2018

Assessment of Black Rail Status in North Carolina, Breeding Season 2017 and 2018 Summaries

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NC Wildlife Resources Commission, Wildlife Management Division
U.S. Fish and Wildlife Service
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EXECUTIVE SUMMARY

The Black Rail (*Laterallus jamaicensis*) is the most secretive and least understood marsh bird in North America with the Eastern Black Rail (*L. j. jamaicensis*), one of two subspecies that occur here, listed as endangered in six states along the Atlantic Coast and proposed for federal listing under the Endangered Species Act (USFWS–R4–ES–2018–0057, 2018). Black Rails require dense vegetation for cover during all stages of their life cycle. They require wetlands with minimal water coverage during the breeding season. Historic population size for the Eastern subspecies was likely in the tens of thousands (25,000 to 100,000; Delaney and Scott 2002) but is now believed to be in the hundreds to low thousands. Eastern Black Rails breed within three geographic areas within North America including the Atlantic Coast, the Gulf Coast, and the Midwest. The Atlantic Coast has generally been thought to support the largest breeding population throughout the range with pairs mostly confined to the highest elevations within tidal salt marshes. The historic breeding range along the Atlantic Coast has contracted more than 450 kilometers south and the population is estimated to be declining by 9% annually (Watts 2016). The primary driver of declines over the past three decades is believed to be sea-level rise and associated tidal inundation during the nesting season.

North Carolina has long been recognized as a stronghold for Black Rails within the mid-Atlantic region. Most of what we know about the distribution and abundance of Black Rails in the state is based on site specific surveys and scattered anecdotal records (Fussell and McCrimmon 1976, Fussell and Wilson 1983, Davis et al. 1988, Collazo et al. 1990, LeGrand 1993, Fussell 1994, Paxton and Watts 2002, Watts 2016). These reports have documented a number of tidal marsh breeding locations, a well-known larger population at the Cedar Island National Wildlife Refuge, and at Piney Island military installation (both in Carteret County). In the late 1800s and early 1900s Black Rails were documented in the western part of the state using agricultural fields but there have not been consistent records since that time (Lee 1999, Watts 2016). Prior to 2014, a comprehensive status assessment for Black Rails in North Carolina had not been conducted, nor were there any existing systematic monitoring programs in place to assess the health of Black Rail populations. The purpose of this project is to gain a systematic view of the distribution of Black Rails in coastal North Carolina to help determine their status and distribution, to expand upon previous survey locations from the 2014 and 2015 field seasons, to determine if Black Rails continue to occupy historic strongholds, and to initiate an inland survey centered on agricultural lands with high density freshwater wetlands, farm ponds, Carolina Bays, and other water features that Black Rails have historically used within the region. We designed a broad survey frame so sampling locations could be used for monitoring purposes into the future.

During the 2017 field season, 284 coastal points were surveyed, and during the 2018 field season 192 points were surveyed. All points surveyed in 2017 were along the outer coast in tidal or impounded wetlands. During the 2018 survey, 169 inland points and 23 coastal points were surveyed. The 2018 coastal survey locations were comprised of a network of previously occupied marshes from year 2000 and on. Three rounds of surveys

were conducted between 18 April and 20 July 2017 and between 1 May and 15 July 2018. All points were surveyed three times unless there were access issues during one of the survey rounds. We conducted a total of 1,394 individual play-back surveys, 844 in 2017 and 550 in 2018. We detected a minimum of 9 individual Black Rails at 4 survey points in 2017 and we detected zero Black Rails in 2018 for survey occupancy of .01% (4 of 476 total survey points, N=284 in 2017, N=192 in 2018). During the 2014 and 2015 breeding seasons, a total of 262 points were surveyed for the presence of black rails within the outer Coastal Plain. Rails were detected within 20 points (.076% occupancy rate) including an estimated 22 individuals at those points. We found no new potential breeding areas during the 2017 survey effort, and detected zero Black Rails during the 2018 survey season.

BACKGROUND

Context

The Black Rail (*Laterallus jamaicensis*) is the most secretive and least understood marsh bird in North America with the Eastern Black Rail (*L. j. jamaicensis*), one of two subspecies that occur here, listed as endangered in six states along the Atlantic Coast and proposed for federal listing under the Endangered Species Act (USFWS–R4–ES–2018–0057, 2018). Black Rails require dense vegetation for cover during all stages of their life cycle. They require wetlands with minimal water coverage during the breeding season. Historic population size for the Eastern subspecies was likely in the tens of thousands (25,000 to 100,000; Delaney and Scott 2002) but is now believed to be in the 315 to 855 range (Watts 2016). Eastern Black Rails breed within three geographic areas within North America including the Atlantic Coast, the Gulf Coast, and the Midwest. The Atlantic Coast has generally been considered to support the largest breeding population throughout the range with pairs mostly confined to the highest elevations within tidal salt marshes. Breeding range along the Atlantic Coast has contracted south more than 450 kilometers and the population is estimated to be declining by 9% annually (Watts 2016). The primary driver of declines over the past three decades is believed to be sea-level rise and associated tidal inundation during the nesting season.

North Carolina has long been recognized as a stronghold for Black Rails within the mid-Atlantic region. Most of what we know about the distribution and abundance of Black Rails in the state is based on scattered anecdotal reports or site specific surveys (Fussell and McCrimmon 1976, Fussell and Wilson 1983, Davis et al. 1988, Collazo et al. 1990, LeGrand 1993, Fussell 1994, Paxton and Watts 2002). These reports have documented a number of tidal marsh breeding locations and a well-known larger population at the Cedar Island National Wildlife Refuge and at Piney Island military installation (both in Carteret County). In the late 1800s and early 1900s Black Rails were documented in the western part of the state using agricultural fields but there have not been consistent records since that time (Lee 1999, Watts 2016). Prior to 2014, a comprehensive status assessment for Black Rails in North Carolina had not been conducted, nor were there any existing systematic

monitoring programs in place to assess the health of Black Rail populations. The purpose of this project is to gain a systematic view of the distribution of Black Rails in coastal North Carolina to help determine their status and distribution, to expand upon previous survey locations from the 2014 and 2015 field seasons, to determine if Black Rails continue to occupy historic strongholds, and to initiate an inland survey centered on agricultural lands with high density freshwater wetlands, farm ponds, Carolina Bays, and other water features that Black Rails have historically used within the region. We designed a broad survey frame so sampling locations could be used for monitoring purposes into the future.

The Eastern Black Rail ranks as a Significantly Rare species within North Carolina and in need of monitoring (North Carolina Wildlife Resources Commission 2005). Establishing a Black Rail species specific surveys ranks as one of the highest research, survey, and monitoring priorities within the plan. Acquisition of important Black Rail breeding habitat is identified as the one of the highest conservation actions necessary to conserve the species with the plan. The 2016 population estimate for the state was 40 to 60 pairs though the uncertainty in this estimate was very high (Watts 2016). Surveys conducted after this estimate have narrowed the uncertainty surrounding the estimate though the remote and extensive nature of the habitat still makes it difficult to achieve a high level of confidence in any population estimate of the species within the state (Watts 2016). The Atlantic Coast Joint Venture recently produced a population objective for Eastern Black Rails, including stabilizing the current population and growing the population to 2,500 pairs in at least 5 population centers (ACJV Black Rail webpage retrieved 25 November 2018). North Carolina currently has a small but essential population of Black Rails and stabilizing and increasing the population is critical to the long term viability of the species in North Carolina and surrounding states.

OBJECTIVES, METHODS, and ACTIVITIES

Study Objectives

The overall objective of this effort is to assess the status and distribution of the black rail population breeding in North Carolina. Our objectives during the 2017-2018 field seasons are to:

 1) Build on the effort conducted during the 2014-2015 field seasons and expand the extent of spatial coverage of Black Rail surveys.

2) Survey a sub-sample of inland sites to determine population levels of Black Rails at freshwater wetlands within North Carolina.

Development of a Survey Frame for 2017 and 2018

The Center for Conservation Biology staff consulted with biologists from the North Carolina Wildlife Resources Commission, Wildlife Management Division, and with the U.S. Fish and Wildlife Service, to

develop a sampling frame for the 2017 and 2018 field seasons. We based our survey frame off of the 2014 and 2015 survey locations, covering new marsh locations along the coast in an effort to increase detections. The agreed upon focus of 2017 survey efforts would include 1) the best examples of high-marsh habitat that were accessible within the outer Coastal Plain and were not surveyed during the 2014 and 2015 field seasons, 2) impounded wetlands that were accessible within the outer Coastal Plain, and 3) areas outside of the national wildlife refuges designated for survey by the USFWS. The focus of the 2018 survey frame included 1) inland freshwater marsh and pond habitats that were accessible within the inner Coastal Plain and centered around Goldsboro, NC, 2) select accessible areas on the outer Coastal Plain with previous Black Rail detections (detections compiled from eBird and 2014-2015 surveys), and 3) areas in the interior ridge of high marsh habitat within Cedar Island National Wildlife Refuge (see Appendix I and II for point names, locations, and survey dates from the 2017 and 2018 seasons).

Refinement of Survey Protocol and Timing of Surveys

We utilized a survey protocol for North Carolina that is consistent with what has been used previously in Maryland, Virginia, North Carolina and elsewhere. Based on known breeding and migration data from the region (Watts 2016) we targeted probable breeding dates in North Carolina as falling between late April and mid-July. We have attached the 2017-2018 protocol (much of the structure and text taken from the recent USFWS protocol authored by Smith and Wiest) as Appendix III. We surveyed coastal points from a half hour after sunset to a half hour before sunrise (as in Wilson et al. 2009). We used the unmodified Smith and Wiest diurnal survey protocol for the 2018 inland points due to the problem of frog calls at freshwater marshes and ponds during the night.

Selection of Survey Point Pool for 2017 and 2018 Seasons and Ground Truthing of Pool

In 2017, we blocked out geographic areas that were not included in the 2017 USFWS study survey frame and then used satellite imagery and previous site visits to select accessible marshes that might have suitable habitat including patches of tidal high marsh and shallowly flooded areas of impoundments. Potential survey points were placed on the landscape and a database of point coordinates was created. The point dataset was examined for natural clusters to improve sampling efficiency. Outlier points were excluded from the survey pool.

In 2018, we created a study grid on the inner Coastal Plain of North Carolina, and decided that the highest density of marsh, pond, and other wetland habitats were centered on Goldsboro, NC ±80km. Potential survey points were placed on the landscape and a database of point coordinates was created. The point dataset was examined for natural clusters to improve sampling efficiency. Outlier points were excluded from the pool. The

final pool included over 220 total inner Coastal Plain points. We also created a pool of points that had previous Black Rail detections (gathered from post-year 2000 eBird reports and from Wilson et al. 2016). A total of 28 points were laid out at or near previous detections of Black Rails.

Between 440 and 480 potential points from the 2017 points and roughly 240 potential points from the 2018 season were visited to assess habitat suitability and survey accessibility. Points that fell on private lands that could not be accessed efficiently or that lacked safe pull-off areas were excluded from the final set of survey points.

RESULTS

2017 and 2018 Breeding Season Surveys

During the 2017 and 2018 field seasons, 284 and 192 points were surveyed, respectively (Figure 1). All points surveyed in 2017 were along the outer coast in tidal or impounded wetlands (Figures 2-3). During the 2018 field season, 169 inland points and 23 coastal points were surveyed (Figures 4-6). Three rounds of surveys were conducted between 18 April and 20 July 2017 and between 1 May and 15 July 2018. All points were surveyed three times unless access issues prevented us from surveying during one of the survey rounds. We conducted a total of 1,394 individual play-back surveys, 844 in 2017 and 550 in 2018.

