Inferring Brown-Capped Rosy-Finch demography and breeding distribution trends from long-term wintering data in New Mexico

New Mexico Department of Game and Fish, Share with Wildlife Program

Semi-Annual Report

June 2023

PRINCIPAL INVESTIGATORS

Abby Lawson
USGS New Mexico Cooperative Fish and Wildlife Research Unit, Department of Fish, Wildlife, and Conservation Ecology, New Mexico State University

Corrie Borgman
USFWS Division of Migratory Bird Management, Southwest Region

Steve Cox
Rio Grande Bird Research, Inc.

PROJECT LEAD

Whitney Watson
Graduate Research Assistant (Report Author), Department of Fish, Wildlife, and Conservation Ecology, New Mexico State University

ABSTRACT

The three Rosy-finch species, Brown-capped (*Leucosticte australis*), Black (*L. atrata*), and Gray-crowned (*L. tephrocotis*; hereafter Rosy-finches) are among the most climate-threatened species in the United States. New Mexico is an important location for understanding the effects of climate change because it is the southernmost location in which Brown-capped Rosy-finches breed and all three species co-occur during winter. Rosy-finches are difficult to study during the breeding season due to their remote, high-elevation breeding sites, so studies in winter when individuals can be found at lower elevations and at bird feeders may lend insight into population trends and direct conservation actions based on the breeding origins of wintering birds. Our study will evaluate long-term demographic and geographic origin trends from

wintering Brown-capped Rosy-finches in New Mexico and evaluate the efficacy of radio frequency identification (RFID)-equipped artificial feeders to monitor population trends. As of June 2023, the analysis of RFID, mark-recapture, and feather sample data is underway.

INTRODUCTION

Rosy-finches are among the most climate-threatened taxa in the United States. The three species found in North America— Brown-capped (*Leucosticte australis*; BCRF), Black (*L. atrata*; BLRF), and Gray-crowned Rosy-finches (*L. tephrocotis*; GCRF; hereafter referred to collectively as Rosy-finches), breed exclusively in high alpine or tundra ecosystems. Because alpine and tundra biomes are predicted to be disproportionately impacted by climate change (Pepin et al. 2015), Rosy-finches face high risk of habitat loss from shrub encroachment and the reduction of forage availability and quality due to changes in phenology (Grace et al. 2002). All three species are protected by the Migratory Bird Treaty Act, and both BCRF and BLRF are listed as Birds of Conservation Concern by the U.S. Fish and Wildlife Service (USFWS 2021) and are included in the Partners in Flight Red Watch list (Rosenberg et al. 2019). They are also included in seven of eight State Wildlife Action Plans throughout their range (including New Mexico). Despite concern for these species, little knowledge exists regarding Rosy-finch life histories, vital rates, and migration patterns.

Although the three Rosy-finch species have distinct breeding ranges (Figure 1), they occupy a broader range of habitats and may occur together outside of the breeding season. The [redacted] northern New Mexico is the southernmost wintering locale in which all three Rosy-finch species co-occur ([redacted] Figure 1), but BCRF is the only species that breeds in New Mexico. Our study leverages an existing, long-term (20 years) mark-recapture dataset with accompanying feather samples [redacted], and includes a novel component: evaluating the efficacy of RFID-equipped artificial feeders to monitor wintering Rosy-finches. The Share with Wildlife funds are being used to support three tasks related to BCRF (below) as part of a larger study focusing on all three Rosy-finch species that will contribute to a PhD dissertation. For ease of presentation, we report results for all three species.

Task 1: Establish new RFID feeders for the winter (2022-23 field season)

Task 2: Demographic analysis of mark-recapture data

Task 3: Stable isotope analysis of feather samples

SUMMARY OF ACTIVITIES TO DATE

During the reporting period (January–June) for calendar year 2023, we have made progress in the following areas:

