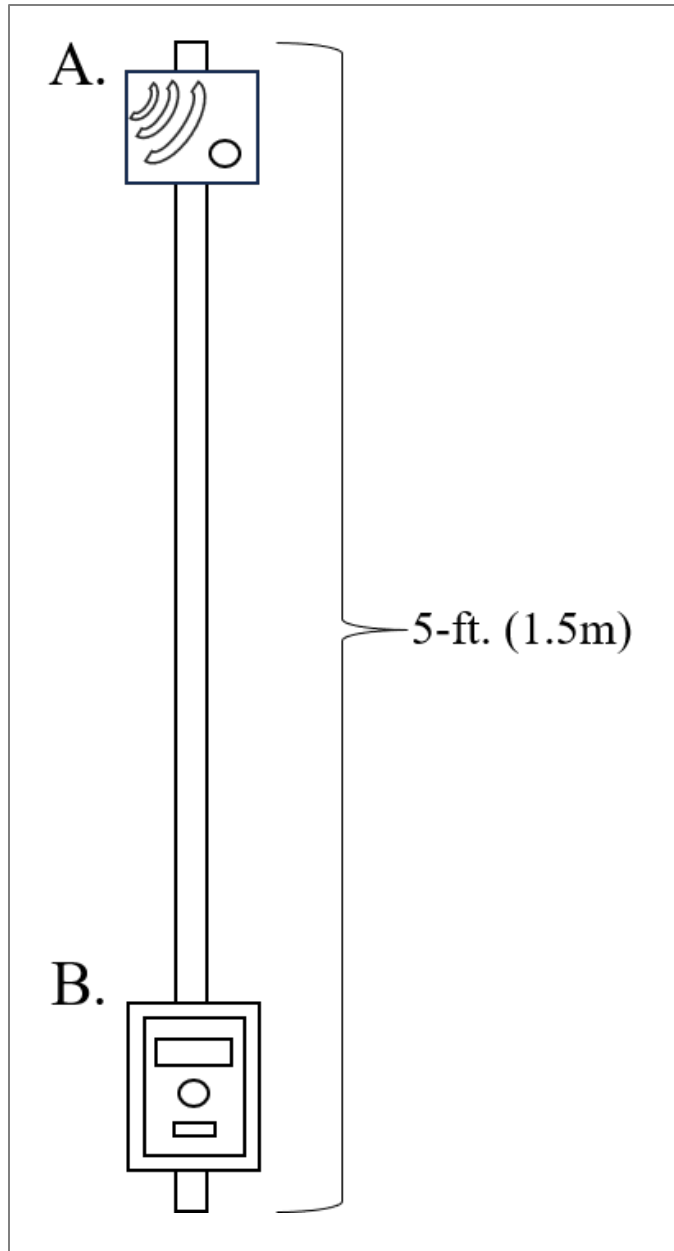


Figure 2. Diagram of the autonomous recoding unit and trail camera dual set-up on a 5-ft U-post. Image A represents the autonomous recording unit (AudioMoth v. 1.2.0) at the top, and Image B represents a Reconyx Hyperfire 2 Professional Trail Camera at the base of the post.

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Rail cameras (Table 1) were set with the following specifications from Olsen (2023): Motion pictures and motion triggering, four pictures per trigger as a rapid-fire event, quiet period of 15-seconds between trigger events, and high sensitivity. Cameras were programmed to trigger for 24-hours and were not constrained by specific time intervals. Cameras were raised slightly off the ground depending on water conditions to prevent damage to the camera if flooding were to occur. Sticks/brush were placed behind the camera to adjust its angle slightly. Additionally, immediate

vegetation in front of the camera was cleared/modified to reduce the likelihood of vegetation triggering the motion sensors. Additionally, manually constructed tunnels were created (depending on the vegetation available) to help guide any potential birds towards the camera's motion sensor. The SD cards were extracted and data stored on an external hard drive for later analysis.

Table 1. Basic specifications of the Reconyx Hyperfire 2 Professional trail camera. An additional modification to allow the camera to focus at close range (2-ft) was added prior to shipment.