We detected a minimum of 9 individual Black Rails at 4 survey points in 2017 and we detected zero Black Rails in 2018 for survey occupancy of .01% (4 of 476 total survey points). During the 2014 and 2015 breeding seasons, 262 points were surveyed for the presence of black rails within the outer Coastal Plain. Rails were detected at 20 points for a survey occupancy of .076% including an estimated 22 individuals (Wilson et al. 2016). All of the 2017 detections occurred at a known Black Rail breeding site (Cedar Island National Wildlife Refuge). We found no new breeding sites during the 2017 or 2018 surveys, and during a resurvey of recent occupied sites we detected zero Black Rails (Figure 5). We surveyed the interior section (Zone 3 from Davis et al. 1988 and Collazo et al. 1990) of Cedar Island National Wildlife Refuge on two separate occasions, surveying roughly half of the higher zone on 7 June and the other half on 30 June 2018 (Figure 6). We detected no Black Rails on either survey, and water levels throughout the high marsh transect were several inches deep on both surveys. We found no new potential breeding areas during the 2017 survey effort, and detected zero Black Rails during the 2018 survey season. We surveyed 15 of the 28 previously occupied sites and detected no Black Rails at any of those sites during the 2018 season.
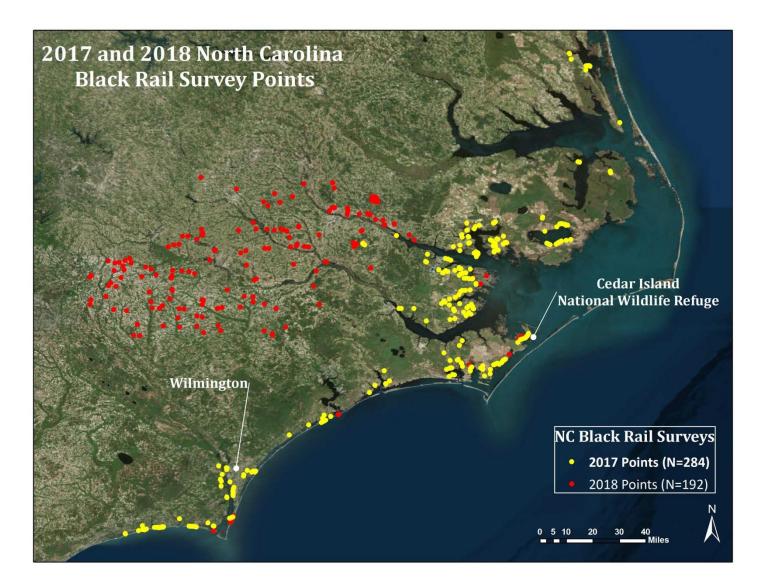
Figure 1. Location of all Black Rail surveys in North Carolina during the 2017 and 2018 seasons.
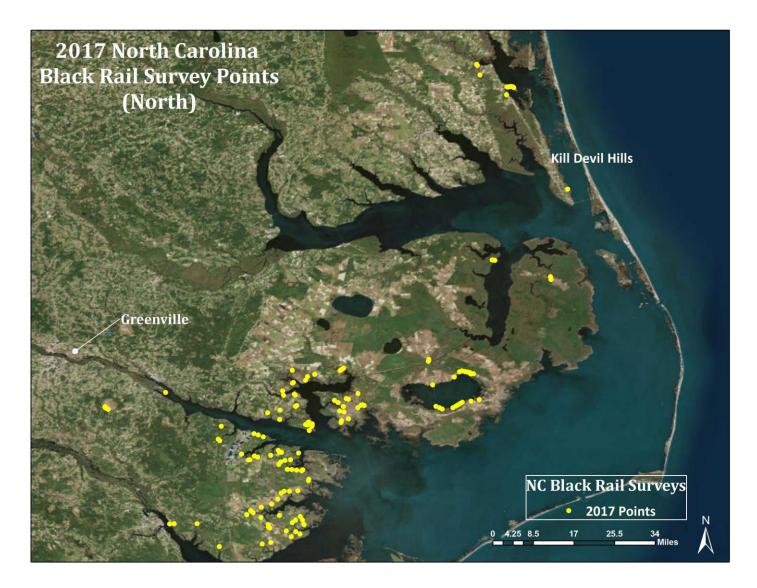
Figure 2. North Carolina Black Rail survey points from the 2017 season. Northern coastal points from the North River to Pamlico County.
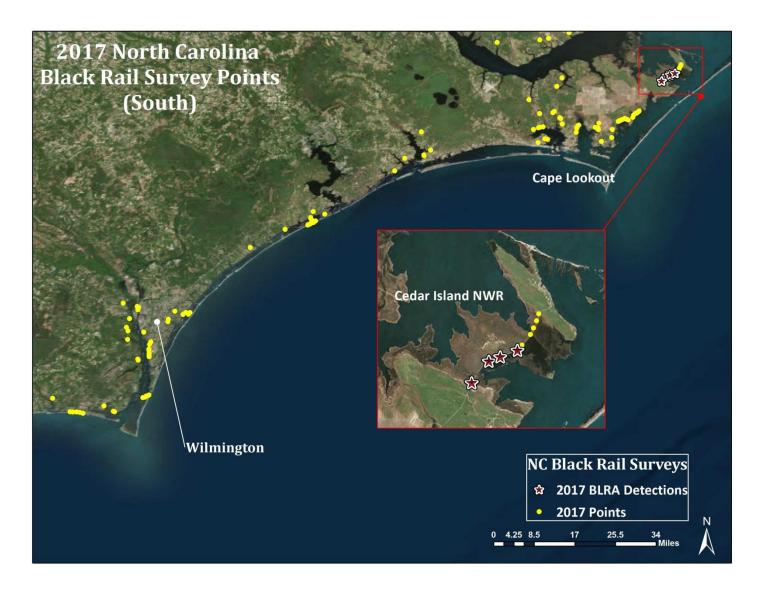
Figure 3. North Carolina Black Rail survey points from the 2017 season. Southern coastal points from the Cedar Island National Wildlife Refuge to Sunset Beach.
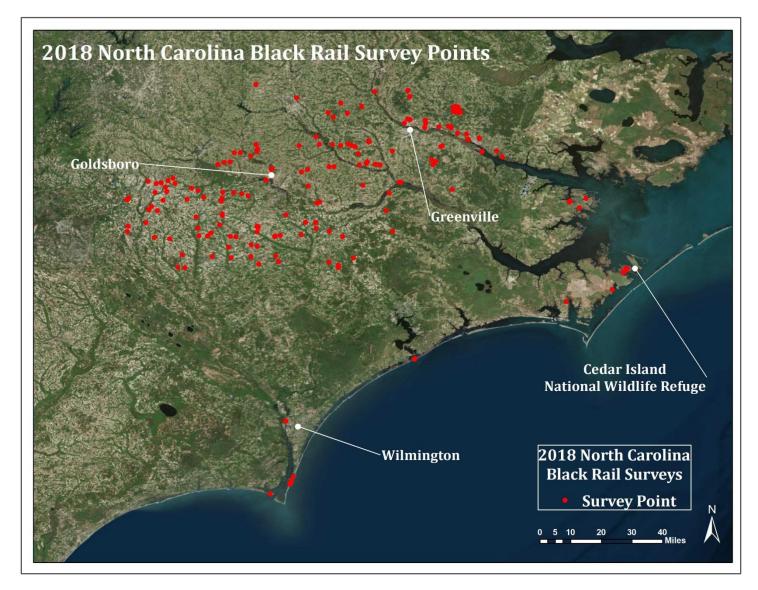
Figure 4. Location of all Black Rail surveys in North Carolina during the 2018 season.
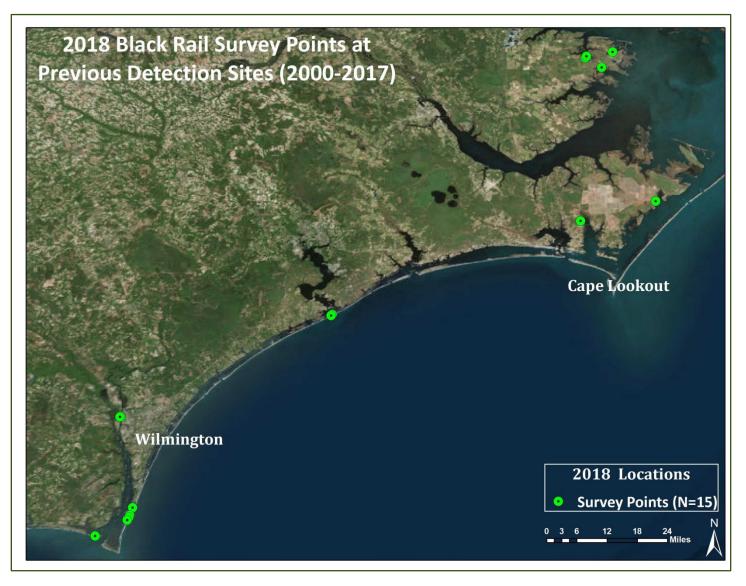
Figure 5. Location of all resurveyed Black Rail locations. Locations gathered from eBird and previous coastal survey detections. A total of 28 points were laid out and due to time constraints 15 were surveyed at least once during the 2018 season.
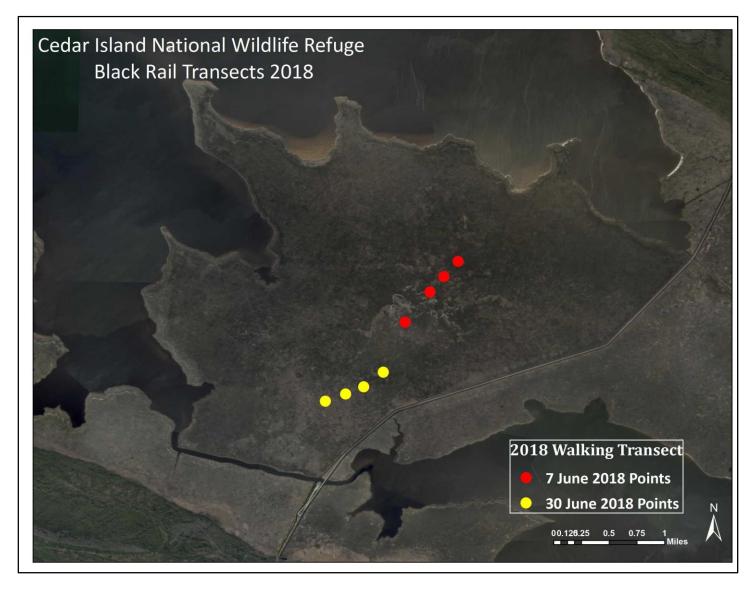
Figure 6. Location of transect survey through Cedar Island National Wildlife Refuge, 7 June and 30 June 2018.

DISCUSSION and PROJECT OUTCOMES

The Eastern Black Rail (*Laterallus jamaicensis jamaicensis*) may be the most imperiled bird species along the Atlantic Coast. Black Rail populations have been declining in the eastern United States for over a century resulting in a retraction of its breeding range, an overall reduction in the number of breeding locations within its core range, and a loss of individuals within historic strongholds (Eddleman et al. 1994, Wilson et al. 2015, Watts 2016). In the mid-Atlantic region, systematic surveys show that populations have also undergone a more abrupt decline and have disappeared from 85% of their known breeding locations since 1992 (Wilson et al. 2007, Wilson et al. 2015). Black Rails now breed in only a dozen or fewer locations per state within its Eastern breeding range and have reached dangerously low levels. It may be unlikely that Black Rails will persist along large portions of the Atlantic Coast without timely and appropriate conservation actions.

The reasons for the recent decline of Black Rails are thought to be driven by a combination of sea-level rise and nest inundation. Impacts to nesting rails are expressed short-term through extreme flooding events or tide anomalies (Theuerkauf et al. 2014) and long-term through the rising sea levels (Raposa et al. 2016, Lentz et al. 2016) and subsequent conversion of high marsh into low marsh habitat and migration of high marsh into nearby upland communities (Wilson et al. 2014, Taillie 2018) . The frequency of tidal inundation of high marsh and coastal habitats has increased significantly in the past several decades (Sweet et al. 2014, Sweet and Park 2014 Pearson et al. 2018) and now disrupts breeding success of high marsh nesting species (Bayard and Elphick 2011, Correll et al. 2016, Field et al. 2017). Long-term sea-level rise combined with nest inundation has likely pushed the Black Rail to nest closer to the upland edge (Wilson et al. 2009, Wilson et al. 2015, Taillie 2018) which puts them at greater risk of nest predation (Wilson et al. 2014). The combined factors of nest inundation and predation drive the demographic rates lower and are likely the main factors contributing to the significant declines on the Atlantic Coast. Within the Cedar Island NWR and Piney Island sites, flood events are driven by wind direction and force (Giese et al. 1985, Pietrafesa et al. 1986). Nor'easter storms flood the marshes of Pamlico Sound with up to a meter of water (Christian et al. 1990) though these storms usually impact the region during the non-breeding season.

