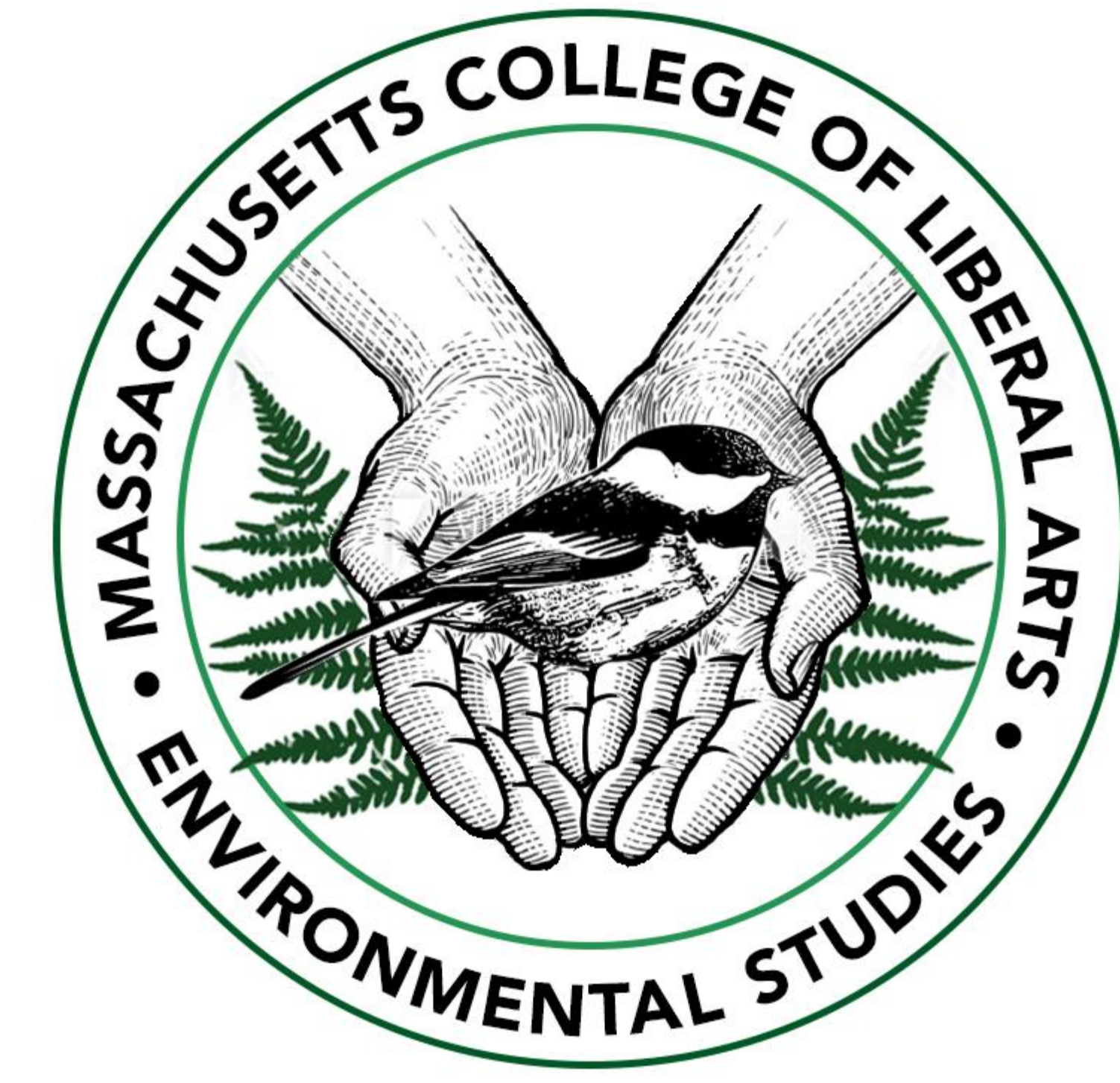


Breeding habitat use during migration by *Junco hyemalis* (Dark-eyed Juncos) in western Massachusetts