- Successful completion of the 2022–2023 Rosy-finch field season by Steve Cox and Rio Grande Bird Research Inc. associates. This included installation of two RFID-equipped feeders by Corrie Borgman. Throughout the season, she made significant improvements in the feeder design and implementation arrangements for future deployments (Task 1)
- Whitney Watson (project PhD student) began at New Mexico State University (NMSU) as a graduate research assistant in January 2023. This semester she successfully completed her Spring semester 2023 coursework, identified three of the required four members of her PhD committee, and initiated preliminary analyses of mark-recapture data (Task 2)
- Whitney traveled to Albuquerque in January 2023 to assist with Rosy-Finch banding on [redacted], obtained [redacted] feather samples, and received training in stable isotope sample preparation (Task 3)
- Whitney has been accepted to IsoCamp 2023 to be held June 19–30, 2023 at the Center for Stable Isotopes (CSI) at the University of New Mexico (UNM) (Task 3)
- Abby Lawson established a contract with UNM's CSI for analysis of n=460 BCRF feather samples. Whitney will deliver the first batch to UNM when she attends Isocamp (Task 3)
- The team brought on an undergraduate researcher (funded via a separate USDA grant), Cynthia Dunkelberger, in affiliation with NMSU's Avian Migration Program to assist with stable isotope feather sample preparation during the Spring 2023 semester. Cynthia will resume work on the project in the 2023-2024 academic year and is focusing on a separate project evaluating isotopic variation among feather samples (Task 3)
- The team hired an undergraduate laboratory technician (funded via a separate grant), Alexes Albillar, to assist with stable isotope sample preparation during Summer 2023 (Task 3)

Next, we detail progress on project-specific tasks identified in the original project scope of work and provide an estimate of percent completion.

Task 1: Establish new RFID feeders for the winter (2022-23 field season)

We initiated a pilot study to evaluate the efficacy of radio frequency identification (RFID)-equipped feeders to improve vital rate estimates and evaluate connectivity among wintering sites. Rosy-finches are known for their nomadic behavior during winter, in which they may make long-range movements within their winter range for reasons that are not well understood. Such movements (temporary emigration) violate the assumptions of many traditional modeling frameworks; therefore, relatively complex modeling frameworks that require thorough data are needed to provide unbiased vital rate estimates.

In recent years, multiple avian studies have demonstrated that fitting grain feeders with RFID-enabled 'smart' devices is an effective way to acquire visit and movement data from wintering birds that were previously marked with tags that the RFID reader can detect at close ranges. This approach was recently used by Latimer and Gardner (2022) for BLRF and GCRF in northern Utah and generated thousands of annual detections to help infer overwinter survival and movement patterns. The RFID component of this study provides a synergistic opportunity to evaluate Rosy-finch winter movements at small (within New Mexico) and broad ranges (across states), given the growing network of RFID-equipped feeders in their wintering range.

An RFID reader apparatus consists of RFID reader card powered by 6,400mAh USB battery packs and 3.5 Watt 6 V solar panel arrays (Voltaicsystems.com). We used Arduino based hardware (https://www.arduino.cc/) that integrates with Electronic Transponder Analysis Gateway (ETAG) open-source software and database (Bridge et al. 2019). These readers detect low-frequency (125 kHz) RFID tags affixed to the legs of tagged Rosy-Finches, and store these detection data both within onboard storage on the reader, as well as on SD memory cards. Birds equipped with RFID tags are detected when they land on or within antenna coils designed to match tag frequencies. Largely based on trial and error, we utilized numerous iterations of feeder and antenna designs to eventually reach an optimal combined design. Antennae were frequently damaged by squirrels chewing on the apparatus, which was improved through more robust housing for the antenna coils, as well as hot pepper and weatherproof coatings to deter squirrels. This method did not completely resolve the squirrel damage issues, but resulted in greater duration between repairs, and the ability to mitigate damage before complete failure of the antenna. Furthermore, card reader performance was improved by using more robust weatherproof housing to protect the reader cards and reduce the need to move componentry.

We deployed two RFID antenna arrays on a platform feeder [redacted] on 20 January 2023. We had planned to deploy a similar RFID-equipped feeder at [redacted] in winter 2023, but after numerous performance and design issues as discussed above, we decided to focus our efforts on improving the reader and antenna designs at [redacted] site before deploying at a site that requires a significantly greater investment of time and travel.

Antennae were checked and repaired as necessary through 8 February, when the entire apparatus was removed for a design overhaul. The apparatus was re-deployed on 10 February. After re-deployment, fewer antennae were damaged, and there were no card performance issues. However, following a severe storm, an entire side of the array disappeared; this was later found but was not salvageable. Data from bird detections were collected by the onboard RFID card reader memory, and a copy was downloaded onto a SD card approximately weekly from the date of deployment through the middle of April.