Black Rails historically nested throughout the western part of the state, with records from wet meadows and hayfields created by the deforestation of the region (Lee 1999, Watts 2016). There were scattered records of Black Rails within these habitats for over a century (Pearson et al. 1942, Chamberlain 1961, LeGrand 1980, Davis 2005). Black Rails primarily breed in tidal or non-tidal high marsh habitat but will also breed in freshwater wetlands. The status and distribution of this interior population remains poorly understood range-wide east of the Mississippi River (Eddleman et al. 1994, Watts 2016). Our goal in initiating a non-coastal survey within the inner coastal plain was to determine whether a population exists in habitats similar to those occupied historically (i.e. wet meadows, pastures, hayfields, farm ponds). We subsampled a large number of interior habitats and didn't detect any rails. Prior to the 2018 North Carolina field season, no systematic surveys were conducted within this region. Management of habitat to support the inland population is

theoretically much easier than management for the coastal population, but the sporadic nature of detections and lack of fidelity shown by rails within the interior sites makes it difficult to effectively manage habitat for these birds.

It is likely that the Carteret County, North Carolina, Black Rail population is the largest and possibly most stable population north of Florida. The high count of Black Rails reported by Fussell and Voight (21 individuals calling) in the first week of May 2018 at Piney Island was an amazing discovery. To put that count in perspective, the previous high count in the Piney Island site was 19 calling birds in 1992 (LeGrand 1993) and virtually all Atlantic Coast sites with large numbers of Black Rails (i.e. Elliot Island, MD, Saxis Marsh, VA) have shown significant declines in recent decades (Wilson et al. 2007, Wilson et al. 2015, Watts 2016). It is possible that the road system within Piney Island is providing localized higher nesting habitat, or that the marsh itself is higher in elevation than surrounding marshes within Pamlico Sound. The lack of development near the training area is no doubt beneficial to breeding rails as well. We detected no significant numbers of Black Rails at Cedar Island NWR in 2014 (we detected 16 individuals at 9 points across 5 survey rounds) and 2017 (9 individuals at 4 points across 3 survey rounds). We did not detect any rails during two interior surveys bisecting zone 3 (see Davis et al. 1988, Collazo et al. 1990 and Christian et al. 1990 for a description of habitat zones within the refuge marsh). The interior transect was flooded during both surveys with 3-5 inches of water throughout. It is possible that in low water years Zone 3 is a hotspot for Black Rail breeding activity, as was shown in Davis et al. 1988.

Continued monitoring of the Carteret population (especially Cedar Island NWR and Piney Island) should be a high priority and management or land acquisition within and near to these population centers should be of the highest priority for actions that can benefit the species within North Carolina. Acquiring drained or ditched farmlands nearby recently occupied Black Rail marshes and converting them to impounded wetlands managed specifically for marsh nesting birds could help stabilize the Black Rail population along the coast.

ACKNOWLEDGMENTS

LITERATURE CITED

Atlantic Coast Joint Venture Black Rail Population Objectives (Atlantic Coast and Florida Gulf Coast). Accessed 25 November 2018 at: https://acjv.org/black-rail/

Chamberlain, B. R. 1961. Regional reports: spring migration, April 1 - May 31, 1961; Southern Atlantic Coast region. Audubon Field Notes 15:399-402.

Christian, R. R., W. L. Bryant, Jr., and M. M. Brinson. 1990. *Juncus roemerianus* production and decomposition along gradients of salinity and hydroperiod. Marine Ecology Progress Series 68:137–145.

Collazo, J.A., B. Jennings, S.G. Williams, and H. Berkhoff. 1990. Feasibility study of Black Rails at Cedar Island National Wildlife Refuge. U.S. Fish and Wildlife Service Project Report compiled by the North Carolina Cooperative Research Unit, North Carolina State University, Department of Zoology. Raleigh, N.C.

Conway, C. J. 2009. Standardized North American Marsh Bird Monitoring Protocols, version 2009-2. Wildlife Research Report # 2009-02. U.S. Geological Survey, Arizona Cooperative Fish and Wildlife Research Unit, Tucson, AZ.

Correll MD, W.A. Wiest, T.P. Hodgman, W.G. Shriver, C.S. Elphick, B.J. McGill, K.M. O'Brien, and B.J. Olsen. 2016. Predictors of specialist avifaunal decline in coastal marshes. Conservation Biology, 31, 172–182.

Davis, K., O. Florschutz, L. Ditto, H. Brohawn, and M. Brinson. 1988. Distribution and abundance of birds on Cedar Island marsh with information on small mammals. Section 10. In: Ecology of an irregularly flooded brackish marsh in coastal North Carolina. E.C. Pendleton and M.M. Brinson (Eds.). Draft Final Report, Vols. 1 and 2. Cooperative Agreement between the U.S. Fish and Wildlife Service and Eastern Carolina University, No. 14-16-0009-85-963.

Davis, R. 2005. Briefs for the files. The Chat 69:108-122.

Delany, S. and S. Scott. 2002. Waterbird Population Estimates – Third Edition. Wetlands International Global Series No. 12, Wageningen, The Netherlands.

Eddleman, W. R., R. E. Flores and M. Legare. 1994. Black Rail (Laterallus jamaicensis), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/123 doi:10.2173/bna.123

Fleming, E., J. Payne, W. Sweet, M. Craghan, J. Haines, J.F. Hart, H. Stiller, and A. Sutton-Grier, 2018: Coastal Effects. In *Impacts, Risks, and Adaptation in the United States: Fourth National Climate Assessment, Volume II* [Reidmiller, D.R., C.W. Avery, D.R. Easterling, K.E. Kunkel, K.L.M. Lewis, T.K. Maycock, and B.C. Stewart (eds.)]. U.S. Global Change Research Program, Washington, DC, USA. doi: 10.7930/NCA4.2018.CH8

Field CR, T.S. Bayard, C. Gjerdrum, J.M. Hill, S. Meiman, and C.S. Elphick. 2017. High-resolution tide projections reveal extinction threshold in response to sea-level rise. Global Change Biology 23:2058–2070

Fussell, J. O., III. and D. A. McCrimmon, Jr. 1976. The nesting season status of the black rail and the Virginia rail in Carteret County, N.C. Unpublished report.

Fussell, J.O., III and J. Wilson. 1983. Natural Areas Inventory of Carteret County, North Carolina. Coastal Energy Impact Program Report No. 9. Office of Coastal Management, North Carolina.

Fussell, J. O. III. 1994. A birders guide to coastal North Carolina. University of North Carolina Press, Chapel Hill, North Carolina.

Giese, G.L., Wilder, H.B., Parker, Jr, G.G. 1985. Hydrology of major estuaries and sounds of North Carolina. U.S. Geological Survey Water-Supply Paper 2221, U.S. Government Printing Office, Washington, D.C.

LeGrand, Jr. H. E. 1980. The nesting season, Southern Atlantic Coast region. American Birds 34:885-887.

LeGrand, H. E. Jr. 1993. Briefs for the files. The Chat 57:79-85.

Lentz, E. E., E. R. Thieler, N. G. Plant, S. R. Stippa, R. M. Horton, and D. B. Gesch, 2016: Evaluation of dynamic coastal response to sea-level rise modifies inundation likelihood. Nature Climate Change, 6 (7), 696–700. doi:10.1038/nclimate2957.

North Carolina Wildlife Resources Commission. 2005. *North Carolina Wildlife Action Plan*. Raleigh, NC.

Paxton, B. J. and B. D. Watts. 2002. Marsh bird callback surveys of high marsh patches along the southeastern shore of the Albemarle-Pamlico Peninsula, North Carolina. The Center for Conservation Biology Technical Report Series, CCBTR-02-09. College of William and Mary, Williamsburg, Virginia.

Pearson, T. G., C. S. Brimley and H. H. Brimley. 1942. Birds of North Carolina. North Carolina Department of Agriculture, State Museum Division. Bynum Printing Company, Raleigh, North Carolina.

Pietrafesa, L.J., Janowitz, G.S. Chao, T.-Y., Weisberg, R.H., Askari, F., Noble, E. 1986. The physical oceanography of Pamlico Sound. Department of Marine, Earth, and Atmospheric Sciences, North Carolina State University, Raleigh.

Raposa, K. B., K. Wasson, E. Smith, J. A. Crooks, P. Delgado, S. H. Fernald, M. C. Ferner, A. Helms, L. A. Hice, J. W. Mora, B. Puckett, D. Sanger, S. Shull, L. Spurrier, R. Stevens, and S. Lerberg, 2016: Assessing tidal marsh resilience to sea-level rise at broad geographic scales with multi-metric indices. *Biological Conservation*, **204** (Part B), 263–275. doi:10.1016/j.biocon.2016.10.015.

Sweet, W. V., J. Park, J. J. Marra, C. Zervas, and S. Gill. 2014. Sea level rise and nuisance flood frequency changes around the United States, NOAA Tech. Rep. NOS CO-OPS 73, 53 pp.

Sweet, W.V. and J. Park (2014). From the extreme and the mean: Acceleration and tipping point of coastal inundation from sea level rise. Earth Futures, 2 579-600. DOI: 10.1002/2014EF000272

Taillie, P.J. 2018. "Coastal Bird Responses to the Salinization-Induced Transition from Forest to Marsh as Sea Level Rises", PhD thesis, NC State University, Raleigh, NC.

Theuerkauf, E. J., A. B. Rodriguez, S. R. Fegley, and R. A. Luettich Jr. 2014. Sea level anomalies exacerbate beach erosion, Geophys. Res. Lett., 41, 5139–5147, doi:10.1002/2014GL060544.

Watts, B. D. 2016. Status and distribution of the Eastern Black Rail along the Atlantic and Gulf Coasts of North America. The Center for Conservation Biology Technical Report Series, CCBTR-16-09. College of William and Mary/Virginia Commonwealth University, Williamsburg, VA. 148 pp.

Wilson, M. D., B. D. Watts, and D. F. Brinker. 2007. Status review of Chesapeake Bay marsh lands and breeding marsh birds. Waterbirds 30:122-137.

Wilson, M. D., B. D. Watts, and F. M. Smith. 2009. Status and Distribution of Black Rails in Virginia. Center for Conservation Biology Technical Report Series, CCBTR-0-010. College of William and Mary and Virginia Commonwealth University. Williamsburg, VA.

Wilson, M. D., C. Turrin, and B. D. Watts. 2014. Assessing the role of marsh habitat change on the distribution and decline of Black Rails in Virginia. Center for Conservation Biology Technical Report Series, CCBTR-14-009. College of William and Mary and Virginia Commonwealth University, Williamsburg, VA. 14 pp.

Wilson, M. D., F. M. Smith, and B. D. Watts. 2015. Re-Survey and Population Status Update of the Black Rail in Virginia. The Center for Conservation Biology Technical Report Series: CCBTR-15-04. College of William and Mary & Virginia Commonwealth University, Williamsburg, VA. 14 pp.

Wilson, M.D., B. D. Watts, and D. Poulton. 2016. Black Rail Status Survey in North Carolina. Center for Biology Technical Report Series, CCBTR-16-01. College of William and Mary and Virginia Commonwealth University. 21 pp.

U.S. Fish and Wildlife Service. 12-Month Petition Finding and Threatened Species Status for Eastern Black Rail With a Section 4(d) Rule. Federal Register Agency Docket No. FWS-R4-ES-2018-0057 pp.50610-50630. Published 9 October 2018. Accessed at: https://www.federalregister.gov on 13 November 2018

APPENDICES

APPENDIX I. TABLE WITH ALL POINTS SURVEYED DURING 2017 NORTH CAROLINA BLACK RAIL SURVEY SEASON, LATITUDE AND LONGITUDE (IN DECIMAL DEGREES), AND SURVEY ROUND DATES.