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Abstract – *Junco hyemalis* (Dark-eyed Juncos) are observed year-round in many parts of Berkshire County in western Massachusetts, and the degree to which these are the same or different individuals throughout the year is part of our ongoing research efforts. Our prior work has demonstrated that juncos from various latitudes north of Berkshire County pass through lower-elevation (~210m) valley locations during fall and spring migration, and that juncos from as far as northern Canada overwinter in the valleys of Berkshire County. However, the use by migratory juncos of higher elevation sites (>500m), where juncos breed in the summer, is unknown. During spring migration 2021, we sampled juncos from two known breeding locations. The “Frost” site is at 518m elevation and has juncos year-round. There, supplemental food (e.g., bird feeders) is available fall through spring. The “Fire Tower” site is at 760m. There, juncos breed, but do not overwinter, and there is no supplemental food. We used deuterium ratios from the most distal secondary feather of juncos to assess migration behavior of individuals captured at the Fire Tower site (n=10) and the Frost site (n=43). During spring migration, junco densities at the Fire Tower were much lower than at the Frost site. At the Fire Tower, the deuterium values from all 10 sampled individuals matched deuterium values of the local breeding population. Additionally, 6 of 10 sampled individuals were observed during the subsequent breeding season (e.g., June and July) at the Fire Tower site. In contrast, ~37% (16 of 43) of the juncos sampled at Frost had isotopic values that aligned with the local breeding population, meaning >60% of the spring juncos at the Frost site were migrants. Both local breeders and migrants were detected across the spring migration period (March 25 through April 30) at the Frost site. Migration is a significant part of the annual cycle of migratory birds, and is influenced by many complex factors. A more nuanced and complete understanding of migratory behavior in specific populations of juncos is important in fully understanding this declining species.

Introduction

The Dark-eyed Junco (*Junco hyemalis* L.) is a widespread songbird across North America. Different junco subspecies, and even different populations within a subspecies, display different migratory behaviors. Yet, most subspecies display long-distance, latitudinal migration, including the Northern Junco subspecies (*J. h. hyemalis*).

In Berkshire County, Massachusetts, Northern Juncos are observed year-round (Fig. 1). However, they are not found in the same locations during the entirety of their annual cycle (Fig. 2). In the summer, they breed only in the mountains ~510m and above. In contrast, during the winter they are found at low-elevation valley sites as well as on lower mountain elevations, with some overlap of summer breeding elevations.