Metric	Specifications
Image Resolution	1080p/3 Megapixel
Image Detail	Color Day; Monochrome Infrared Night
Illumination Type/Range	No-Glow HO Covert IR 150 ft
Video	720p HD with Audio up to 90 seconds
Image Data	Date, Time, Temperature, Moon phase
Trigger Speed	0.2 seconds
Temperature Range	-40 to 140 Fahrenheit
Modifications	Focus ~2-ft

Vegetation measurement

Vegetation sampling methodology followed procedures from Olsen (2023). Vegetation points were the same as the call-playback and trail camera/ARU survey points. At each of these points, a 50 m transect in each cardinal direction was generated, with the 'point' acting as the center. To assess cover classes using Daubenmire classifications (Class 1= 0–5%, Class 2= 5–25%, Class 3=25–50%, Class 4=50–75%, Class 5=75–95%, Class 6=95–100%; Daubenmire 1959), surveyors placed a 20 × 50 cm quadrat constructed with PVC pipes every 25 m along each transect for a total of 8 cover-class measurements. Surveyors then recorded the percent cover for the following classes within each of the 8 quadrats: water, bare ground, detritus, and 'vegetation'. Vegetation was further split into the following categories: cordgrass (*Spartina alterniflora*, *S. spartinae*, *S. patens*), saltgrass (*Distichlis spicata*), tall emergent (non-woody cover ≥1 m in height; e.g., *Typha* spp., *Juncus* spp.), short emergent (non-woody cover <1 m in height; e.g., *Salicornia bigelovii*, *Batis maritima*), woody vegetative (woody plants <1 m in height or otherwise considered non-shrubs; e.g., *Borrchia frutescens*), and shrub (e.g., *Iva frutescens*, *Baccharis halimifolia*, *Lycium carolinianum*). Surveyors also measured water levels (cm) using a ruler at each of the four cardinal directions at the 50 m mark of the transects. These four measures were averaged for a value of standing water at each survey point.

Standing biomass was measured using clip plots in 1 m² quadrats created with PVC pipes. These plots were randomly placed six times per point, using a random number generator (-50 to 50), where negative coordinate values (-50 to 0) were associated with transects directly south and west, and positive values (0 to 50) were associated with the north and east transects. Any values that caused overlap with other quadrats were re-generated. Surveyors evenly clipped any vegetative material within the quadrat to ~1 cm above ground. Material was then transported in labeled bags and dried at

50°C in a drying cabinet for a minimum of 96 hours. The material was then weighed and averaged to obtain a point-specific average biomass value (g/m²).

Analysis Methods

Autonomous Recording Units & Trail Cameras

Acoustic data was analyzed using cluster analysis techniques in Kaleidoscope Pro (v. 5.6.6). A pre-built and trained advanced classifier shared from Olsen (2023) was used to cluster the following vocalization types: ‘Kee-kee-JERR’, Growls, and ‘other’. The latter category, ‘other’ consists of the less frequent ‘Churr’ calls or similar single-note vocalizations (Figure 3). Trail camera photos were manually examined for Black Rails by two observers.