Point ID	Latitude	Longitude	Round 1 Date	Round 2 Date	Round 3 Date
CCB-NC-2014-002	34.936314	-76.352629	5/13/2017	7/8/2017	7/20/2017
CCB-NC-2014-005	34.939492	-76.342795	6/11/2017	7/8/2017	7/20/2017
CCB-NC-2014-006	34.9702	-76.30903	5/13/2017	6/11/2017	7/8/2017
CCB-NC-2014-194	34.955399	-76.316246	5/13/2017	6/11/2017	7/8/2017
CCB-NC-2014-200	34.96520704	-76.31095919	5/13/2017	6/11/2017	7/8/2017
CCB-NC-2014-201	34.96008	-76.31351	5/13/2017	6/11/2017	7/8/2017
CCB-NC-2014-203	34.9477	-76.32368	5/13/2017	6/11/2017	7/8/2017
CCB-NC-2014-204	34.94412	-76.32776	5/13/2017	6/11/2017	7/20/2017
CCB-NC-2014-208	34.92093	-76.36755	5/13/2017	6/11/2017	7/8/2017
CCB-NC-2017-001	36.4997167	-76.08654097	5/8/2017	Road Flooded	7/7/2017
CCB-NC-2017-002	36.49746389	-76.08452152	5/8/2017	5/26/2017	7/7/2017
CCB-NC-2017-003	36.46807384	-76.07636785	5/8/2017	5/26/2017	7/7/2017
CCB-NC-2017-004	36.43160409	-75.99449736	5/8/2017	5/27/2017	7/7/2017
CCB-NC-2017-005	36.43122858	-75.99154056	5/8/2017	5/27/2017	7/7/2017
CCB-NC-2017-006	36.43225159	-75.98799979	5/8/2017	5/27/2017	7/7/2017
CCB-NC-2017-007	36.4326976	-75.98493118	5/8/2017	5/27/2017	7/7/2017
CCB-NC-2017-008	36.43307344	-75.98224696	5/8/2017	5/27/2017	7/7/2017
CCB-NC-2017-009	36.43273531	-75.97917038	5/8/2017	5/27/2017	7/7/2017

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CCB-NC-2017-010	36.43166662	-75.97605935	5/8/2017	5/26/2017	7/7/2017
CCB-NC-2017-011	36.43007825	-75.97375869	5/8/2017	5/26/2017	7/7/2017
CCB-NC-2017-012	36.40787325	-75.99565742	5/8/2017	5/27/2017	7/7/2017
CCB-NC-2017-020	36.12169965	-75.81061785	5/8/2017	5/27/2017	7/6/2017
CCB-NC-2017-032	35.90721999	-76.03912404	5/9/2017	5/27/2017	7/6/2017
CCB-NC-2017-033	35.90551201	-76.03064205	5/9/2017	5/27/2017	Point Skipped
CCB-NC-2017-034	35.90666469	-76.03436102	5/9/2017	5/27/2017	7/6/2017
CCB-NC-2017-035	35.60533653	-76.23164403	5/9/2017	5/26/2017	7/7/2017
CCB-NC-2017-036	35.60249926	-76.23246278	5/10/2017	5/26/2017	7/7/2017
CCB-NC-2017-037	35.59983138	-76.23314062	5/10/2017	5/26/2017	7/7/2017
CCB-NC-2017-039	35.45726535	-77.20916689	4/26/2017	5/20/2017	6/17/2017
CCB-NC-2017-040	35.45565996	-77.20613432	4/26/2017	5/20/2017	6/17/2017
CCB-NC-2017-041	35.46195352	-77.21383536	4/26/2017	5/20/2017	6/17/2017
CCB-NC-2017-042	35.45906209	-77.21241706	4/26/2017	5/20/2017	6/17/2017
CCB-NC-2017-043	35.50499417	-77.02974706	4/26/2017	5/20/2017	6/17/2017
CCB-NC-2017-049	35.44398565	-76.71979501	5/7/2017	5/31/2017	6/26/2017
CCB-NC-2017-050	35.45189917	-76.68238842	5/7/2017	5/31/2017	6/26/2017
CCB-NC-2017-053	35.42306341	-76.68384737	5/7/2017	5/31/2017	6/26/2017
CCB-NC-2017-055	35.3894027	-76.59365038	5/8/2017	5/30/2017	6/26/2017
CCB-NC-2017-056	35.40245189	-76.58684931	5/8/2017	5/30/2017	6/26/2017
CCB-NC-2017-057	35.40353995	-76.58533872	5/8/2017	5/30/2017	6/26/2017
CCB-NC-2017-058	35.40628779	-76.58509615	5/8/2017	5/30/2017	6/26/2017
CCB-NC-2017-059	35.40837673	-76.58517335	5/8/2017	5/30/2017	6/26/2017

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CCB-NC-2017-060	35.4100241	-76.58462894	5/8/2017	5/30/2017	6/26/2017
CCB-NC-2017-061	35.40674167	-76.60073116	5/8/2017	5/30/2017	6/26/2017
CCB-NC-2017-062	35.4084478	-76.6052076	5/8/2017	5/30/2017	6/26/2017
CCB-NC-2017-063	35.41558273	-76.59659193	5/8/2017	5/30/2017	6/26/2017
CCB-NC-2017-064	35.41523287	-76.5946651	5/8/2017	5/30/2017	6/26/2017
CCB-NC-2017-065	35.46304023	-76.63577682	5/8/2017	5/30/2017	6/26/2017
CCB-NC-2017-066	35.46548758	-76.63173624	5/8/2017	5/30/2017	6/26/2017
CCB-NC-2017-067	35.50008447	-76.63849466	5/8/2017	5/30/2017	6/26/2017
CCB-NC-2017-068	35.49745917	-76.63637588	5/8/2017	5/30/2017	6/26/2017
CCB-NC-2017-069	35.49683581	-76.67180702	5/8/2017	5/29/2017	6/26/2017
CCB-NC-2017-070	35.50999749	-76.67415429	5/8/2017	5/29/2017	6/26/2017
CCB-NC-2017-073	35.53519316	-76.64210047	5/8/2017	5/29/2017	6/26/2017
CCB-NC-2017-074	35.53339977	-76.64500538	5/8/2017	5/29/2017	6/26/2017
CCB-NC-2017-077	35.54197705	-76.60534674	5/8/2017	5/29/2017	6/27/2017
CCB-NC-2017-078	35.57238266	-76.64533462	5/8/2017	5/29/2017	6/26/2017
CCB-NC-2017-079	35.55305743	-76.59913609	5/8/2017	5/29/2017	6/27/2017
CCB-NC-2017-080	35.56017148	-76.57715455	5/7/2017	5/30/2017	6/26/2017
CCB-NC-2017-082	35.57365294	-76.49726931	5/7/2017	5/30/2017	6/27/2017
CCB-NC-2017-083	35.57206892	-76.5003603	5/7/2017	5/30/2017	6/27/2017
CCB-NC-2017-084	35.57515254	-76.49477167	5/7/2017	5/30/2017	6/27/2017
CCB-NC-2017-085	35.57688969	-76.49239574	5/7/2017	5/30/2017	6/27/2017
CCB-NC-2017-086	35.57906882	-76.4898328	5/7/2017	5/30/2017	6/27/2017
CCB-NC-2017-091	35.46578874	-76.42788995	5/7/2017	5/29/2017	6/26/2017

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CCB-NC-2017-092	35.46740226	-76.43197713	5/7/2017	5/29/2017	6/26/2017
CCB-NC-2017-093	35.46596895	-76.43716243	5/7/2017	5/29/2017	6/26/2017
CCB-NC-2017-094	35.45867577	-76.44682819	5/7/2017	5/29/2017	6/26/2017
CCB-NC-2017-096	35.42557463	-76.47481469	5/6/2017	5/29/2017	7/21/2017
CCB-NC-2017-099	35.41998667	-76.49596416	5/6/2017	5/30/2017	7/21/2017
CCB-NC-2017-100	35.41647096	-76.49681409	5/6/2017	5/30/2017	7/21/2017
CCB-NC-2017-101	35.41433031	-76.49736805	5/6/2017	5/29/2017	7/21/2017
CCB-NC-2017-103	35.5015622	-76.44627356	5/7/2017	5/30/2017	6/27/2017
CCB-NC-2017-104	35.48665138	-76.48190344	5/7/2017	5/30/2017	6/27/2017
CCB-NC-2017-105	35.48445683	-76.47514083	5/7/2017	5/30/2017	6/27/2017
CCB-NC-2017-106	35.46248627	-76.49037704	5/7/2017	5/30/2017	6/27/2017
CCB-NC-2017-107	35.47485192	-76.50670976	5/7/2017	5/30/2017	6/27/2017
CCB-NC-2017-109	35.4812158	-76.51715177	5/7/2017	5/30/2017	6/27/2017
CCB-NC-2017-113	35.44630894	-76.48818224	5/7/2017	5/30/2017	6/26/2017
CCB-NC-2017-114	35.44902066	-76.50135473	5/7/2017	5/30/2017	6/26/2017
CCB-NC-2017-122	35.5280465	-76.21987785	5/10/2017	5/26/2017	7/7/2017
CCB-NC-2017-123	35.55219434	-76.15404798	5/10/2017	Point Skipped	7/7/2017
CCB-NC-2017-124	35.56793338	-76.13863399	5/10/2017	Point Skipped	7/7/2017
CCB-NC-2017-125	35.57030311	-76.13109581	5/10/2017	5/26/2017	7/7/2017
CCB-NC-2017-126	35.568659	-76.12189718	5/10/2017	5/26/2017	7/7/2017
CCB-NC-2017-127	35.56713492	-76.11408792	5/10/2017	Point Skipped	7/7/2017
CCB-NC-2017-128	35.5653028	-76.10708292	5/10/2017	Point Skipped	7/7/2017
CCB-NC-2017-129	35.56168442	-76.09640873	5/10/2017	Point Skipped	7/7/2017

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CCB-NC-2017-130	35.56111805	-76.10498752	5/10/2017	Point Skipped	7/7/2017
CCB-NC-2017-134	35.4835722	-76.07839795	5/10/2017	5/26/2017	7/6/2017
CCB-NC-2017-135	35.47863493	-76.10347308	5/10/2017	5/26/2017	7/6/2017
CCB-NC-2017-136	35.4754519	-76.12990835	5/9/2017	5/27/2017	7/6/2017
CCB-NC-2017-137	35.47145641	-76.13651924	5/9/2017	5/27/2017	7/6/2017
CCB-NC-2017-138	35.46764449	-76.14296073	5/9/2017	5/27/2017	7/6/2017
CCB-NC-2017-139	35.46426826	-76.14923836	5/9/2017	5/27/2017	7/6/2017
CCB-NC-2017-140	35.45892145	-76.15824723	5/9/2017	5/27/2017	7/6/2017
CCB-NC-2017-143	35.45529569	-76.19089399	5/9/2017	5/27/2017	7/6/2017
CCB-NC-2017-144	35.45863931	-76.19907908	5/9/2017	5/27/2017	7/6/2017
CCB-NC-2017-145	35.46297703	-76.20948002	5/9/2017	5/27/2017	7/6/2017
CCB-NC-2017-148	35.40276974	-76.86089245	4/26/2017	5/20/2017	6/17/2017
CCB-NC-2017-151	35.36298092	-76.86971675	4/26/2017	5/20/2017	6/16/2017
CCB-NC-2017-152	35.35949581	-76.86542094	4/26/2017	5/20/2017	6/16/2017
CCB-NC-2017-153	35.37642701	-76.74819726	4/25/2017	5/21/2017	6/21/2017
CCB-NC-2017-154	35.37074408	-76.73309558	4/25/2017	5/21/2017	6/21/2017
CCB-NC-2017-155	35.38017455	-76.76170612	4/25/2017	5/21/2017	7/21/2017
CCB-NC-2017-156	35.31836925	-76.7993443	4/25/2017	5/21/2017	6/21/2017
CCB-NC-2017-157	35.30095903	-76.77402584	4/25/2017	5/21/2017	6/21/2017
CCB-NC-2017-158	35.30081168	-76.77804152	4/25/2017	5/21/2017	6/21/2017
CCB-NC-2017-159	35.31272697	-76.76025689	4/25/2017	5/22/2017	6/21/2017
CCB-NC-2017-160	35.30879159	-76.75055793	4/25/2017	5/22/2017	6/21/2017
CCB-NC-2017-161	35.31469228	-76.71098672	4/25/2017	6/22/2017	7/21/2017

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CCB-NC-2017-173	35.32986897	-76.6879618	4/25/2017	5/22/2017	7/21/2017
CCB-NC-2017-174	35.32362479	-76.68422464	4/26/2017	5/22/2017	7/21/2017
CCB-NC-2017-175	35.3236807	-76.67743689	4/26/2017	5/22/2017	6/22/2017
CCB-NC-2017-176	35.32176853	-76.62653267	4/26/2017	5/22/2017	6/22/2017
CCB-NC-2017-177	35.30126162	-76.65094555	4/26/2017	5/22/2017	6/22/2017
CCB-NC-2017-179	35.29920151	-76.6675636	4/26/2017	5/22/2017	6/22/2017
CCB-NC-2017-180	35.29439441	-76.68029898	4/26/2017	5/22/2017	6/22/2017
CCB-NC-2017-181	35.28686738	-76.68634057	4/26/2017	5/22/2017	6/22/2017
CCB-NC-2017-182	35.27206217	-76.65979165	4/26/2017	5/21/2017	6/22/2017
CCB-NC-2017-183	35.27130864	-76.64702131	4/26/2017	5/21/2017	6/22/2017
CCB-NC-2017-184	35.26930545	-76.63243856	4/26/2017	5/21/2017	6/22/2017
CCB-NC-2017-185	35.2676294	-76.61693347	4/26/2017	5/21/2017	6/21/2017
CCB-NC-2017-186	35.27081067	-76.61319346	4/26/2017	5/21/2017	6/21/2017
CCB-NC-2017-188	35.2417434	-76.59522643	4/26/2017	5/21/2017	6/21/2017
CCB-NC-2017-189	35.23799644	-76.59555995	4/26/2017	5/21/2017	6/21/2017
CCB-NC-2017-190	35.20696722	-76.62799858	4/24/2017	5/27/2017	6/21/2017
CCB-NC-2017-198	35.20528355	-76.6537664	4/25/2017	5/28/2017	6/21/2017
CCB-NC-2017-199	35.20517106	-76.6699283	4/25/2017	5/28/2017	6/21/2017
CCB-NC-2017-200	35.2004865	-76.67929499	4/24/2017	5/28/2017	6/21/2017
CCB-NC-2017-201	35.18160492	-76.68880938	4/25/2017	5/28/2017	6/22/2017
CCB-NC-2017-202	35.16672956	-76.70794987	4/24/2017	5/28/2017	6/22/2017
CCB-NC-2017-203	35.15706464	-76.7393007	4/24/2017	5/28/2017	6/22/2017
CCB-NC-2017-204	35.14693754	-76.77124766	4/24/2017	5/28/2017	6/22/2017