Between 20 January and 10 April 2023, we recorded 2,810 detections of 51 unique tags at [redacted] RFID readers. 54 birds were banded and fitted with RFID tags during winter 2023 and 94% of tagged birds were detected at least once at the RFID readers. The number of detections for individual birds ranged from 1 -255 detections (Mean: 55.1 ± 1 SD). The RFID apparatus was removed on 16 April after no new detections had been recorded for 6 days. Deployment of an RFID-equipped feeder at [redacted] is planned for winter 2024.

Percent completion: 40%

Task 2: Demographic analysis of mark-recapture data

We are using existing mark-recapture data from a long-term study on wintering Rosy-finches to examine demographic trends. Among Rosy-finch studies, this dataset is unique in its extreme longevity, large sample size, and the location in which the effects of climate change are predicted to be more acute compared to other locales. Specifically, we are evaluating trends in winter abundance and survival probability.

Whitney has begun data quality assurance/quality control procedures and preliminary analysis of the long-term Rosy-finch mark-recapture data set to estimate Rosy-finch survival and abundance. The number of individuals captured and banded varied among years with between 1 and 312 captures for BCRF, 8 and 607 for BLRF, and 3 and 189 for GCRF, with banding efforts remaining relatively consistent among years (Figure 2). In a rudimentary Cormack-Jolly-Seber survival analysis including year, sex, and age at first capture as covariates, the top model in the BCRF analysis included age at first capture as a covariate for survival and year as a covariate for detection probability, the top model in the BLRF analysis included year as a covariate for both survival rate and detection probability, and the top model in the GCRF analysis was the null model with no covariates. Brown-capped Rosy-finch survival averaged across all years was 0.36 (95% CI: 0.30–0.43) for juveniles and 0.25 (95% CI: 0.18–0.33) for adults, BLRF survival (of juveniles and adults together) varied by year from 0.07 to 1.00, and GCRF survival of both juveniles and adults averaged across all years was estimated to be 0.37 (95% CI: 0.25–0.51; Figure 3).

Percent completion: 15%

Task 3: Stable isotope analysis of feather samples

Two stable isotopes of hydrogen occur in nature—protium [^{1}H] and deuterium [^{2}H]—and the ratio of these isotopes (δD) in precipitation varies geographically and with elevation in a predictable pattern (Hobson and Wassenaar 1997, Meehan et al. 2004). Consequently, the δD signature of a particular location is reflected in local soils and tissues of the local vegetation. This signature is then also reflected in consumer tissues (such as feathers) grown in a particular location as a result of nutrient uptake in that location (Bowen et al. 2005, Wunder 2012). Because Rosy-finches undergo complete molts each breeding season (Pyle 1997), a feather collected during the winter is assumed to have been grown on the breeding grounds during the preceding breeding season, and should thus reflect the δD signatures of local diet items. We can thus infer the breeding locations of individuals by generating probability-of-origin maps (Campbell et al. 2020; Figure 4) based on the δD signatures of feathers sampled over the winter when Rosy-finches can be much more readily located and captured than during the breeding season. Using the results of these stable isotope analyses, we will also investigate the influence of climate covariates at locations of breeding origin and local site conditions that might explain any observed variances in abundance, survival, or breeding origin.

Whitney has received training in feather cleaning, weighing, and packaging for isotopic analysis from the Center for Stable Isotopes at the University of New Mexico (UNM), and has been accepted to the IsoCamp course at UNM. Whitney will attend this course in late June 2023 to receive more in-depth training in stable isotope research. Together with undergraduate researchers Cynthia and Alexes and based on a feather prioritization plan, Whitney has organized the feather samples collected by Rio Grande Bird Research [redacted], , has cleaned ~400 BCRF feathers, and has weighed and packaged ~80 of these feathers for analysis as of June 2023.