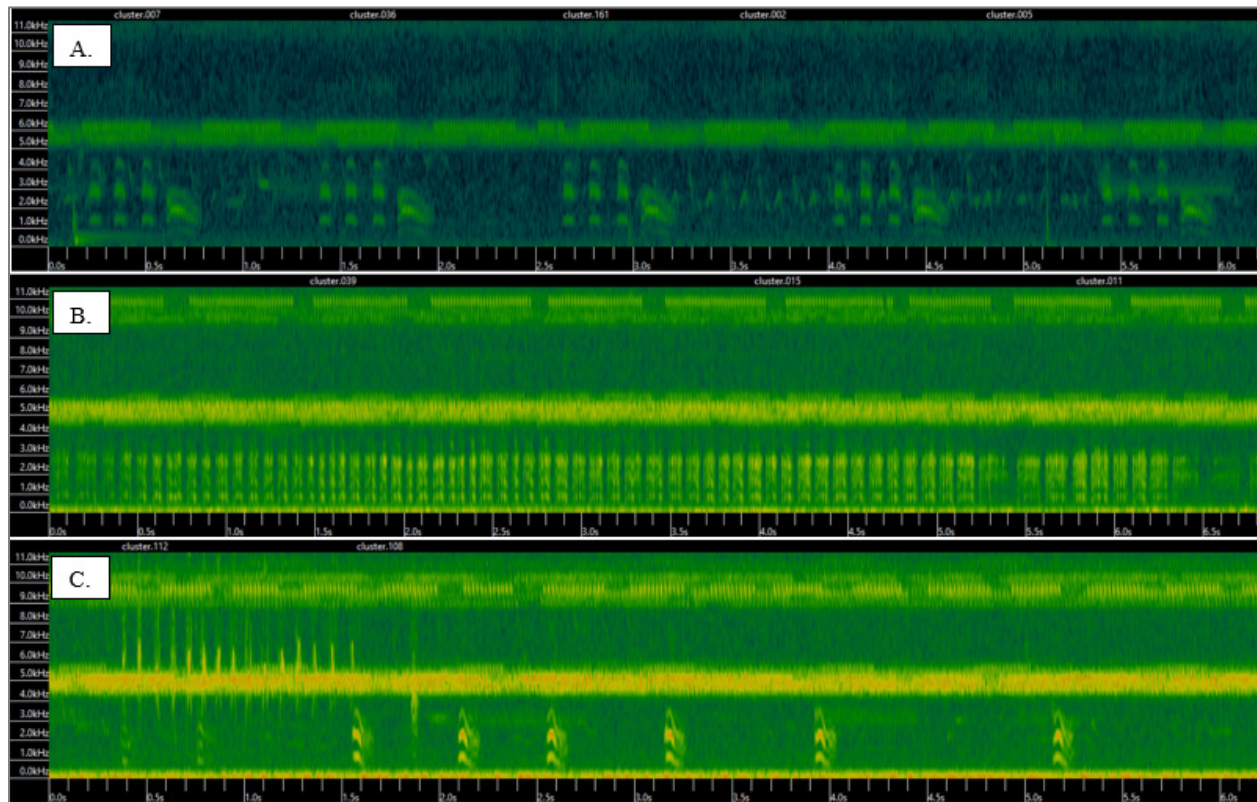


Figure 3. Examples of the typical Eastern Black Rail (*Laterallus jamaicensis jamaicensis*) vocalizations. Frequency (kHz) is displayed on the Y-axis and time (seconds) is displayed on the X-axis. Panel A reflects the song (‘Kee-kee-JERR’), where in this sequence the song is emitted four separate times, peaking at ~4.0 kHz. Panel B reflects the ‘growl’. Panel C displays an example of the simplistic, single-note calls often described as Churr, Churts, or Pows. Spectrograms were generated using Kaleidoscope Pro (v. 5.6.6) and audio file clusters from Olsen 2023.

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Occupancy Analyses

Occupancy models are an analytical technique used for estimating presence/absence of a target species, while accounting for the likelihood of detecting the species if present (i.e. detection probability; MacKenzie et al. 2002). Covariates can be added to the model to help determine how

biotic and abiotic factors influence occupancy and detection of the target species at a given location (MacKenzie et al. 2018). We conducted occupancy modeling in Program R (v.4.3.2) with the package ‘unmarked’ (Fiske and Chandler 2011, Kellner et al. 2023). In order to assess generated models, we used the package ‘AICcmodavg’ (Mazerolle 2023). We utilized Quasi Akaike’s Information Criterion with small sample adjustment (QAICc) to assess model support (Burnham and Anderson 2002). Model goodness of fit was assessed by bootstrapping 1,000 simulations and using the mean bootstrapped $\hat{c}$ divided by the model $\hat{c}$ to determine if there was need for an overall $\hat{c}$ adjustment. Models were adjusted only if the overall $\hat{c}$ was greater than 1.2.

Unplanned fire

During May 2024, an unplanned fire, believed to have been started by lightning, occurred (Figure 4). This fire affected sampling sites in the North Shooting Range unit. Fourteen points were affected, and the fire destroyed two cameras and ARUs.



Figure 4. During early and mid-May 2024, an unplanned fire affected the North Shooting Range. Panel A shows the extent of the burned area in black as of 13 May 2024, as sketched by the field crew. The blue points are survey points, the black is the burned area, and the red shows where the fire was still moving at this date. Panel B shows an image of the fire, and panel C shows the aftermath of the fire at one of the points.