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CCB-NC-2017-205	35.1406087	-76.76451531	4/24/2017	5/28/2017	6/22/2017
CCB-NC-2017-206	35.13390125	-76.78325775	4/24/2017	5/28/2017	6/22/2017
CCB-NC-2017-207	35.12556771	-76.74054852	4/24/2017	5/28/2017	6/22/2017
CCB-NC-2017-208	35.10440391	-76.71827596	4/23/2017	5/28/2017	6/22/2017
CCB-NC-2017-209	35.09706588	-76.71703845	4/24/2017	5/28/2017	6/22/2017
CCB-NC-2017-210	35.09387364	-76.71343222	4/24/2017	5/28/2017	6/22/2017
CCB-NC-2017-211	35.05028883	-76.71068371	4/23/2017	5/31/2017	7/6/2017
CCB-NC-2017-212	35.04572396	-76.73671338	4/23/2017	5/31/2017	7/5/2017
CCB-NC-2017-213	35.06747492	-76.64861471	4/23/2017	5/28/2017	7/6/2017
CCB-NC-2017-214	35.08561076	-76.6634858	4/23/2017	5/28/2017	7/6/2017
CCB-NC-2017-215	35.08319953	-76.6345928	4/23/2017	5/28/2017	7/6/2017
CCB-NC-2017-216	35.07600409	-76.62242412	4/23/2017	5/28/2017	7/6/2017
CCB-NC-2017-217	35.11051901	-76.64528383	4/23/2017	5/28/2017	7/6/2017
CCB-NC-2017-218	35.11790296	-76.63556367	4/23/2017	5/28/2017	7/6/2017
CCB-NC-2017-219	35.11829817	-76.61450657	4/23/2017	5/28/2017	7/6/2017
CCB-NC-2017-220	35.10602262	-76.61068266	4/25/2017	5/28/2017	7/6/2017
CCB-NC-2017-221	35.10354132	-76.60907049	4/25/2017	5/28/2017	7/6/2017
CCB-NC-2017-222	35.12901451	-76.62097639	4/23/2017	5/28/2017	7/6/2017
CCB-NC-2017-223	35.13211431	-76.68426965	4/23/2017	5/28/2017	6/22/2017
CCB-NC-2017-224	35.03804991	-76.86641822	4/23/2017	5/28/2017	7/5/2017
CCB-NC-2017-225	35.1068215	-76.93390075	4/23/2017	5/28/2017	6/30/2017
CCB-NC-2017-228	35.10694706	-77.0034817	4/23/2017	Gate Closed	6/30/2017
CCB-NC-2017-229	35.10639402	-77.01705962	4/23/2017	5/28/2017	6/30/2017

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CCB-NC-2017-236	34.93038386	-76.66991414	4/30/2017	5/21/2017	6/22/2017
CCB-NC-2017-237	34.90418379	-76.68569567	4/30/2017	5/21/2017	6/22/2017
CCB-NC-2017-238	34.86429239	-76.76986942	4/29/2017	5/21/2017	6/22/2017
CCB-NC-2017-239	34.82179773	-76.73744537	4/29/2017	5/21/2017	7/20/2017
CCB-NC-2017-240	34.82847266	-76.69263781	4/29/2017	5/21/2017	6/23/2017
CCB-NC-2017-241	34.82438816	-76.69767718	4/29/2017	5/21/2017	6/23/2017
CCB-NC-2017-243	34.7815853	-76.72711819	4/29/2017	5/21/2017	6/22/2017
CCB-NC-2017-244	34.78020421	-76.73638313	4/29/2017	5/21/2017	6/22/2017
CCB-NC-2017-245	34.77891097	-76.74073359	4/29/2017	5/21/2017	6/22/2017
CCB-NC-2017-246	34.77358838	-76.75640423	4/29/2017	5/21/2017	6/22/2017
CCB-NC-2017-249	34.82976926	-76.4354656	5/3/2017	5/20/2017	6/22/2017
CCB-NC-2017-250	34.82736147	-76.43825459	5/3/2017	5/20/2017	6/22/2017
CCB-NC-2017-251	34.82496047	-76.44097016	5/3/2017	5/20/2017	6/22/2017
CCB-NC-2017-252	34.82319307	-76.44354626	5/3/2017	5/20/2017	6/22/2017
CCB-NC-2017-253	34.82175641	-76.44784844	5/3/2017	5/20/2017	6/22/2017
CCB-NC-2017-254	34.8176398	-76.45207719	5/3/2017	5/20/2017	6/22/2017
CCB-NC-2017-255	34.81072633	-76.45485629	5/3/2017	5/20/2017	6/22/2017
CCB-NC-2017-256	34.80236337	-76.46906278	5/3/2017	5/20/2017	6/22/2017
CCB-NC-2017-257	34.8039374	-76.47232753	5/3/2017	5/20/2017	6/22/2017
CCB-NC-2017-258	34.80558814	-76.47561735	5/3/2017	5/20/2017	6/22/2017
CCB-NC-2017-259	34.80716041	-76.47943078	5/3/2017	5/20/2017	6/23/2017
CCB-NC-2017-260	34.8056075	-76.48316525	5/2/2017	5/20/2017	6/23/2017
CCB-NC-2017-261	34.80408065	-76.48636873	5/2/2017	5/20/2017	6/23/2017

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CCB-NC-2017-262	34.80259462	-76.48958537	5/2/2017	5/20/2017	6/23/2017
CCB-NC-2017-263	34.80126291	-76.49257159	5/2/2017	5/21/2017	6/23/2017
CCB-NC-2017-264	34.79989724	-76.49547122	5/2/2017	5/21/2017	6/23/2017
CCB-NC-2017-265	34.79818784	-76.4991974	5/2/2017	5/21/2017	6/23/2017
CCB-NC-2017-266	34.77359299	-76.51724624	5/2/2017	5/21/2017	6/23/2017
CCB-NC-2017-267	34.74946341	-76.51882865	5/2/2017	5/21/2017	6/23/2017
CCB-NC-2017-268	34.73725299	-76.54973885	5/2/2017	5/21/2017	6/23/2017
CCB-NC-2017-269	34.77802282	-76.5610053	5/2/2017	5/21/2017	6/23/2017
CCB-NC-2017-270	34.78040194	-76.56932736	5/2/2017	5/21/2017	6/23/2017
CCB-NC-2017-271	34.79308477	-76.55813676	5/2/2017	5/21/2017	6/23/2017
CCB-NC-2017-272	34.77363355	-76.55908434	5/2/2017	5/21/2017	6/23/2017
CCB-NC-2017-283	34.78488391	-76.62226067	4/30/2017	5/20/2017	6/23/2017
CCB-NC-2017-284	34.77771051	-76.62483425	4/30/2017	5/20/2017	6/23/2017
CCB-NC-2017-285	34.7651768	-76.62671741	4/30/2017	5/20/2017	6/23/2017
CCB-NC-2017-286	34.79011875	-76.66917586	4/29/2017	5/20/2017	6/23/2017
CCB-NC-2017-287	34.80662523	-76.67369119	4/29/2017	5/20/2017	6/23/2017
CCB-NC-2017-290	34.74396707	-76.71372115	4/30/2017	5/21/2017	6/23/2017
CCB-NC-2017-291	34.7450138	-76.72165026	4/30/2017	5/20/2017	6/23/2017
CCB-NC-2017-292	34.73408908	-76.74218508	4/30/2017	5/20/2017	6/23/2017
CCB-NC-2017-293	34.71097531	-77.06793191	5/3/2017	5/20/2017	6/30/2017
CCB-NC-2017-294	34.76601566	-77.09623391	5/3/2017	5/20/2017	6/30/2017
CCB-NC-2017-296	34.68629521	-77.14680059	5/3/2017	5/20/2017	6/30/2017
CCB-NC-2017-297	34.69350281	-77.08750642	5/3/2017	5/20/2017	6/30/2017

Point ID	Latitude	Longitude	Round 1 Date	Round 2 Date	Round 3 Date
CCB-NC-2017-298	34.69662298	-77.08861794	5/3/2017	5/20/2017	6/30/2017
CCB-NC-2017-299	34.64787081	-77.17708499	5/4/2017	5/20/2017	6/30/2017
CCB-NC-2017-301	34.51673526	-77.38915712	5/11/2017	6/4/2017	6/30/2017
CCB-NC-2017-302	34.52431066	-77.42422801	5/11/2017	6/4/2017	6/30/2017
CCB-NC-2017-303	34.5061708	-77.43220154	5/11/2017	6/4/2017	6/29/2017
CCB-NC-2017-304	34.50334601	-77.43095742	5/11/2017	6/4/2017	6/29/2017
CCB-NC-2017-305	34.49777154	-77.42791839	5/12/2017	6/3/2017	6/29/2017
CCB-NC-2017-306	34.4943679	-77.42649556	5/12/2017	6/3/2017	6/29/2017
CCB-NC-2017-307	34.49009146	-77.42767666	5/12/2017	6/3/2017	6/29/2017
CCB-NC-2017-308	34.49607421	-77.41656032	5/12/2017	6/3/2017	6/29/2017
CCB-NC-2017-309	34.49167681	-77.42279193	5/12/2017	6/3/2017	6/29/2017
CCB-NC-2017-310	34.48673844	-77.43334257	5/12/2017	6/3/2017	6/29/2017
CCB-NC-2017-311	34.48549482	-77.43613089	5/12/2017	6/3/2017	6/29/2017
CCB-NC-2017-312	34.48354997	-77.44031472	5/12/2017	6/3/2017	6/29/2017
CCB-NC-2017-322	34.47052675	-77.50923065	5/12/2017	6/3/2017	7/20/2017
CCB-NC-2017-327	34.4155102	-77.614591	5/12/2017	6/3/2017	6/29/2017
CCB-NC-2017-333	34.22189604	-77.84349692	5/12/2017	6/4/2017	6/30/2017
CCB-NC-2017-334	34.21223396	-77.81931672	5/12/2017	6/4/2017	6/30/2017
CCB-NC-2017-335	34.21814036	-77.81027843	5/12/2017	6/4/2017	6/30/2017
CCB-NC-2017-336	34.21554993	-77.80254799	5/12/2017	6/4/2017	7/20/2017
CCB-NC-2017-337	34.21778237	-77.79755948	5/12/2017	6/4/2017	6/30/2017
CCB-NC-2017-338	34.21263822	-77.80239827	5/12/2017	6/4/2017	6/30/2017
CCB-NC-2017-342	34.19770142	-77.86312683	5/12/2017	6/4/2017	6/30/2017