<u>Percent completion:</u> 15%

Project Timeline for Remainder of 2023

Quarter 3: July 1, 2023 – September 30, 2023:

- Whitney will enroll in in Fall 2023 semester coursework at NMSU, begin preliminary analyses of breeding origin data, and conduct a literature review to advance her understanding of mark-recapture analysis techniques and meet with committee members to refine plans for demographic trend analysis. She will then begin more complex analysis of Rosy-finch survival and abundance based on mark-recapture data
- The NMSU team will submit multiple batches of cleaned and processed stable isotope samples (target: complete 460 BCRF samples)

Quarter 4: October 1, 2023 – December 31, 2023:

- Whitney to finalize PhD committee and hold preliminary exam (required by the NMSU Biology Department), and present preliminary demographic analyses at the Chihuahuan Desert Conferences (*pending acceptance of submitted abstract*)
- Initiate 2023-2024 Rosy-finch banding season [redacted] (lead: Steve Cox), construct and deploy all RFID reader-equipped bird feeders
- Prepare and submit reports for NMDGF and USFWS grants (PI team and Whitney)

LITERATURE CITED

Bowen, G. J., L. I. Wassenaar, and K. A. Hobson. 2005. Global application of stable hydrogen and oxygen isotopes to wildlife forensics. Oecologia 143:337–348.

Bridge, E. S., J. Wilhelm, M. M. Pandit, A. Moreno, C. M. Curry, T. D. Pearson, D. S. Proppe, C. Holwerda, J. M. Eadie, T. F. Stair, A. C. Olson, B. E. Lyon, C. L. Branch, A. M. Pitera, D. Kozlovsky, B. R. Sonnenberg, V. V. Pravosudov, and J. E. Ruyle. 2019. An Arduino-Based RFID Platform for Animal Research. Frontiers in Ecology and Evolution 7:257.

Campbell, C. J., M. C. Fitzpatrick, H. B. Vander Zanden, and D. M. Nelson. 2020. Advancing interpretation of stable isotope assignment maps: comparing and summarizing origins of known-provenance migratory bats. Animal Migration 7:27–41.

Fink, D., T. Auer, A. Johnston, M. Strimas-Mackey, S. Ligocki, O. Robinson, W. Hochachka, L. Jaromczyk, A. Rodewald, C. Wood, I. Davies, A. Spencer. 2022. eBird Status and Trends, Data Version: 2021; Released: 2022. Cornell Lab of Ornithology, Ithaca, New York. https://doi.org/10.2173/ebirdst.2021

Grace, J., F. Berninger, and L. Nagy. 2002. Impacts of Climate Change on the Tree Line. Annals of Botany 90:537–544.

Hobson, K. A., and L. I. Wassenaar. 1997. Linking breeding and wintering grounds of neotropical migrant songbirds using stable hydrogen isotopic analysis of feathers. Oecologia 109:142–148.

Latimer, C.E. and Gardner, J.H. 2022. Leveraging RFID-enabled bird feeders to monitor Rosy-Finch phenology and demographics. Bird Conservancy of the Rockies and Sageland Collaborative.

Meehan, T. D., J. T. Giermakowski, and P. M. Cryan. 2004. GIS-based model of stable hydrogen isotope ratios in North American growing-season precipitation for use in animal movement studies. Isotopes in Environmental and Health Studies 40:291–300.

Pepin, N., H. F. Diaz, R. S. Bradley, and M. Baraer. 2015. Elevation-dependent warming in mountain regions of the world. Nature Climate Change 5:424–430.

Pyle, P. 1997. Identification Guide to North American Birds, Part I. Slate Creek Press, Bolinas, CA, USA.

Rosenberg, K. V., A. M. Dokter, P. J. Blancher, J. R. Sauer, A. C. Smith, P. A. Smith, J. C. Stanton, A. Panjabi, L. Helft, M. Parr, and P. P. Marra. 2019. Decline of the North American avifauna. Science 366:120–124.

USFWS. 2021. Birds of Conservation Concern 2021. U.S. Department of Interior, Falls Church, Virginia.

Wunder, M. B. 2012. Determining geographic patterns of migration and dispersal using stable isotopes in keratins. Journal of Mammalogy 93:360–367.