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Results

Summary of Black Rail Detections & Vegetation Sampling

For the season, 60 trail cameras were deployed and 31,294 images were generated. Of these images, the overwhelming majority was of moving vegetation and there were zero detections of Black Rails. For passive acoustic surveys, only one Black Rail was detected one time out of 60 successful deployments, with no subsequent detections at that point or any other points. This single confirmed recording (ARU) came from Bird Island Basin (Figure 5).

Call-playback surveyors expressed concern over misidentifications with Sora (*Porzana carolina*) early into the season, which led to additional training: these misidentifications were removed and are not included in any subsequent analyses or summaries. Surveyors detected rails at nine locations, eight of which were located in Upper Bird Island Basin and one located in the North Shooting Range (Figure 5). There were 14 detections (13 by observers, one by ARU) at the 10 sites, with two individuals detected on four occasions, while the remaining detections were of single individuals. Of the detections, six were during the morning period of surveys and eight were in the evening period. The earliest detected Black Rail was 14 March and the latest detection was 7 May. Six of the detections were during March, six detections were during April, and there were two detections in early May.

The average above ground biomass per point was 233.52 g/m², with the majority of the vegetation structure comprised of a mixture of short emergent vegetation, tall emergent vegetation, and detritus. In contrast, very few points displayed a Daubenmire cover class >1 (cover of 0–5%) for shrubs (2 points), saltgrass (17 points), cordgrass (4 points), and woody vegetation (8 points).

Non-target species detected during surveys are summarized in Butler and Olsen (2025).