Point ID	Latitude	Longitude	Round 1 Date	Round 2 Date	Round 3 Date
CCB-NC-2017-343	34.19025661	-77.86467833	5/11/2017	6/4/2017	6/30/2017
CCB-NC-2017-344	33.96745171	-77.92199378	5/16/2017	6/3/2017	6/29/2017
CCB-NC-2017-345	33.96577978	-77.92520564	5/16/2017	6/3/2017	6/29/2017
CCB-NC-2017-346	33.96427682	-77.93058657	5/16/2017	6/3/2017	6/29/2017
CCB-NC-2017-347	33.96119965	-77.93393958	5/16/2017	6/3/2017	6/29/2017
CCB-NC-2017-348	33.95958974	-77.94035518	5/16/2017	6/3/2017	6/29/2017
CCB-NC-2017-352	34.08422168	-77.92117151	5/16/2017	6/3/2017	6/29/2017
CCB-NC-2017-353	34.08701395	-77.92122147	5/16/2017	6/3/2017	7/20/2017
CCB-NC-2017-354	34.0895576	-77.92130034	5/16/2017	6/3/2017	6/29/2017
CCB-NC-2017-355	34.09381385	-77.92146211	5/16/2017	6/3/2017	6/29/2017
CCB-NC-2017-356	34.10309932	-77.92179546	5/16/2017	6/3/2017	6/29/2017
CCB-NC-2017-357	34.10706539	-77.92195204	5/16/2017	6/3/2017	6/29/2017
CCB-NC-2017-358	34.12159952	-77.91980065	5/16/2017	6/3/2017	6/29/2017
CCB-NC-2017-359	34.12914659	-77.91606861	5/16/2017	6/3/2017	6/30/2017
CCB-NC-2017-362	34.15867008	-77.93790448	5/17/2017	6/4/2017	6/30/2017
CCB-NC-2017-363	34.2295058	-77.95474774	5/16/2017	6/3/2017	6/29/2017
CCB-NC-2017-364	34.23404912	-77.95324671	5/16/2017	6/3/2017	6/29/2017
CCB-NC-2017-365	34.23476276	-77.95608516	5/16/2017	6/3/2017	6/29/2017
CCB-NC-2017-366	34.23625792	-77.95773195	5/16/2017	6/3/2017	6/29/2017
CCB-NC-2017-367	34.22666894	-77.9554675	5/16/2017	6/3/2017	6/29/2017
CCB-NC-2017-371	34.24672717	-78.00017766	5/16/2017	6/3/2017	6/29/2017
CCB-NC-2017-372	34.19990796	-77.9806101	5/16/2017	6/3/2017	6/29/2017
CCB-NC-2017-373	34.17347713	-77.99029229	5/16/2017	6/3/2017	6/29/2017

Point ID	Latitude	Longitude	Round 1 Date	Round 2 Date	Round 3 Date
CCB-NC-2017-374	34.16271175	-77.98527757	5/16/2017	6/3/2017	6/29/2017
CCB-NC-2017-375	34.13623734	-77.98692193	5/16/2017	6/3/2017	6/29/2017
CCB-NC-2017-377	34.07656959	-77.95602665	5/16/2017	6/3/2017	6/29/2017
CCB-NC-2017-382	33.91712031	-78.02625711	5/16/2017	6/3/2017	6/29/2017
CCB-NC-2017-383	33.91839788	-78.0299361	5/16/2017	6/3/2017	6/29/2017
CCB-NC-2017-386	33.93462315	-78.05794607	5/16/2017	6/3/2017	6/28/2017
CCB-NC-2017-393	33.91246232	-78.12232738	5/16/2017	6/3/2017	6/28/2017
CCB-NC-2017-394	33.91495711	-78.13224158	5/16/2017	6/3/2017	6/28/2017
CCB-NC-2017-395	33.91591114	-78.14167961	5/16/2017	6/3/2017	6/28/2017
CCB-NC-2017-396	33.91648589	-78.15284556	5/16/2017	6/3/2017	6/28/2017
CCB-NC-2017-397	33.91686232	-78.16101037	5/16/2017	6/3/2017	6/28/2017
CCB-NC-2017-398	33.95786365	-78.21371745	5/16/2017	6/2/2017	6/29/2017
CCB-NC-2017-402	33.91378398	-78.30010068	5/16/2017	6/2/2017	6/29/2017
CCB-NC-2017-403	33.91345021	-78.3052221	5/16/2017	6/2/2017	6/29/2017
CCB-NC-2017-404	33.9112477	-78.30258893	5/16/2017	6/2/2017	6/29/2017
CCB-NC-2017-405	33.91337218	-78.30864955	5/16/2017	6/2/2017	6/29/2017
CCB-NC-2017-406	33.91002243	-78.31534191	5/16/2017	6/2/2017	6/29/2017
CCB-NC-2017-407	33.90918818	-78.32412606	5/16/2017	6/2/2017	6/29/2017
CCB-NC-2017-408	33.90968523	-78.33201863	5/16/2017	6/2/2017	6/29/2017
CCB-NC-2017-410	33.91051244	-78.33784129	5/16/2017	6/2/2017	6/29/2017
CCB-NC-2017-411	33.90999477	-78.35024759	5/16/2017	6/2/2017	6/29/2017
CCB-NC-2017-414	33.91912828	-78.41626011	5/16/2017	6/2/2017	6/29/2017
CCB-NC-2017-415	33.90170314	-78.39457344	5/16/2017	6/2/2017	6/28/2017

Point ID	Latitude	Longitude	Round 1 Date	Round 2 Date	Round 3 Date
CCB-NC-2017-416	33.89924347	-78.39887562	5/16/2017	6/2/2017	6/29/2017
CCB-NC-2017-417	33.90039557	-78.39753393	5/16/2017	6/2/2017	6/28/2017
CCB-NC-2017-418	33.89752476	-78.4037357	5/16/2017	6/2/2017	6/29/2017
CCB-NC-2017-420	33.89786096	-78.41531597	5/16/2017	6/2/2017	6/29/2017
CCB-NC-2017-421	33.89180345	-78.43777905	5/16/2017	6/2/2017	6/29/2017
CCB-NC-2017-424	33.87685214	-78.50945212	5/16/2017	6/2/2017	6/28/2017
CCB-NC-2017-425	33.87401277	-78.50872968	5/16/2017	6/2/2017	6/28/2017
CCB-NC-2017-436	35.8564358	-75.86251893	5/9/2017	5/27/2017	7/6/2017
CCB-NC-2017-437	35.84751871	-75.86092771	5/9/2017	5/27/2017	7/6/2017
CCB-NC-2017-438	35.45394159	-77.20321356	4/26/2017	5/20/2017	6/17/2017
CCB-NC-2017-439	34.78689389	-76.61859426	4/30/2017	5/20/2017	6/23/2017
CCB-NC-2017-440	34.80927827	-76.67631783	4/29/2017	5/20/2017	6/23/2017
CCB-NC-2017-441	34.07354138	-77.95466032	5/16/2017	6/3/2017	6/29/2017

APPENDIX II. TABLE WITH ALL POINTS SURVEYED DURING 2018 BLACK RAIL SEASON, LATITUDE AND LONGITUDE (IN DECIMAL DEGREES), AND SURVEY ROUND DATES.

Point ID	Latitude	Longitude	Round 1 Date	Round 2 Date	Round 3 Date
CCB-NC-2018-001	35.31337204	-78.57116859	05/05 AM	05/30 PM	06/21 PM
CCB-NC-2018-004	35.27574017	-78.53245954	05/05 PM	05/30 PM	06/21 PM

Point ID	Latitude	Longitude	Round 1 Date	Round 2 Date	Round 3 Date
CCB-NC-2018-005	35.24717289	-78.58690054	05/05 PM	05/30 PM	06/21 PM
CCB-NC-2018-007	35.23136692	-78.59993962	05/05 PM	05/30 PM	06/21 PM
CCB-NC-2018-008	35.22634622	-78.55982185	05/05 PM	05/30 PM	06/21 PM
CCB-NC-2018-009	35.31718647	-78.51552431	05/05 AM	05/30 PM	06/22 PM
CCB-NC-2018-010	35.33768524	-78.52181725	05/05 AM	05/30 PM	06/21 PM
CCB-NC-2018-011	35.36866856	-78.50943761	05/07 AM	06/03 AM	06/27 PM
CCB-NC-2018-012	35.35866243	-78.5415109	05/05 AM	05/30 PM	06/21 PM
CCB-NC-2018-013	35.35458895	-78.56599969	05/05 AM	05/30 PM	06/21 PM
CCB-NC-2018-014	35.36575864	-78.60323243	05/05 AM	05/30 PM	06/21 PM
CCB-NC-2018-016	35.82212946	-78.09561628	05/08 PM	06/04 AM	07/07 PM
CCB-NC-2018-017	35.27803322	-78.70399902	05/05 PM	05/30 PM	06/21 PM
CCB-NC-2018-018	35.28644125	-78.69544851	05/05 PM	05/30 PM	06/21 PM
CCB-NC-2018-019	35.27884021	-78.69966171	05/05 PM	05/30 PM	06/21 PM
CCB-NC-2018-029	35.10071634	-78.57339034	05/04 PM	05/31 PM	06/25 PM
CCB-NC-2018-030	35.09397742	-78.50231415	05/04 PM	05/31 PM	06/25 PM
CCB-NC-2018-032	35.05570517	-78.22395402	05/04 PM	05/31 AM	06/25 PM
CCB-NC-2018-034	35.1032549	-78.18934287	05/05 AM	05/29 PM	06/21 AM
CCB-NC-2018-036	35.06626374	-78.11821348	05/04 AM	06/02 PM	07/03 PM
CCB-NC-2018-037	35.05840846	-78.08869375	05/04 AM	06/02 PM	07/03 PM
CCB-NC-2018-039	35.12889846	-78.70149152	05/04 PM	05/31 PM	06/25 PM
CCB-NC-2018-040	35.15343478	-78.69686148	05/04 PM	05/31 PM	06/25 PM
CCB-NC-2018-041	35.17145645	-78.61432347	05/04 PM	05/31 PM	06/25 PM

Point ID	Latitude	Longitude	Round 1 Date	Round 2 Date	Round 3 Date
CCB-NC-2018-042	35.10827586	-78.36300497	05/05 AM	05/29 PM	06/21 PM
CCB-NC-2018-043	35.10641256	-78.32294058	05/05 AM	05/29 PM	06/21 PM
CCB-NC-2018-045	35.14422089	-78.36844053	05/05 AM	05/29 PM	06/21 PM
CCB-NC-2018-047	35.12237393	-78.30588092	05/05 AM	05/29 PM	06/21 PM
CCB-NC-2018-049	35.15996496	-78.26632521	05/05 AM	05/29 PM	06/21 AM
CCB-NC-2018-050	35.10542487	-78.21491448	05/05 AM	05/29 PM	06/21 PM
CCB-NC-2018-051	35.12702785	-78.0902283	05/04 PM	06/06 AM	07/05 AM
CCB-NC-2018-052	35.1532439	-78.0902596	05/04 PM	06/06 AM	07/05 AM
CCB-NC-2018-053	35.1535473	-78.08681191	05/04 PM	06/06 AM	07/05 AM
CCB-NC-2018-054	35.14808624	-78.08345277	05/04 PM	06/06 AM	07/05 AM
CCB-NC-2018-057	35.10733169	-78.0049188	05/04 AM	06/02 PM	07/03 PM
CCB-NC-2018-058	35.105035	-78.007121	05/04 AM	06/02 PM	07/03 PM
CCB-NC-2018-060	35.11094674	-77.98022189	05/04 AM	06/02 PM	07/03 PM
CCB-NC-2018-061	35.11369921	-77.88109286	05/04 AM	06/02 PM	07/03 PM
CCB-NC-2018-064	35.1431245	-77.81171539	05/04 AM	06/02 PM	07/03 PM
CCB-NC-2018-065	35.17263437	-77.86055054	05/04 AM	06/02 PM	07/03 PM
CCB-NC-2018-066	35.17112162	-77.81235951	05/04 AM	06/02 PM	07/03 PM
CCB-NC-2018-067	35.13038924	-77.74913421	05/04 AM	06/03 PM	06/22 AM
CCB-NC-2018-069	35.10500782	-77.68601128	05/03 PM	06/03 PM	06/22 AM
CCB-NC-2018-070	35.12907548	-77.44959753	05/11 PM	06/11 AM	07/05 PM
CCB-NC-2018-071	35.19693686	-78.37784351	05/04 PM	05/31 PM	07/08 AM
CCB-NC-2018-072	35.20445475	-78.25351427	05/05 AM	05/29 PM	06/21 AM