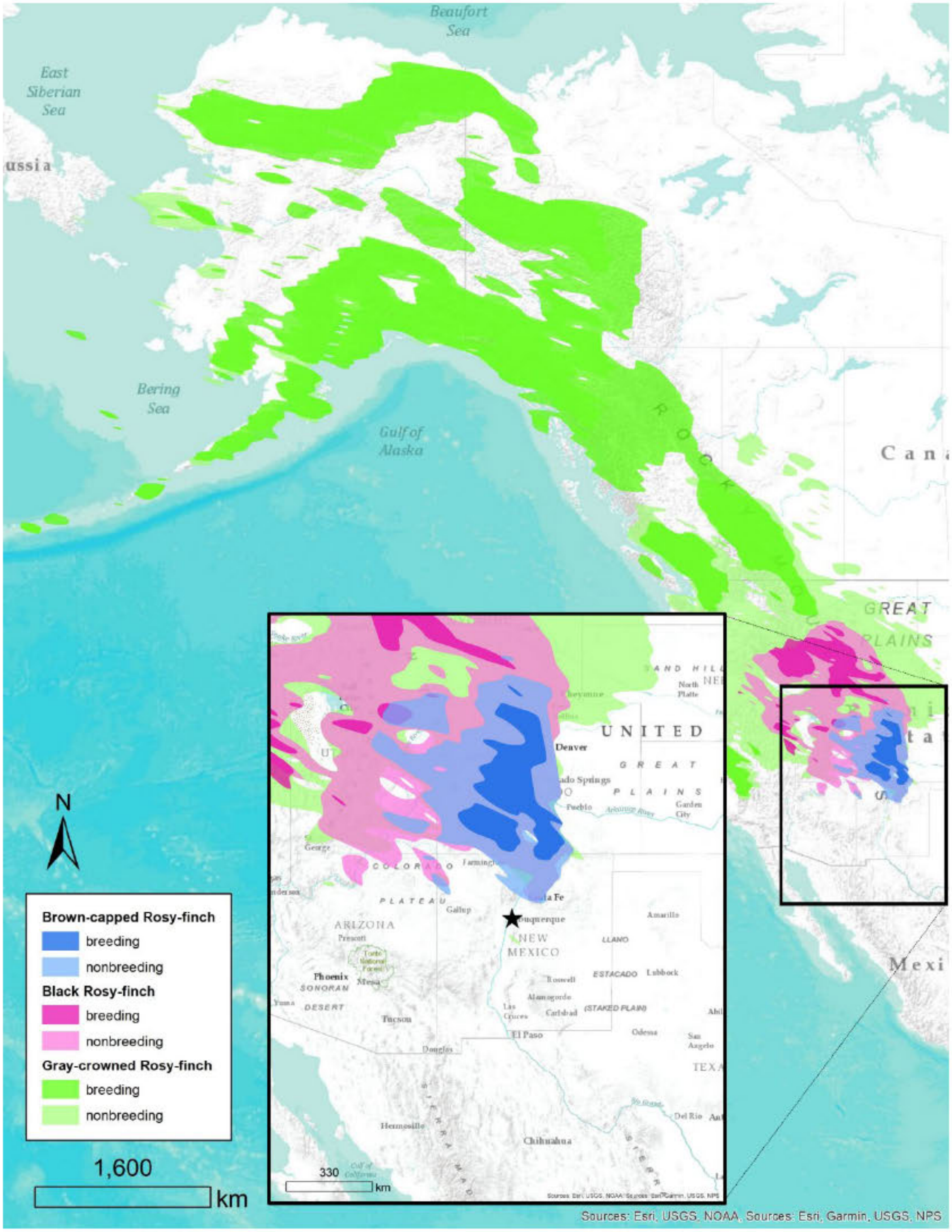

Figure 1. Distributions of each of the three North American Rosy-finch species. Darker colors represent breeding ranges, and the black star indicates the study site [redacted] in northern New Mexico. Data layers from Fink et al. 2022.