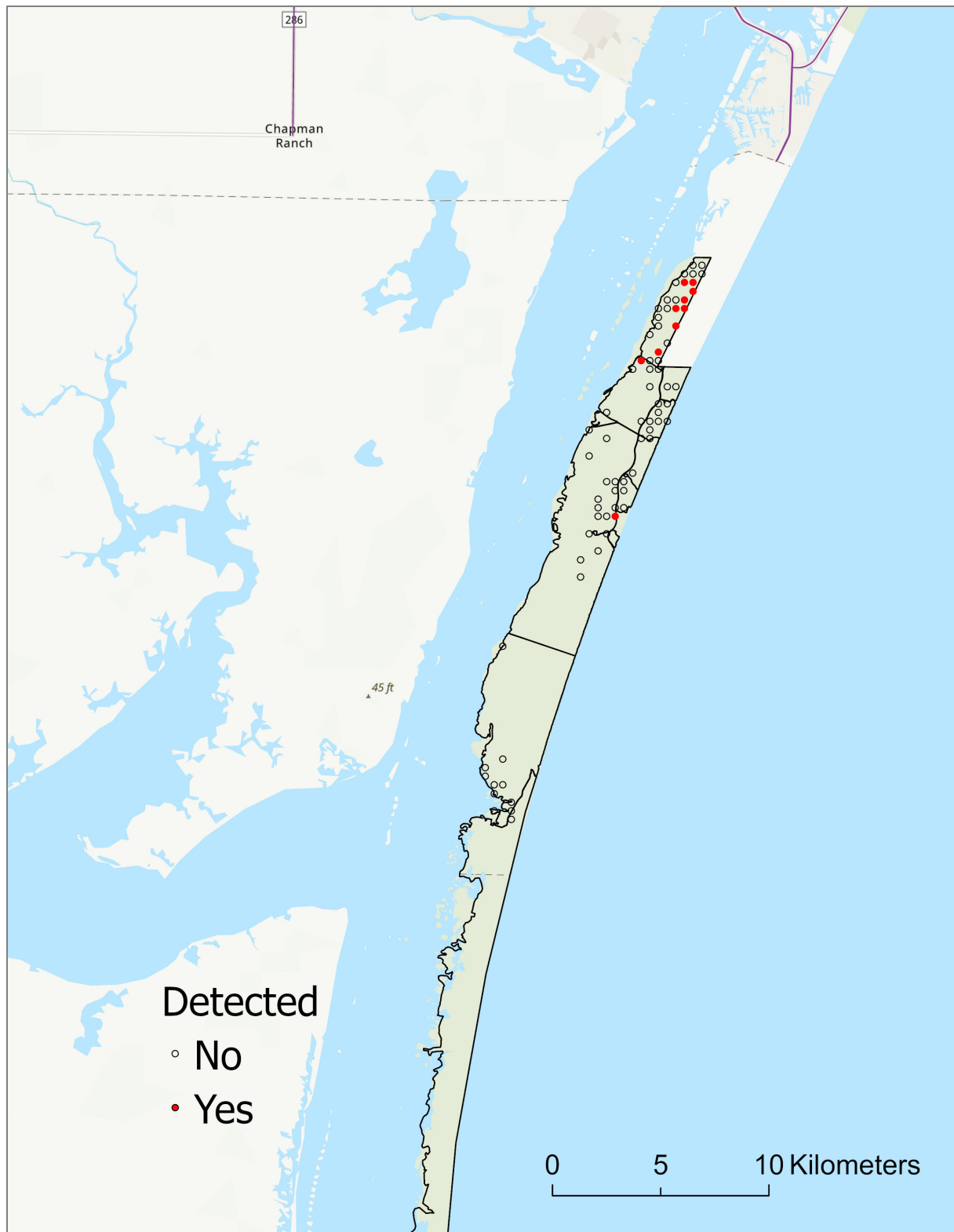


Figure 5. Eastern Black Rails were detected at 10 sites (shown in red), with the majority of the detections from Upper Bird Island ($n = 8$), along with a single detection from Bird Island Basin (recorded by an ARU), and a single detection from the North Shooting Range.

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Occupancy

Due to the extremely low/zero number of detections via trail cameras ($n = 0$) and ARUs ($n = 1$), occupancy modeling was only conducted for the call-playback portion of surveys.

Points missing data for either site covariates or survey covariates were removed from analyses, for a total of 66 points analyzed. Data were further truncated to the first four revisits due to inconsistent revisit attempts stemming from logistical constraints. Black Rails were detected on three of four occasions at one point, on two of four occasions at an additional point, and the remaining points had only single observations ($n = 6$). As a rough rule of thumb, the events per variable should be at least 10 (Moons et al. 2014), although other authors have suggested that larger sample sizes are required (van der Ploeg et al. 2014, Bujang et al. 2018). Additionally, since we had <10 detections of our target species and <10 points occupied, we were unable to analyze covariates influencing detection or occupancy without significant overdispersion of resulting models ($\hat{c} > 1.5$ in models containing >0 variables), although we provided tables with the rankings for completeness (see Tables 2 & 3). With the null model, estimated detection probability ($\hat{p}$) was 0.088 (SE=0.081). Using the null model, we calculated the proportion of area sampled that was occupied as 0.106 (10.6%).

Table 2. Black Rail model ranking using corrected quasi Akaike information criterion (QAICc) values to visualize variables influencing detection probability ($\hat{p}$). Note that due to having <10 detections of Black Rail, these data should be examined and interpreted with extreme caution. Date indicates the Julian date of the call-playback survey conducted. Water represents water levels at the time of a call-playback survey (cm). Wind indicates the wind speed (kph) at the time of the call-playback survey. Time indicates the time of day (AM or PM) the survey was conducted. Cloud indicates the percentage of cloud cover during the survey conducted. Temperature indicates the ambient temperature ($^{\circ}\text{C}$) during a survey. Noise indicates the ambient levels of background noise (dB) during a given call-playback survey, not including the sound of the playback tape itself. There were two surveyors conducting surveys, and thus the surveyor variable indicates which surveyor conducted the given call-playback survey.

Model	QAICc	ΔQAIC	QAICc Weight	Cumulative Weight
$\Psi(.)\hat{p}(\text{date})$	71.12	0.00	0.50	0.50
$\Psi(.)\hat{p}(\text{water})$	72.83	1.71	0.21	0.71
$\Psi(.)\hat{p}(.)$	74.93	3.81	0.07	0.79
$\Psi(.)\hat{p}(\text{wind})$	75.27	4.15	0.06	0.85
$\Psi(.)\hat{p}(\text{time})$	76.37	5.25	0.04	0.89
$\Psi(.)\hat{p}(\text{surveyor})$	76.54	5.42	0.03	0.92
$\Psi(.)\hat{p}(\text{noise})$	76.96	5.85	0.03	0.95
$\Psi(.)\hat{p}(\text{cloud})$	76.98	5.86	0.03	0.98
$\Psi(.)\hat{p}(\text{temperature})$	77.12	6.00	0.02	1.00