Point ID	Latitude	Longitude	Round 1 Date	Round 2 Date	Round 3 Date
CCB-NC-2018-073	35.21129188	-78.25303382	05/05 AM	05/29 PM	06/21 AM
CCB-NC-2018-075	35.20755554	-77.95392252	05/04 AM	06/02 PM	07/03 PM
CCB-NC-2018-078	35.22710039	-77.48124771	05/11 PM	06/11 AM	07/05 PM
CCB-NC-2018-080	35.01920466	-78.44277892	05/04 PM	06/06 AM	07/05 AM
CCB-NC-2018-081	34.95942508	-78.46332687	05/04 PM	05/31 AM	06/25 PM
CCB-NC-2018-082	34.95723856	-78.43011213	05/04 PM	05/31 AM	06/25 PM
CCB-NC-2018-084	35.01123842	-78.30183262	05/04 PM	05/31 AM	06/25 PM
CCB-NC-2018-085	35.00538628	-78.21252221	05/04 PM	05/31 AM	06/25 PM
CCB-NC-2018-086	35.00964043	-78.11890689	05/04 AM	06/03 PM	06/22 AM
CCB-NC-2018-088	34.97491586	-78.08221322	05/04 AM	06/03 PM	06/22 AM
CCB-NC-2018-089	34.98535197	-77.9881569	05/04 AM	06/03 PM	06/22 AM
CCB-NC-2018-090	35.0130832	-78.00176082	05/04 AM	06/03 PM	06/22 AM
CCB-NC-2018-092	34.98416503	-77.75090285	05/03 PM	06/03 PM	06/22 AM
CCB-NC-2018-094	34.96863474	-77.70561291	05/03 PM	06/03 PM	06/22 AM
CCB-NC-2018-095	34.95852914	-77.70596228	05/03 PM	06/03 PM	06/22 AM
CCB-NC-2018-096	35.00368476	-77.63441999	05/03 PM	06/03 PM	06/22 AM
CCB-NC-2018-098	35.32100673	-78.36831643	05/07 AM	06/03 AM	06/27 PM
CCB-NC-2018-099	35.45930442	-77.24615113	05/09 PM	06/05 AM	06/27 AM
CCB-NC-2018-102	35.42514085	-78.01801522	05/08 AM	05/31 PM	07/04 AM
CCB-NC-2018-103	35.43406763	-77.72615991	05/09 AM	05/30 PM	06/28 AM
CCB-NC-2018-111	35.44278932	-77.60722321	05/11 AM	06/04 PM	07/06 AM
CCB-NC-2018-112	35.44986751	-77.57551604	05/11 AM	06/04 PM	07/06 AM

Point ID	Latitude	Longitude	Round 1 Date	Round 2 Date	Round 3 Date
CCB-NC-2018-113	35.44573089	-77.53221918	05/11 AM	06/04 PM	07/06 AM
CCB-NC-2018-114	35.44347107	-77.25947718	05/09 PM	06/05 AM	06/27 AM
CCB-NC-2018-115	35.46717174	-77.26567024	05/09 PM	06/05 AM	06/27 AM
CCB-NC-2018-117	35.3616956	-77.41911361	05/11 PM	06/11 AM	07/05 PM
CCB-NC-2018-119	35.50060544	-78.19732044	05/08 AM	05/31 PM	07/04 AM
CCB-NC-2018-122	35.53888031	-77.73459938	05/09 AM	05/30 PM	06/28 AM
CCB-NC-2018-124	35.53401203	-77.69549552	05/09 AM	05/30 PM	06/28 AM
CCB-NC-2018-126	35.37951808	-78.48526996	05/07 AM	06/03 AM	06/27 PM
CCB-NC-2018-128	35.27134428	-78.25885919	05/07 PM	06/03 AM	06/27 PM
CCB-NC-2018-130	35.44214718	-77.50919838	05/11 AM	06/04 PM	07/06 AM
CCB-NC-2018-131	35.2857971	-78.25387738	05/07 PM	06/03 AM	06/27 PM
CCB-NC-2018-132	35.43458266	-77.74946621	05/09 AM	05/30 PM	06/28 AM
CCB-NC-2018-134	35.42130129	-77.85121039	05/09 AM	05/30 PM	06/28 AM
CCB-NC-2018-135	35.40940403	-77.87992761	05/09 AM	05/30 PM	06/28 AM
CCB-NC-2018-136	35.29680893	-78.1310498	05/07 PM	06/03 AM	06/27 PM
CCB-NC-2018-137	35.31252795	-78.2002098	05/07 PM	06/03 AM	06/27 PM
CCB-NC-2018-139	35.27993422	-78.41981449	05/07 AM	06/03 AM	06/27 PM
CCB-NC-2018-140	35.29078035	-78.34075849	05/07 PM	06/03 AM	06/27 PM
CCB-NC-2018-141	35.31406027	-78.25111014	05/07 PM	06/03 AM	06/27 PM
CCB-NC-2018-142	35.30712895	-78.16213849	05/07 PM	06/03 AM	06/27 PM
CCB-NC-2018-143	35.31046301	-77.46677791	05/11 PM	06/11 AM	07/05 PM
CCB-NC-2018-145	35.32795304	-77.16989853	05/11 PM	06/12 AM	07/05 AM

Point ID	Latitude	Longitude	Round 1 Date	Round 2 Date	Round 3 Date
CCB-NC-2018-146	35.36018591	-77.41209991	05/11 PM	06/11 AM	07/05 PM
CCB-NC-2018-148	35.34659347	-77.59106371	05/11 PM	06/11 AM	07/05 PM
CCB-NC-2018-149	35.34274579	-77.8490466	05/09 AM	05/30 PM	06/28 AM
CCB-NC-2018-151	35.33215397	-78.3977651	05/07 AM	06/03 AM	06/27 PM
CCB-NC-2018-152	35.3553544	-78.47632801	05/07 AM	06/03 AM	06/27 PM
CCB-NC-2018-153	35.44420904	-78.2739328	05/08 AM	05/31 PM	07/04 AM
CCB-NC-2018-154	35.45340879	-78.24449162	05/08 AM	05/31 PM	07/04 AM
CCB-NC-2018-156	35.75866527	-77.90226601	05/08 PM	06/04 AM	07/07 PM
CCB-NC-2018-157	35.73474969	-77.69440742	05/08 PM	06/04 AM	07/07 PM
CCB-NC-2018-158	35.68932626	-77.75381584	05/08 PM	06/04 AM	07/07 PM
CCB-NC-2018-159	35.68604428	-77.66402363	05/08 PM	06/04 AM	07/07 PM
CCB-NC-2018-160	35.71794062	-77.59690772	05/08 PM	06/04 AM	07/07 PM
CCB-NC-2018-161	35.78739633	-77.53476025	05/08 PM	06/04 AM	07/07 PM
CCB-NC-2018-165	35.5406487	-77.7958716	05/09 AM	05/30 PM	06/28 AM
CCB-NC-2018-166	35.37222428	-78.04809207	05/08 AM	05/31 PM	07/04 AM
CCB-NC-2018-167	35.57568869	-77.8115751	05/09 AM	05/30 PM	06/28 AM
CCB-NC-2018-168	35.66755635	-77.73057075	05/12 PM	06/04 AM	07/07 PM
CCB-NC-2018-169	35.7931862	-77.37859092	05/08 AM	06/04 AM	07/07 PM
CCB-NC-2018-170	35.79404075	-77.37697931	05/08 AM	06/04 AM	07/07 PM
CCB-NC-2018-171	35.63992089	-77.39424124	05/08 AM	06/04 AM	07/07 PM
CCB-NC-2018-172	35.65962749	-77.37867975	05/08 AM	06/04 AM	07/07 PM
CCB-NC-2018-173	35.65657944	-77.36760358	05/08 AM	06/04 AM	07/07 PM

Point ID	Latitude	Longitude	Round 1 Date	Round 2 Date	Round 3 Date
CCB-NC-2018-174	35.6541814	-77.29616002	05/09 PM	06/05 AM	06/27 AM
CCB-NC-2018-175	35.63935954	-77.2939501	05/09 PM	06/05 AM	06/27 AM
CCB-NC-2018-176	35.61969066	-77.29843879	05/09 PM	06/05 AM	06/27 AM
CCB-NC-2018-177	35.61855847	-77.17340909	05/09 PM	06/05 AM	06/27 AM
CCB-NC-2018-178	35.62201936	-77.23224485	05/09 PM	06/05 AM	06/27 AM
CCB-NC-2018-179	35.56317087	-77.09199651	05/12 PM	06/10 AM	06/28 PM
CCB-NC-2018-180	35.56315508	-77.09558594	05/12 PM	06/10 AM	06/28 PM
CCB-NC-2018-182	35.5669461	-77.04054626	05/12 PM	06/10 AM	06/28 PM
CCB-NC-2018-184	35.50607819	-77.02914288	05/12 PM	06/10 AM	06/28 PM
CCB-NC-2018-185	35.50409128	-77.03015778	05/12 PM	06/10 AM	06/28 PM
CCB-NC-2018-186	35.53957669	-78.09398417	05/08 AM	05/31 PM	07/04 AM
CCB-NC-2018-187	35.50652097	-78.0880326	05/08 AM	05/31 PM	07/04 AM
CCB-NC-2018-188	35.5106384	-78.09143874	05/08 AM	05/31 PM	07/04 AM
CCB-NC-2018-189	35.48431787	-78.11897117	05/08 AM	05/31 PM	07/04 AM
CCB-NC-2018-190	35.50104496	-78.16764905	05/08 AM	05/31 PM	07/04 AM
CCB-NC-2018-191	35.45660947	-78.21591182	05/08 AM	05/31 PM	07/04 AM
CCB-NC-2018-192	35.51629839	-78.08716667	05/08 AM	05/31 PM	07/04 AM
CCB-NC-2018-193	35.53260778	-77.89191835	05/09 AM	05/30 PM	06/28 AM
CCB-NC-2018-194	35.53195476	-77.21713486	05/09 PM	06/05 AM	06/27 AM
CCB-NC-2018-195	35.5292835	-77.22256447	05/09 PM	06/05 AM	06/27 AM
CCB-NC-2018-196	35.55610713	-77.56261674	05/11 AM	06/04 PM	07/06 AM
CCB-NC-2018-197	35.55390894	-77.56299927	05/11 AM	06/04 PM	07/06 AM

Point ID	Latitude	Longitude	Round 1 Date	Round 2 Date	Round 3 Date
CCB-NC-2018-198	35.55124345	-77.56334713	05/11 AM	06/04 PM	07/06 AM
CCB-NC-2018-199	35.47959369	-76.93186756	05/12 PM	06/10 AM	06/28 PM
CCB-NC-2018-200	35.50826483	-76.95963958	05/12 PM	06/10 AM	06/28 PM
CCB-NC-2018-201	35.58855978	-77.10171041	05/12 PM	06/10 AM	06/28 PM
CCB-NC-2018-202	35.5928974	-77.1442037	05/12 PM	06/10 AM	06/28 PM
CCB-NC-2018-204	35.62530935	-77.1826383	05/09 PM	06/05 AM	06/27 AM
CCB-NC-2018-205	35.62573622	-77.18714931	05/09 PM	06/05 AM	06/27 AM
CCB-NC-2018-206	35.53412447	-77.64310778	05/11 AM	06/04 PM	07/06 AM
CCB-NC-2018-207	35.52898407	-77.62729178	05/11 AM	06/04 PM	07/06 AM
CCB-NC-2018-208	35.54189673	-77.66053117	05/11 AM	06/04 PM	07/06 AM
CCB-NC-2018-209	35.50811543	-77.45161435	05/11 AM	06/04 PM	07/06 AM
CCB-NC-2018-210	35.49548692	-77.61362055	05/11 AM	06/04 PM	07/09 PM
CCB-NC-2018-211	35.56955259	-77.04179644	05/12 PM	06/10 AM	06/28 PM
CCB-NC-2018-212	35.69737806	-77.15568444	05/07 AM	06/09 AM	07/08 AM
CCB-NC-2018-213	35.69695264	-77.16329566	05/13 AM	06/09 AM	07/08 AM
CCB-NC-2018-214	35.6930739	-77.15826736	05/07 AM	06/09 AM	07/08 AM
CCB-NC-2018-215	35.69621652	-77.15141406	05/13 AM	06/09 AM	07/08 AM
CCB-NC-2018-216	35.70124846	-77.15822755	05/07 AM	06/09 AM	07/08 AM
CCB-NC-2018-217	35.68819631	-77.13618828	05/07 AM	06/09 AM	07/08 AM
CCB-NC-2018-218	35.69073313	-77.13082935	05/13 AM	06/09 AM	07/08 AM
CCB-NC-2018-219	35.69911598	-77.13852859	05/13 AM	06/09 AM	07/08 AM
CCB-NC-2018-220	35.71283876	-77.15639819	05/14 AM	06/09 AM	07/08 AM