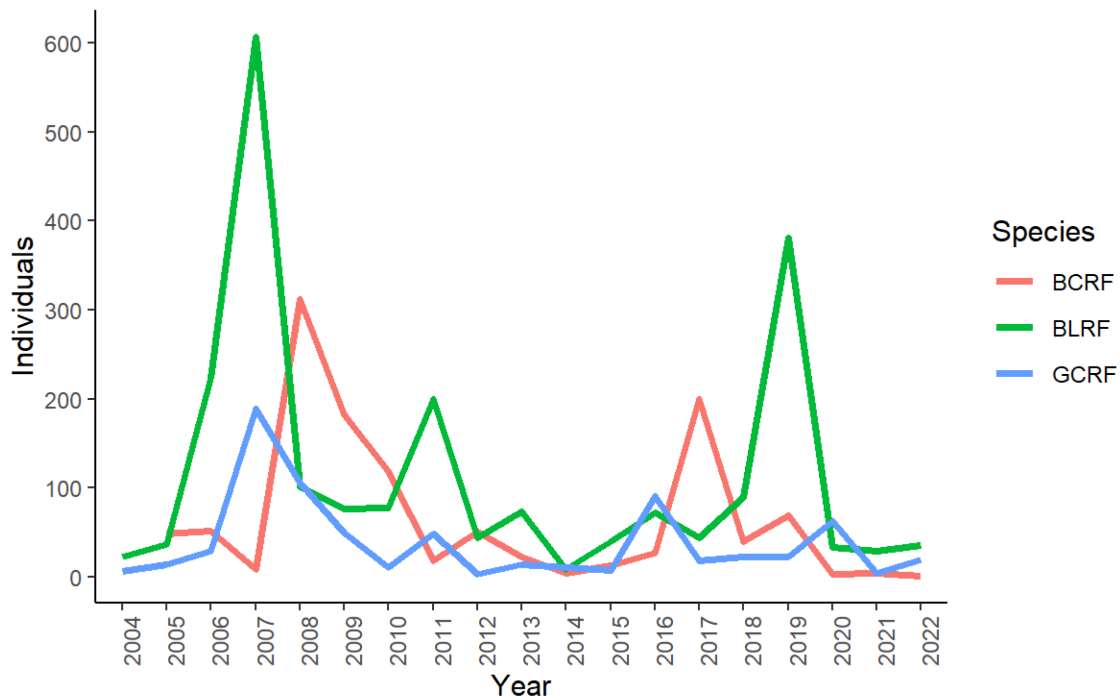

Figure 2. Number of unique Rosy-finches captured by species during each winter banding season [redacted] NM 2004–2022. Year denotes latter year of winter season (e.g., "2004" refers to November 2003–April 2004 winter season).