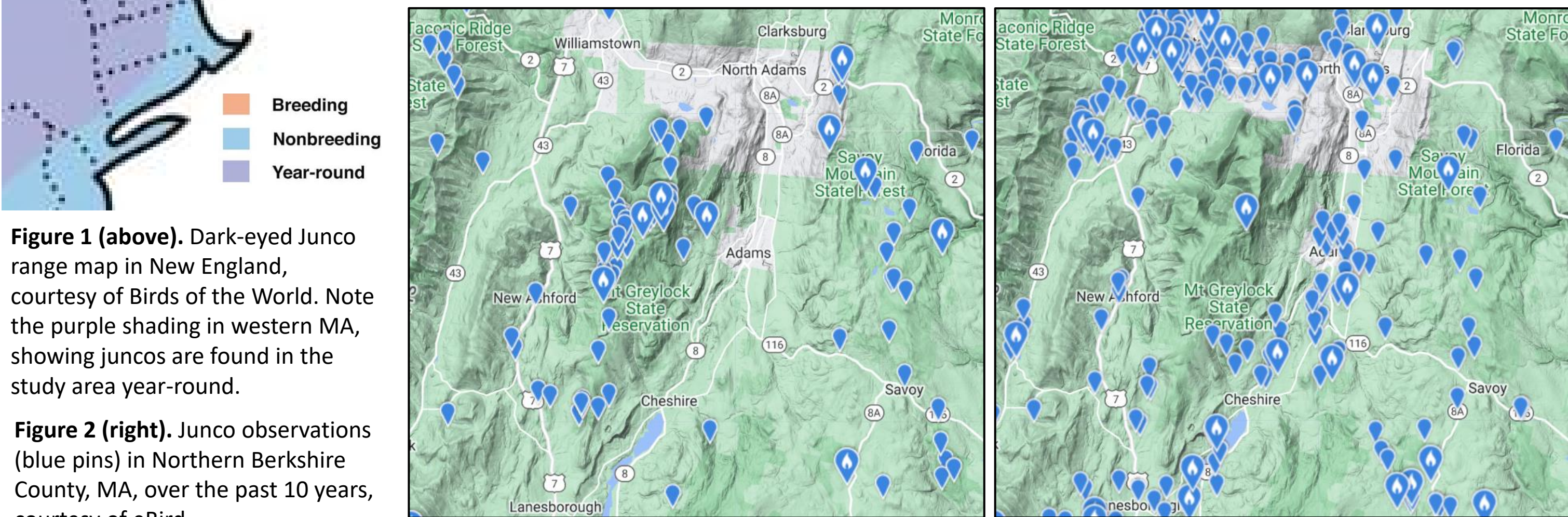


Figure 1 (above). Dark-eyed Junco range map in New England, courtesy of Birds of the World. Note the purple shading in western MA, showing juncos are found in the study area year-round.

Determining the degree to which these are the same or different individuals throughout the year is part of our ongoing research. Our prior work has demonstrated that juncos from various latitudes north of Berkshire County pass through lower-elevation (~210m) valley locations during fall and spring migration, and that juncos from as far as northern Canada overwinter in the valleys of Berkshire County. However, the use by migratory juncos of higher elevation sites (>510m), where juncos breed in the summer, is unknown.

Hypotheses

We seek to elucidate the springtime migratory behavior at higher elevation breeding sites of the Northern Junco subspecies (*J. h. hyemalis*) in this portion of their range where they are found year-round. We generated three hypotheses related to junco use of high elevation (>510m) habitat during spring migration.

Residents-Only Hypothesis. ONLY local breeding juncos will be found in high-elevation (>510m) breeding habitats. Due to higher elevation breeding habitat experiencing harsh inclement weather during the winter and through early spring, non-local juncos may conserve energy by passing through milder, lower-elevation areas in the valleys during migration farther north.

Migrants-And-Breeders Hypothesis. Northern-breeding migrants pass through Berkshire County breeding areas WHILE local breeders are already present and potentially establishing territories. Early arrival to breeding areas may allow them to incur benefits such as territory and mate choice.

Migrants-Before-Breeders Hypothesis. Migrants pass through the Berkshire County breeding areas BEFORE the local breeders show up to establish breeding territories. Due to the further distance non-local breeding juncos travel, an earlier migration start is needed to allow them to arrive on-time phenologically.

Methods

Isotopic analysis. We used stable hydrogen isotopes from the most distal secondary feather to assess migration behavior by inferring the geographic region of the junco when the feather was growing. Feathers were cleaned using 2:1 chloroform:methanol solution with an ultrasonicator. ~300 micrograms of feather tissue were packed into silver capsules. The UC Davis Stable Isotope Facility analyzed the samples using Isotope Ratio Mass Spectrometry. The resulting deuterium values were compared to August rainfall deuterium values.

Capture sites (Figure). The “Frost” site (518m) has juncos year-round. Supplemental food is available fall through spring. At the “Fire Tower” site (760m), juncos breed, but do not overwinter, and there is no supplemental food.