Point ID	Latitude	Longitude	Round 1 Date	Round 2 Date	Round 3 Date
CCB-NC-2018-221	35.71770377	-77.15268077	05/13 AM	06/09 AM	07/08 AM
CCB-NC-2018-222	35.70802204	-77.15368604	05/13 AM	06/09 AM	07/08 AM
CCB-NC-2018-223	35.70799733	-77.16170247	05/07 AM	06/09 AM	07/08 AM
CCB-NC-2018-224	35.71673401	-77.16302859	05/14 AM	06/09 AM	07/08 AM
CCB-NC-2018-225	35.71569544	-77.14251353	05/14 AM	06/09 AM	07/08 AM
CCB-NC-2018-227	35.70787005	-77.13825656	05/14 AM	06/09 AM	07/08 AM
CCB-NC-2018-228	35.69015426	-77.14105974	05/07 AM	06/09 AM	07/08 AM
CCB-NC-2018-300	35.425339	-78.020002	05/15/PM	05/31 PM	07/04 AM
CCB-NC-2018-301	35.422365	-78.023644	05/15/PM	05/31 PM	07/04 AM
CCB-NC-2018-302	35.2623962	-77.807282	05/16 PM	06/12 AM	07/05 AM
CCB-NC-2018-303	35.268006	-77.794284	05/16 PM	06/12 AM	07/05 AM
CCB-NC-2018-304	35.458276	-77.570198	05/11 AM	06/04 PM	07/06 AM
CCB-NC-2018-305	35.76535	-77.36902	05/08 PM	06/04 AM	07/07 PM
CCB-NC-2018-800	35.24054653	-76.56975796	05/26 PM	06/15 PM	07/02 PM
CCB-NC-2018-801	35.28485959	-76.53857784	05/26 PM	06/15 PM	07/02 PM
CCB-NC-2018-803A	34.85508317	-76.41398005	No Survey	06/16 PM	No Survey
CCB-NC-2018-805	35.26826311	-76.61668967	05/27 PM	06/15 PM	07/02 PM
CCB-NC-2018-806	35.27268628	-76.61354468	05/27 PM	06/15 PM	07/02 PM
CCB-NC-2018-807	34.52902232	-77.34512055	05/22 PM	No Survey	No Survey
CCB-NC-2018-809	33.97275819	-77.91975998	05/21 PM	06/13 PM	06/29 PM
CCB-NC-2018-810	33.95133755	-77.92821582	05/21 PM	06/13 PM	06/29 PM
CCB-NC-2018-811	33.9453964	-77.93072189	05/21 PM	06/13 PM	06/29 PM

Point ID	Latitude	Longitude	Round 1 Date	Round 2 Date	Round 3 Date
CCB-NC-2018-812	33.9370548	-77.93538236	05/21 PM	06/13 PM	06/29 PM
CCB-NC-2018-814	34.23393531	-77.9532388	05/20 PM	06/13 PM	06/29 PM
CCB-NC-2018-815	34.23475252	-77.95603649	05/21 PM	06/13 PM	06/29 PM
CCB-NC-2018-816	33.891512	-78.0278194	05/20 PM	No Survey	No Survey
CCB-NC-2018-817	34.79851256	-76.63065247	No Survey	06/16 PM	No Survey
CCB-NC-2018-820	34.52630462	-77.34869626	05/22 PM	No Survey	No Survey
CCB-NC-2018-901	34.9512306	-76.34998611	No Survey	06/07 PM	No Survey
CCB-NC-2018-902	34.953250	-76.34816944	No Survey	06/07 PM	No Survey
CCB-NC-2018-903	34.9552361	-76.34633889	No Survey	06/07 PM	No Survey
CCB-NC-2018-907	34.9465389	-76.34839722	No Survey	06/07 PM	No Survey
CCB-NC-2018-914	34.9407500	-76.35608333	No Survey	No Survey	06/30 PM
CCB-NC-2018-916	34.9388611	-76.35863889	No Survey	No Survey	06/30 PM
CCB-NC-2018-917	34.9379167	-76.36100000	No Survey	No Survey	06/30 PM
CCB-NC-2018-918	34.9369722	-76.36363889	No Survey	No Survey	06/30 PM

Survey Playback Sources:

Ki-ki-kerr: Sourced from Cornell Lab of Ornithology, Macaulay Library in 2007.

Churt: Sourced from Christy Hand, South Carolina DNR

Growl: Sourced from Cornell Lab of Ornithology, Macaulay Library in 2007.

Eek-eek call: Sourced from Cornell Lab of Ornithology, Macaulay Library, Florida call.

Survey Windows: All 2017 surveys will take place between 18 April and 21 July 2017, with survey window one between 18 April and 17 May 2017, window 2 between 18 May and 17 June 2017, and window 3 between 18 June and 21 July 2017. All 2018 surveys will take place between 1 May and 15 July 2018, with survey window one between 1 May and 25 May 2018, survey window two between 26 May and 19 June 2018, and survey window three between 20 June and 15 July 2018.

Survey Time of Day: All 2017 and 2018 coastal surveys will take place between a half hour after sunset and will conclude by a half hour prior to sunrise. All inland 2018 surveys will follow standard SC and USFWS protocols and start a half hour before sunrise to 3.5 hours after sunrise or 3.5 hours before sunset to .5 hours after sunset.

Survey Routes: A survey route is a set of points that can be surveyed together during the same night. The number of points per route will depend primarily on logistics. The factor most limiting the number of points per route is the time needed to travel between points. The playback/listening period lasts for 10 minutes. Plan to spend around 12-15 minutes per survey point. It might be possible to survey up to 3-4 points per hour on routes where points are close together and where you can drive from point to point. Routes with more complicated logistics (long distance between points/boat based points) will include fewer points. Surveyors should carefully consider safety and convenience when planning routes, and find safe places to park when doing road based points. Routes can be reorganized during the field season, and care should be taken not to sample the same point repeatedly at the same time of day (e.g., alternate the order of locations along a given route on subsequent visits).

Survey Points and Broadcast Equipment Placement: Surveyor(s) will stand at pre-selected survey point coordinates. Survey points should be marked with pin flagging (and labeled with survey point ID with a permanent marker in a nook of the flagging) during scouting, if visited, or the first survey of the season for ease of location through the rest of the season. Each point should be surveyed at least 3 times, with a 10-day minimum between surveys of the same point.

The game caller should be placed on the ground near the center of the point (on road based surveys) or the bow of the boat during playback surveys. Surveyor should stand 5m away from caller if possible to better hear responses. When surveyors are surrounded completely by marsh, orient the caller toward magnetic north. At survey points located on the edge of open water or upland habitat, orient the broadcast caller towards the center of appropriate marsh habitat. Do not rotate the speaker during the broadcast survey. Speakers should not face the surveyors. Both speakers of the broadcast callers should be operational in open marsh and only the forward speaker operational when the surveying

from the edge of open water or upland habitat. Sound pressure should be 70-80 dB at 3 feet in front of the speaker; the appropriate volume level on the FoxPro NX3 or NX4, in combination with this project's audio file, is illustrated in the figure below. When viewed straight on, the centerline of the volume knob should align with the trailing edge of the last marked volume setting. Replace batteries in game caller with freshly charged batteries at least every other day of surveys and daily, if necessary.

Figure1. NX4 or NX3 volume level during surveys.

Surveyors: If two observers survey the same point, each surveyor should fill out a separate data sheet and record their data separately without pointing out or discussing bird observations with the other surveyor. Each surveyor should stand 1-2 meters away from each other and avoid cueing the other surveyor with sudden writing activity. Once that evening survey window is completed, surveyors may discuss their observations and any discrepancies, but the original data sheets must not be altered; obvious mistakes should be noted in the comments section of the data sheet, but the original data must not be changed. If a change is necessary while conducting the survey, strike a line through the data and proceed to correct the data on the next available line, but do not erase data from the data sheet. Similarly, if a surveyor must be accompanied by an untrained individual for safety reasons, the surveyor should instruct the accompanying individual neither to collect data nor influence the surveyor in any way (e.g., call out bird sightings during the survey).

Weather Restrictions: Surveys should only be conducted when wind speed is <20 kmph (moderate breeze; dust and loose paper raised; small branches begin to move), and not during periods of sustained rain or heavy fog. Even winds <20 kmph affect the detection probability of marsh birds, especially Black Rail, and perhaps even suppresses their calling behavior. Surveyors should postpone surveys if they believe winds (or other ambient noise) are dramatically affecting the detection probability of marsh birds. If wind speed increases to >20 kmph, or sustained rains/fog begin during a morning or evening survey window, surveyors should cease surveys for that window and visit unsurveyed sites at another time.

Recording Bird Detections: We distinguish between primary and secondary species, which differ in the way data are recorded as described below. Primary Species & 4-letter AOU codes: Each individual is recorded on a separate line and record minute by minute data.

BLRA - Black Rail

CLRA – Clapper Rail

KIRA – King Rail

CLING – Clapper/King

LEBI – Least Bittern

VIRA - Virginia Rail

SORA – Sora Rail

CWWI – Chuck Will's Widow

WPWI – Whip Poor Will

<u>**Secondary Species & 4-letter AOU codes:**</u> All individuals in a given distance band are recorded on a single line

SESP – Seaside Sparrow

MAWR – Marsh Wren

SEWR – Sedge Wren

<u>**Incidental Species:**</u> **record all species heard or seen, including owls, herons, etc… in this portion of the data sheet.**

<u>**Distance and direction:**</u> For Black Rail, the only primary species, record an estimate of the exact distance and the general direction (N, NE, E, SE, S, SW, W, or NW, or to the degree marker on a compass) to the initial detection of each individual. Recalling the orientation of the broadcast caller can make this determination more efficient. For secondary species, record the estimated distance band at the time of first detection.

<u>**Time of detection:**</u> Detections of each individual marsh bird should be recorded minute-by-minute during the 10-minute survey period. The beginning of each passive minute during the survey period is indicated by "start". Surveyors should distinguish and indicate the call type(s) of all Black Rail detections during a given survey minute using the call type codes on the provided "cheat sheet"; multiple call types may be recorded in a given minute (e.g., a Black Rail *ki-ki-kerr* followed by a *growl* would be recorded K, GR). For secondary species, indicate the number of individuals detected in each minute using dot and line notation. <u>Remember that for secondary species, each line of the data corresponds to a single distance band</u>. Examples are provided below.

<u>**Species Identification:**</u> *King Rail vs. Clapper Rail*: These species make similar vocalizations. King Rails typically breed in freshwater marshes and Clapper Rails breed in saltwater marshes. In brackish marshes or inland salt marshes (e.g., N. Pamlico Sound), however, surveyors may not be able to confidently identify vocalizations to species and should, in these situations, record these individuals as KCRA (King-Clapper Rails).

<u>**Birds detected at a prior survey point:**</u> If a surveyor suspects that a marsh bird detected during a survey is an individual detected at a previous survey point, the surveyor should proceed to record the requisite detection data <u>and record</u>

"detected at a previous point" in the comments column. When in doubt, be conservative as to whether an individual bird detected at the current point was the same individual recorded at a previous point (i.e., make a note in the *comments* column).

Birds detected outside the survey period (approaching or leaving): Record any Black Rail detected outside of the survey period by recording the distance and direction of the detection, indication the call type(s) in the "outside survey period" column, and recording your coordinates at the time of detection in the notes column. For example, if a Black Rail is detected while moving between survey points, record the detection data on the data sheet for the prior (or forthcoming) survey point as described, and record coordinates of the location where you detected the Rail.

Protocol Sources:

Conway, Courtney J. 2009. Standardized North American Marsh Bird Monitoring Protocols, version 2009-2. Wildlife Research Report #2009-02. U.S.Geological Survey, Arizona Cooperative Fish and Wildlife Research Unit, Tucson, AZ. **Conway Protocol**

Conway, Courtney J. 2011. Standardized North American Marsh Bird Monitoring Protocol. Waterbirds 34: 319-346. **Conway Protocol**

Conway, Courtney J., Christina Sulzman, and Barbara E. Raulston. 2004. Factors affecting detection probabilities of Black Rail. Journal of Wildlife Management 68 (2): 360-370.

Florida Fish & Wildlife Conservation Commission. 2016. DRAFT - 2016 Black Rail Survey Protocol. **Florida Protocol**

SHARP. 2012. SMI Avian Point-Count/Callback Survey Protocol (revised November 2012), Summary of the Standardized North American Marsh Bird Monitoring Protocols, Modified From Courtney Conway Wildlife Research Report #2007-04. **SHARP Protocol**

South Carolina Division of Natural Resources. 2016. 2016 Black Rail Survey Protocol - South Carolina. **South Carolina Protocol**

Smith, A. and W. Wiest. 2017 Secretive Marshbird Survey, Southeast Region. **(Regional Protocol).**

Wilson, M.D., B.D. Watts, and F.M. Smith. 2009. Status and Distribution of Black Rail in Virginia. Center for Conservation Biology Technical Report Series, CCBTR-09-10. College of William and Mary and Virginia Commonwealth University. Williamsburg, VA. **Virginia, Maryland, North Carolina, Georgia Protocol.**