Table 3. Black Rail model ranking using corrected quasi Akaike information criterion (QAICc) values to visualize variables influencing occupancy estimation (Ψ). Note that due to having <10 detections of Black Rail, these data should be examined and interpreted with extreme caution. Woody represents the percentage cover of woody vegetation. Tall emergent represents the percent cover of non-woody vegetation ≥ 1 m in height. Short emergent represents the percent cover of non-woody cover <1 m in height. Cordgrass represents the percent cover of the following species: *Spartina alterniflora*, *S. spartinae*, and *S. patens*. Saltgrass refers to the percent cover of the following species: *Distichlis spicata*. Shrub represents the percentage cover of woody vegetation ≥ 1 m in height. Standing water is the average standing water at a given point (cm). Water cover is the percent cover of water at a call-playback point. Bare ground refers to the percentage of a point covered in no vegetation or detritus. The selection refers to the specific section of the property the survey was conducted in.

Model	QAICc	Δ QAICc	QAICc Weight	Cumulative Weight
$\Psi(\text{woody})\hat{p}(\cdot)$	72.52	0.00	0.32	0.32
$\Psi(\text{tall emergent})\hat{p}(\cdot)$	73.24	0.72	0.22	0.55
$\Psi(\cdot)\hat{p}(\cdot)$	74.93	2.41	0.10	0.64
$\Psi(\text{standing water})\hat{p}(\cdot)$	75.09	2.57	0.09	0.73
$\Psi(\text{biomass})\hat{p}(\cdot)$	75.60	3.09	0.07	0.80
$\Psi(\text{cordgrass})\hat{p}(\cdot)$	76.20	3.68	0.05	0.85
$\Psi(\text{water cover})\hat{p}(\cdot)$	76.66	4.14	0.04	0.89
$\Psi(\text{shrub})\hat{p}(\cdot)$	76.67	4.15	0.04	0.93
$\Psi(\text{short emergent})\hat{p}(\cdot)$	77.22	4.71	0.03	0.96
$\Psi(\text{saltgrass})\hat{p}(\cdot)$	77.90	5.38	0.02	0.99
$\Psi(\text{bare ground})\hat{p}(\cdot)$	79.21	6.69	0.01	1.00
$\Psi(\text{section})\hat{p}(\cdot)$	82.01	9.49	0.00	1.00

The corrected quasi Akaike Information Criterion was used due to the models displaying overdispersion when conducting a Pearson Chi-square test on both the null and subsequent global models ($\hat{c} > 1.5$). When variables were ranked for detection probability (Table 3) both date and water performed better than the null model (Δ QAICc < 2.00). When variables were ranked for occupancy probability both percent cover of woody vegetation and percent cover of tall emergent vegetation performed better than the null model (Δ QAICc < 2.00). Again, while these results are suggestive, the sample size of this study is too small to confidently state that these variables affected detection and probability.

Discussion

Black Rail detections appeared to be concentrated in on the northern units of Padre Island National Seashore (Figure 4; primarily Upper Bird Island Basin, with additional detections at Bird Island Basin and the North Shooting Range). The call-playback surveys were most effective at detecting Black Rails in this region and the one detection via acoustic monitoring (i.e., with ARUs) was also at one of the same points confirmed by call-playback surveyors. Even so, detection probability was very low, with a median of only one detection out of four call-playback revisits at sites where Black Rails were detected. Black Rails were detected on call-playback surveys as late as 7 May, indicating that the species is likely breeding in this region rather than representing overwintering individuals that migrate out of the system, although some individuals are known to migrate as late as early May (Watts 2020). Black Rail surveys that focus on northern management units (Figure 4) that sample outside of these months may reveal more insights as to the proportion of area occupied by Black Rail year-round. Targeted surveys in management areas where Black Rails were detected during the course of this survey may allow for less resource-intensive surveys for long-term monitoring, as occupancy estimates were low throughout the entirety of PAIS.