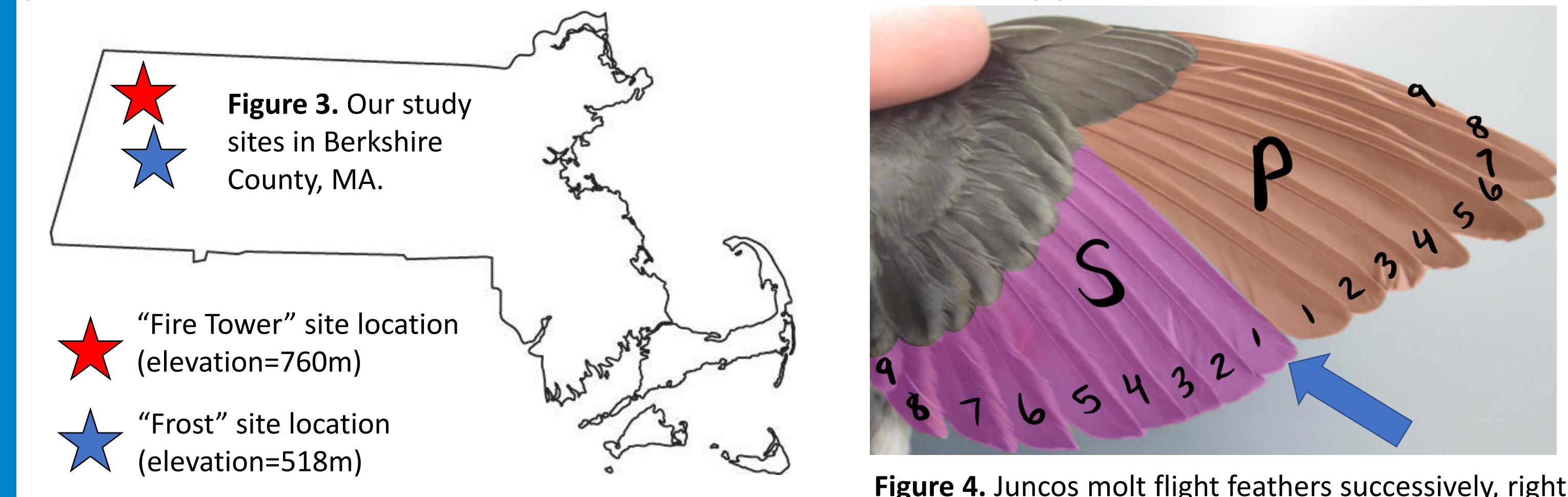


Figure 3. Our study sites in Berkshire County, MA.

Capture methods. Spring migration takes place from approx. mid-March through mid-May. From late March-early May 2021, juncos were captured at two known breeding sites using both passive and active mist nets and baited traps.

Known-location breeding juncos. Known-location Berkshire County breeding juncos were sampled to use for a reference of local deuterium values.