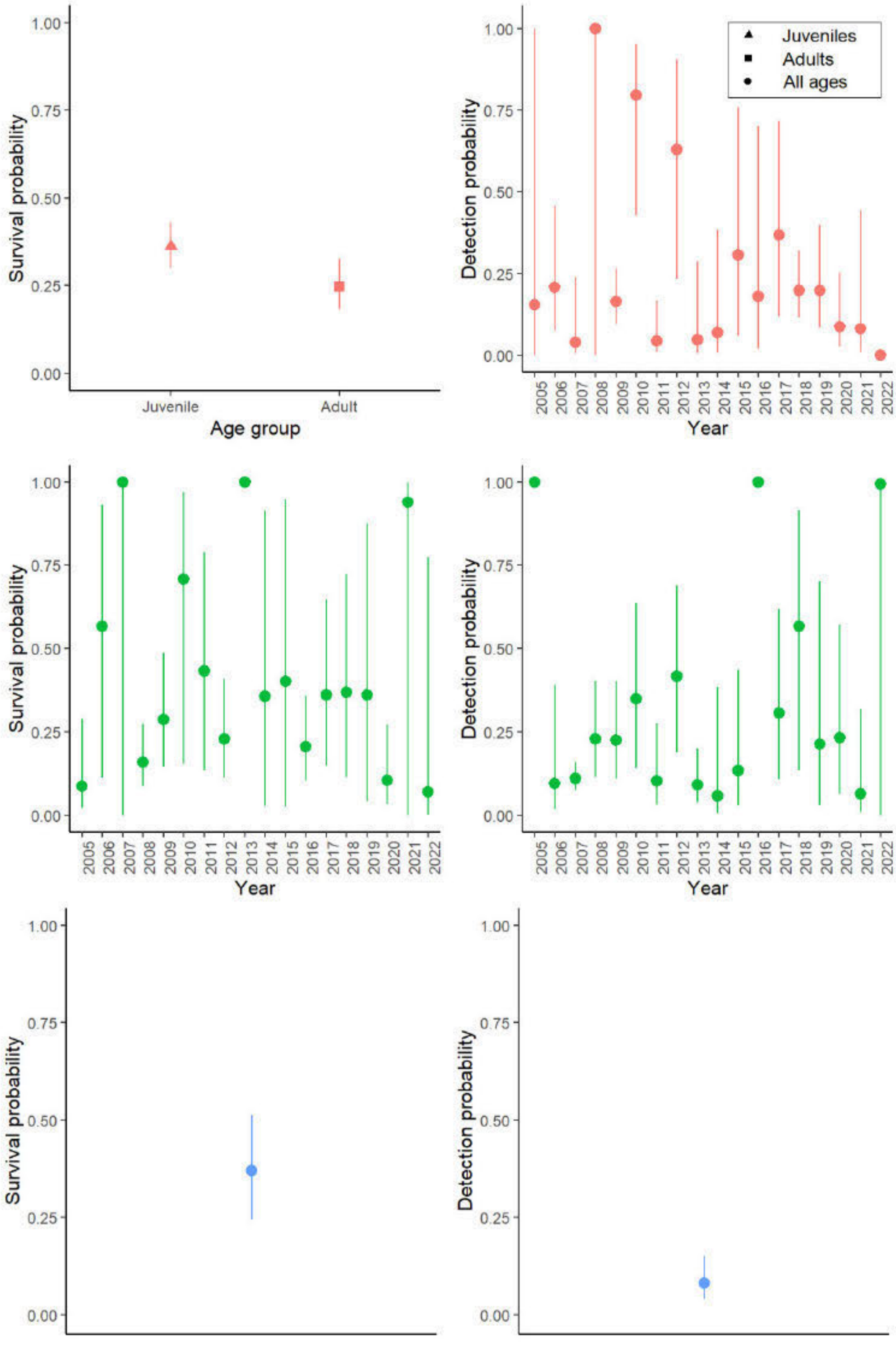

Figure 3. Apparent survival (left) and detection (right) probability estimates for Brown-capped Rosy-finches (top; in red), Black Rosy-finches (middle; in green), and Gray-crowned Rosy-finches (bottom; in blue) overwintering [redacted] from 2004 to 2022. Juveniles are indicated by hollow circles; adults by filled circles.

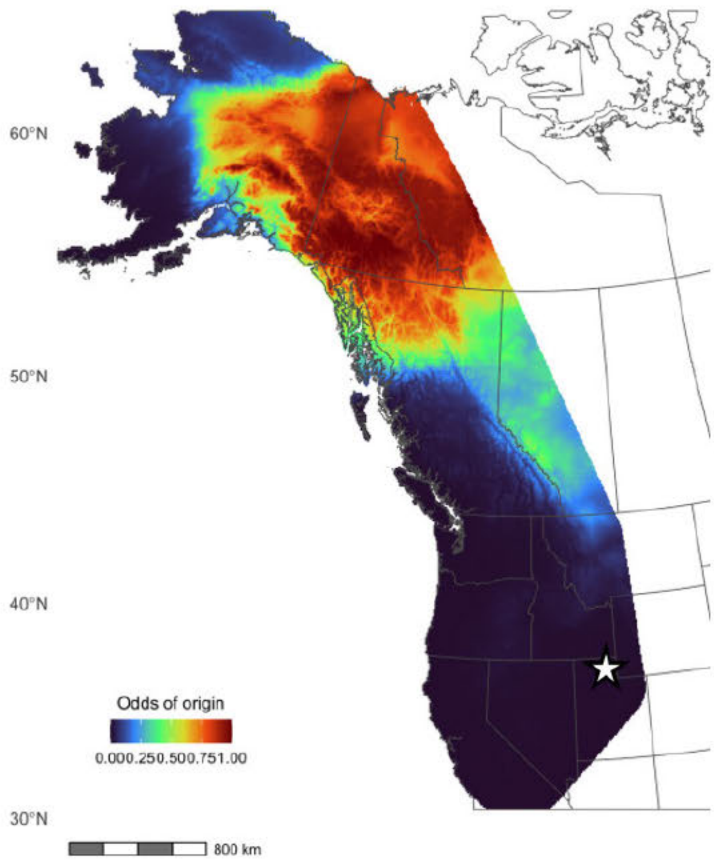

Figure 4. Probability-of-origin map derived from the ratio of deuterium to protium (δD) feather value for a Gray-crowned Rosy-finch sampled in northern Utah (white star) during winter. Colors on the right of the spectrum indicate higher breeding origin odds. (Courtesy of C. Campbell)