Passive acoustic monitoring can allow for an affordable and effective implementation of long-term surveys and data collection (Gibb et al. 2018, Darras et al. 2019). For Black Rail, ARUs generally allow for better or equivalent detection estimates when compared with traditional call-playback monitoring (Bobay et al. 2018, Olsen 2023). Additionally, for other secretive marsh birds of interest including Nelson's Sparrow (*Ammospiza nelsoni*), King Rail (*Rallus elegans*), Clapper Rail (*R. crepitans*), Sora (*Porzana carolina*), Least Bittern (*Ixobrychus exilis*), and Yellow Rail (*Coturnicops noveboracensis*) ARUs can be immensely valuable in determining habitat use, landscape distribution, and occupancy (Allen et al. 2004, Sidie-Slettedahl et al. 2015, Stiffler et al. 2018). In contrast, our deployed ARUs detected only a single instance of a Black Rail vocalizing even when placed in areas where in-field surveyors previously detected Black Rail. This suggests that call-playback surveys may be more effective at detecting Black Rails in areas where they exist at low densities. There are multiple potential explanations for the relatively low rate of detections with the ARUs. For example, the ARUs in this study were not always placed at points during the exact same time as the call-playback surveys were being conducted and were randomly selected for 14-day deployments. Additionally, fewer points were successfully sampled with acoustic units than with call-playback as many units failed due to user error (e.g., not changing out batteries or turning the units on). Finally, wildfires during May limited the surveyors' ability to safely access units and temporarily eliminated suitable habitat. Black Rails were not detected on any of the burned points prior to the unplanned fire, but there was one detection of a Black Rail at the North Shooting Range unit that was very close to the edge of the fire, so it is possible that this fire may have affected some individuals. Future iterations of Black Rail monitoring should consider the use of passive acoustic surveys but with a more targeted approach to areas where occupancy has been determined so that areas can be monitored long-term. Additionally, the acoustic data accumulated through ARU deployment can be saved and used for separate analyses or to examine other target species occupying PAIS (e.g.,

Eastern Meadowlark [*Sturnella magna*], Sedge Wren [*Cistothorus stellaris*], various migrant passerines, etc.).

Trail cameras have been used to successfully monitor Black Rails and to describe intimate aspects of their breeding phenology, molt timing, and nesting behavior (e.g., Hand et al. 2019, Hand et al. 2021). Determining occupancy with trail cameras for secretive species rather than monitoring known individuals, however, may be less effective than other methodology. For example, Olsen (2023) utilized camera traps to assess occupancy of Black Rail generating a detection estimate of 0.002 (0.2%) and 24 Black Rail photos for their 2022 season. Similarly, we detected zero Black Rail using trail cameras during this study. Black Rails are extremely small, and require targeted vegetation modification to aid in the likelihood of successfully capturing them on camera. The proportion of area occupied at PAIS was estimated to be 10.6% and the maximum number of Black Rail detected on a given survey were 3 individuals, indicating that densities and abundance at PAIS may also be similarly low. In areas where occupancy is not known and potential numbers of individuals are projected to be low, the capacity to capture a Black Rail on a trail camera if individuals are present would be similarly reduced. Thus, in future monitoring of Black Rail at PAIS, trail cameras should only be used in areas where occupancy is known or strongly suspected in order to reduce the amount of visual data generated and time required to sort through photos.

Average above ground biomass is shown to be an important variable for influencing Black Rail and Yellow Rail occupancy (Olsen 2023), with increasing biomass correlating with an increase in occupancy probability up to 2000 g/m². At PAIS, average biomass was 233.52 g/m², which is on the lower end of the amount of biomass that influences presence of Black Rail in a given location. Given the hydrology of PAIS and the low annual rainfall, the amount of biomass that can be generated in this region is lower than in equivalent saltmarshes further up the Texas Gulf Coast where rain deposition averages higher. This may help to explain the low estimate of occupancy at PAIS, however additional surveys will be necessary to successfully parse habitat information as it relates to explaining occupancy (Table 3), as we failed to obtain enough detections to adequately model these covariates. Standing water availability should also be considered and continue to be monitored in areas where Black Rail are suspected to occupy, as the overall lack of rainfall at PAIS may lead to a stronger reliance on available standing water in this region (Table 3). Associations between habitat covariates and occupancy generated from this study should be interpreted with caution, however, and additional surveys are necessary to understand these relationships in this specific region.