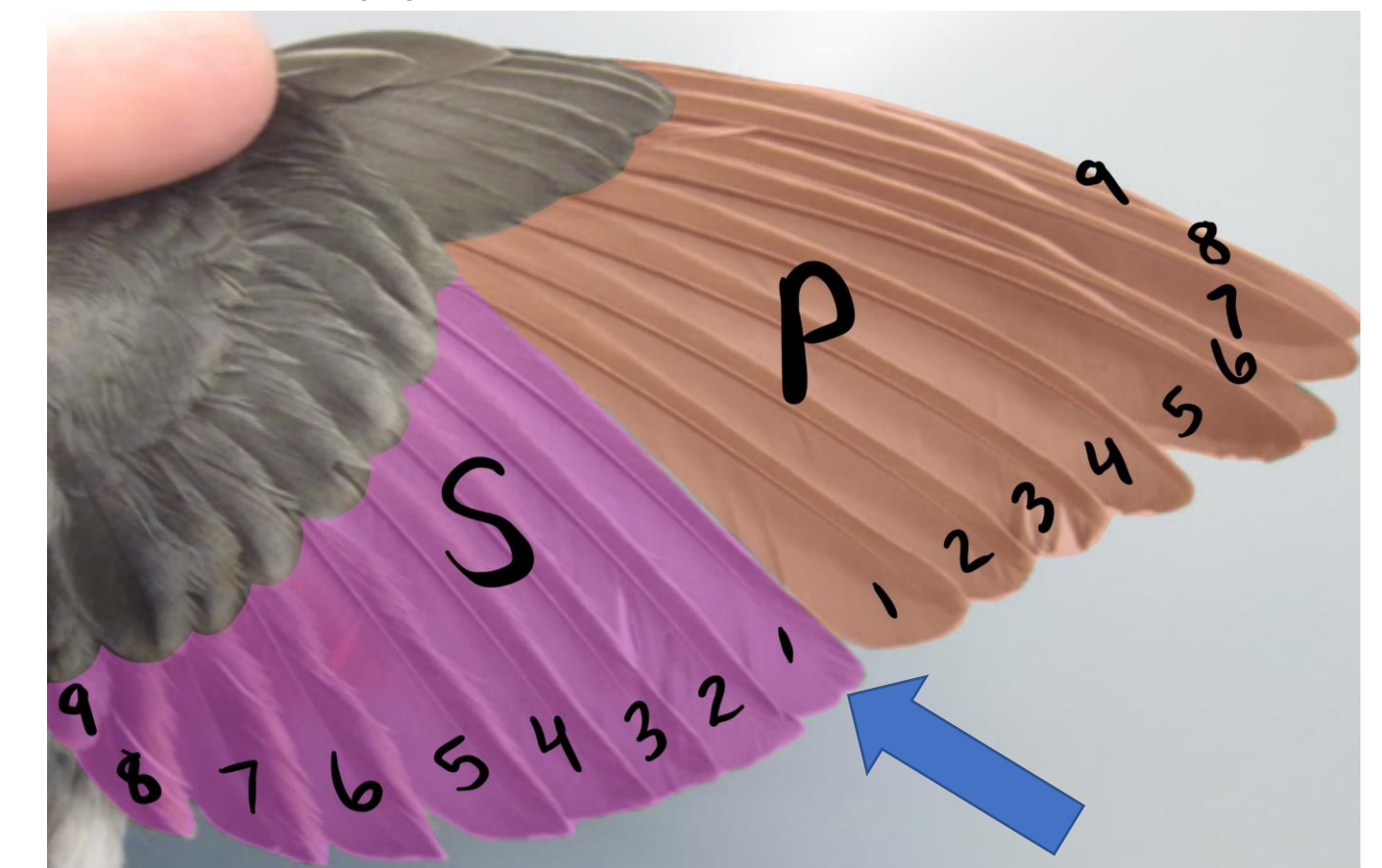


Figure 4. Juncos molt flight feathers successively, right after breeding. The feathers most likely to be grown at or near to their breeding elevation are P1 and S1.

Results

Known-location breeding juncos (n=40) sampled in Berkshire County provided a basis for local deuterium values. Known-location breeding junco deuterium values ranged from -46.5 to -67.0 (mean=-59.6; sd=5.7). Isotopic fractionation accounts for differences between rainfall and feather deuterium values.

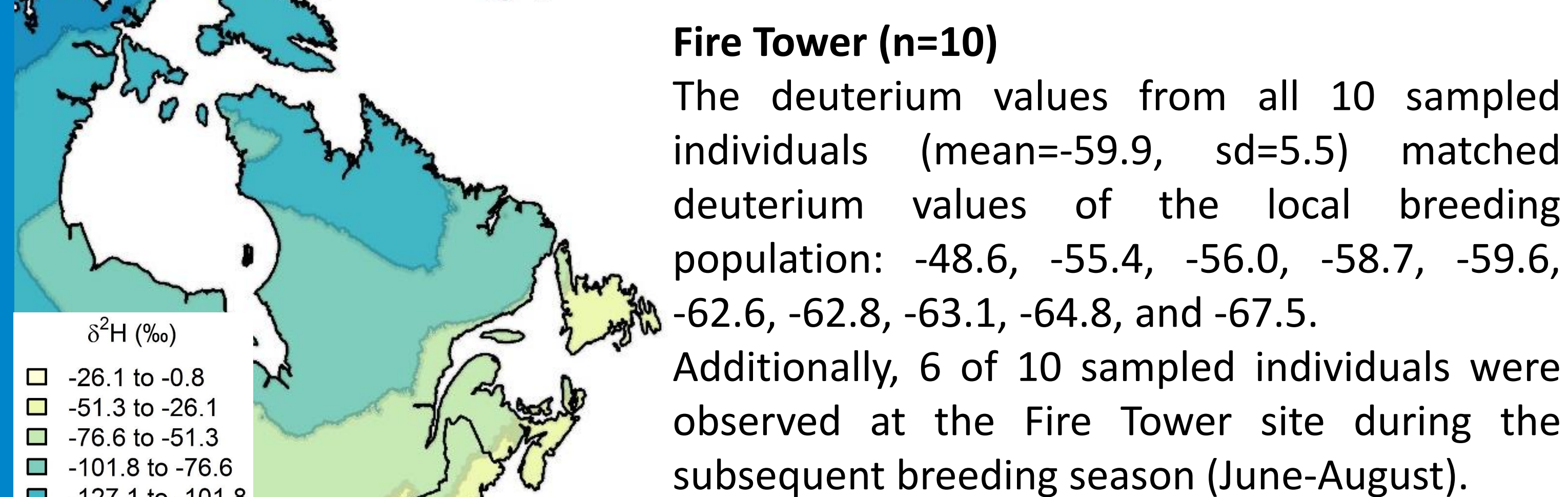


Figure 5 (left). Base map shows August deuterium values rain map, courtesy of <http://waterisotopes.org>. Our study sites within northwestern Massachusetts (orange star) fall within the -51.3 to -26.1 dH expected rainband.

Results

Fire Tower (n=10)
The deuterium values from all 10 sampled individuals (mean=-59.9, sd=5.5) matched deuterium values of the local breeding population: -48.6, -55.4, -56.0, -58.7, -59.6, -62.6, -62.8, -63.1, -64.8, and -67.5. Additionally, 6 of 10 sampled individuals were observed at the Fire Tower site during the subsequent breeding season (June-August).

Results (cont.)

Frost (n=43): 16 of 43 (~37%) of the juncos sampled at Frost during spring migration had isotopic values that aligned with the local breeding population (mean=-62.0, sd=6.8). The other >60% were migrants from further north (mean=-87.4, sd=8.7). Overall mean= -78.0, sd=14.8.