We utilized two in-field surveyors for this study, specifically for trail camera/ARU deployment as well as call-playback surveys. Surveyors were trained prior to their field season in the specific Black Rail vocalizations most likely to be encountered (Figure 3) and were selected for their experience with birds in this region. The software system LarkWire was also provided for additional practice with similarly encountered species (e.g., Sedge Wren, Marsh Wren [*Cistothorus palustris*], Eastern Meadowlark, Red-winged Blackbird [*Agelaius phoeniceus*], etc.). Even so, during the first three weeks of the season surveyors expressed the potential for misidentifications, which required additional evaluation. Commonly misidentified species included Sora, which would often flush from the ground visually mimicking a Black Rail during pre-dawn and post-sunset time periods (although

Sora lack the white trailing edge). Soft vocalizations from Sora and chattering from Sedge Wren presented misidentification issues for surveyors as well. Future surveys should implement a longer and stronger training period for in-field surveyors conducting call-playback emphasizing both visual and auditory field marks, to reduce the potential for both false positive detections and false negative detections. Passive acoustic monitoring may also help with this, as the audio files are able to be cross-evaluated by multiple observers or even computer software trained to identify typical Black Rail vocalizations.

Conclusions

Patterns of occupancy at PAIS

Prior to 2022, Black Rails had only been documented at Padre Island National Seashore twice. Surveys for Black Rails during 2022 used ARUs deployed at nine sites and Black Rails were confirmed at three of the nine sites (33%), including one point at North Site (Upper Bird Island Basin) and two points at Big Pond (North Shooting Range; Tolchin et al. 2023). During 2023, three ARUs were deployed and Black Rails were not detected at any sites (Tolchin 2024).

During the course of this study, Black Rails were detected at ten sites on three management units (Upper Bird Island Basin, Bird Island Basin, and the North Shooting Range). The occupancy analysis suggests that approximately 10.6% of potentially suitable habitat at Padre Island National Seashore that was surveyed during this study was occupied during 2024. This is considerably lower than the reported occupancy further north along the Texas coast, where occupancy in suitable habitat at the mid-Coast National Wildlife Refuge complex, for example, was reported to be approximately 75% (Butler et al. 2023). The difference in occupancy may be due to differences in vegetative structure and density. For example, Olsen (2023) found that Black Rail occupancy along the Texas Gulf Coast was positively correlated with increasing above-ground biomass (AGB) and the average AGB that would result in 50% of suitable habitat being occupied was approximately 1,400 g/m². This is considerably higher than the average AGB of 233.52 g/m² observed at study sites in Padre Island National Seashore. It is also possible that the unplanned fire may have temporarily reduced occupancy rates in the North Shooting Range, as there was one detection of a Black Rail very near the burned area.

Management Recommendations

Since Black Rails were detected in multiple sites in multiple units in this study, as well as in the 2022 study, it appears that Black Rails are present in small numbers at Padre Island National Seashore annually. Consequently, periodic surveys should be carried out to determine the relative proportion of sites occupied. The overall detectability of Black Rails is very low, with an estimated detection probability of 9%. This suggests that multiple revisits to sites will be required in order to assess whether Black Rails are present. The surveys can be done by either using ARUs or employing field technicians. Both approaches have advantages and disadvantages so the logistical and financial constraints will need to be carefully considered beforehand. Given that individuals in Texas may pair up as early as February (Olsen et al. 2024) and that our surveys did not detect any individuals after early May, the peak time for surveys for this species at Padre Island National Seashore should be between mid-February to early May.

In general, it is suggested that Black Rail habitat contain 10% or less of woody vegetation (Watts et al. 2023) and prescribed burning can be very effective at reducing woody vegetation encroachment. Consequently, prescribed burning would likely be an effective management technique to maintain Black Rail populations at Padre Island National Seashore. Given that Black Rails may pair up as early as mid-February, prescribed burning should be conducted outside of the breeding season when possible (i.e., from September through mid-February). However, the fire return interval chosen for

management should be long enough that the AGB (above-ground biomass) of the graminoid and herbaceous vegetation is similar to that of areas where Black Rail occupancy of suitable habitat is at least 50% (~1,400 g/m²). Since all the Black Rails detected in this study were located in Upper Bird Basin, Bird Basin, and the Upper Shooting Range, efforts to monitor and manage these birds at Padre Island National Seashore should largely focus on these three units.

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1201 Oakridge Drive, Suite 150
Fort Collins, CO 80525