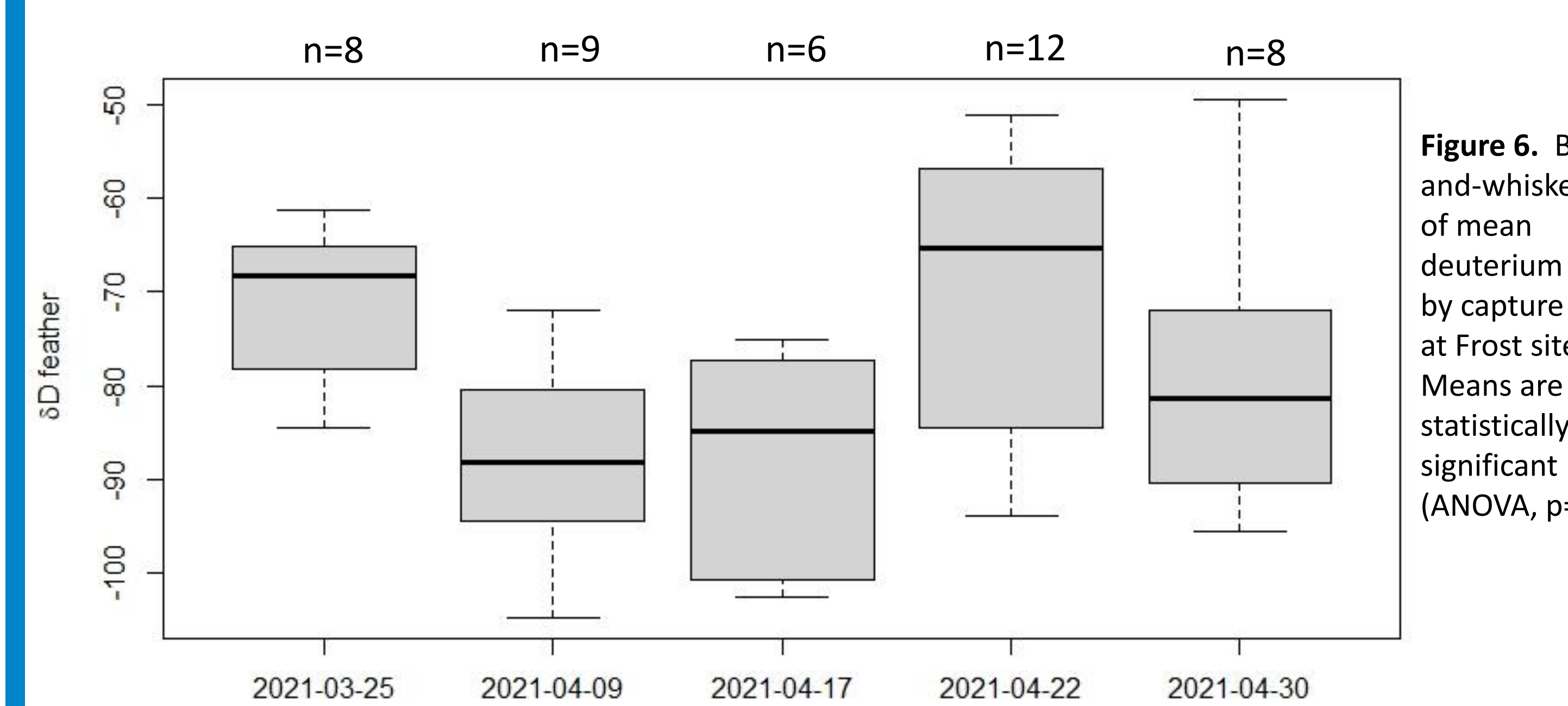


Figure 6. Box-and-whisker plot of mean deuterium values by capture dates at Frost site. Means are not statistically significant (ANOVA, p=0.96).

Results by Date
Residents-Only Hypothesis: ONLY local breeding juncos were found in the higher elevation breeding Fire Tower (760m) site.

Migrants-And-Breeders Hypothesis: Northern-breeding migrants pass through Berkshire County breeding areas WHILE local breeders are already present and potentially establishing territories at the Frost (518m) site.

Migrants-Before-Breeders Hypothesis: Neither of the sampled sites were found to have migrants passing through the Berkshire County breeding areas BEFORE the local breeders showed up to establish breeding territories.

Discussion

- We found support for both the **Residents-Only Hypothesis** and the **Migrants-And-Breeders Hypothesis**.
- Despite lack of support, the **Migrants-Before-Breeders Hypothesis** has not been ruled out. We sampled just two breeding locations of many throughout Berkshire County.
- At the **Frost site**, both local breeders and migrants were detected across the spring migration period (March 25 through April 30). Despite variation in mean deuterium values across capture dates, no significant difference was found.
- At the **Fire Tower site**, all deuterium values matched local breeder basis, and 60% of juncos sampled became known-location breeders.
- At the **Fire Tower site**, use of active mist nets potentially biased junco captures towards that of local breeders
- Significance:** The continent-wide junco population has declined by about 170 million individuals since 1970, with New England populations showing a similar pattern. Fine-scale details regarding junco migratory behavior can help to inform conservation of this declining species, as well as contributing to understanding of other ecological processes.

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