

Assessing changes in the composition of golden-cheeked warbler B songs over time

Dr. Darren Proppe, Lisa O'Donnell, Chris Warren, Ally Yost

Species-specific bird vocalizations often vary by region. These spatially distinct vocal types are known as dialects. Dialects can reflect regional characteristics, such that vocal traits are best suited for the environments in which they are propagated (e.g., vegetation, noise). Alternatively, dialects can be related to genetically isolated metapopulations. Golden-cheeked warblers, an endangered species that breeds exclusively in Central Texas, exhibit these spatially distinct dialects. Finn (2020, Thesis, Texas A&M University) quantified warbler songs and found distinct differences in both their A and B songs (the most common song types) in Northern, Central, and Southern populations. However, as the climate and landscapes change, individuals may move between locations or shift to new regions. Such a pattern might result in observable changes in the dialect of a particular region. The City of Austin Wildland Conservation Division has been documenting golden-cheeked warbler distribution and productivity for over 10 years. In 2008-2010, Chris Warren, a Texas State University graduate student, worked alongside the City of Austin to record golden-cheeked warblers across several tracts in the Balcones Canyonlands Preserve (BCP) in Travis County, Texas. The data was used to inform detection probabilities and measures of population estimation (Warren et al. 2013, *Auk*). However, this extensive acoustic dataset also provides the opportunity to compare vocalizations from this time period to the current timeframe.

Recently, field biologists working on the BCP have reported an audible difference in golden-cheeked warbler B songs compared to previous years. Our goal was to quantify and compare B songs from the 2008-2010 (2008 hereafter) to 2020-2021 (2020 hereafter) to determine whether we could statistically detect and quantify changes between the two time periods. In March – May of 2020 and 2021, biologists, volunteers, and student researchers recorded golden-cheeked warbler B songs on several of the BCP properties that were also used in the 2008 study. Recording from one or both time periods occurred at Bohl's, Forest Ridge, Kent Butler, Emma Long Park, Wild Basin Wilderness Preserve, Vireo Preserve, St. Edward's Park, Barton Creek Wilderness, Canyon Creek, JJ&T, and Reicher Ranch. Recordings from 29 and 32 individuals were analyzed for 2008 and 2020, respectively. Since individuals are known to vary B song traits, we analyzed up to five variants per individual. Variants were identified as songs which visually differed from other songs on the same recording. For each variant we quantified up to five B song replicates. For each song we quantified the composition of note types (buzz, trill, tone, down-swoop, up-swoop), the type of note in each position (syntax or order (position 1-5)), note duration (mean duration per note and total duration per song), and note frequency (lowest, highest, peak; in decibels; Figure 1). Note position analysis was limited to the first five song segments, although some positions regularly contained two types of notes (e.g., tone + buzz). For multi-note positions we labelled notes with increasing letters (e.g., 3a + 3b). We used generalized mixed-effect models to assess variation in each variable between the two time periods. Track ID and Variant were included in all models as random terms to account for repeated measures.

Song composition varied significantly between time periods (Figure 2). Buzz and up-swoops were less common in 2020 and shorter in duration, leading to an overall reduction in the total duration per song of these note types. Tones were shortened in duration, but not significantly less common. Trills became more common in 2020 and were longer in duration, increasing their overall duration per song. Down-swoops were longer in duration, but not more common. Notes also differed by position, with buzz notes being replaced with trills in position one and four, but becoming more common for position three (Figure 3). Note frequency decreased for buzz and trill notes in 2020, but increased for up- and down-swoops. In summary, our results support the hypothesis that B songs in golden-cheeked warblers have changed over time (Figure 4). The next step will be to assess why B songs are changing. Habitat change, settlement of individuals from different regions, or random drift could all account for the observed changes.

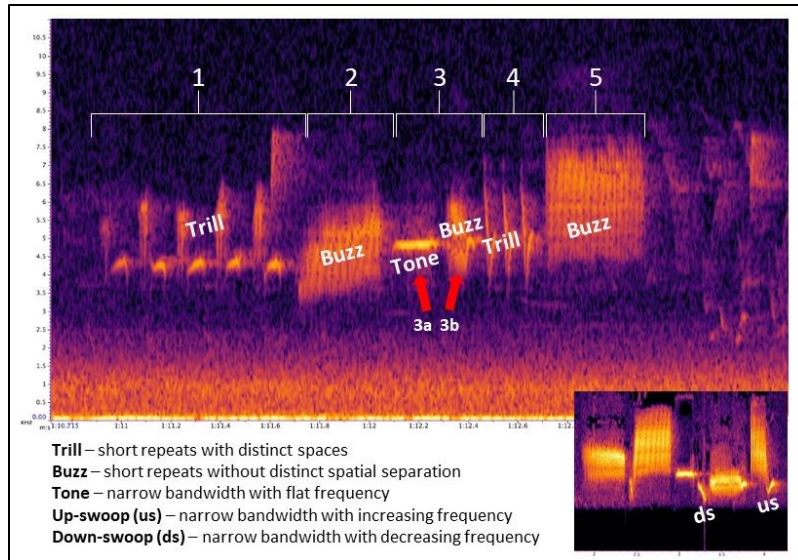


Figure 1. Typical golden-cheeked warbler B song. Note type composition was analyzed for each song and in each position, marked as 1-5 above the song spectrogram.

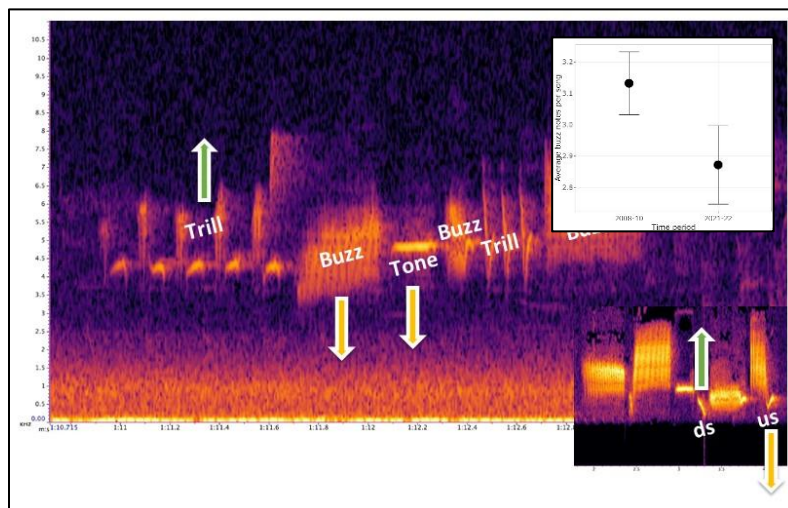


Figure 2. Arrows on the image above indicate the direction of change between past (2008-2010) and current (2021-2022) B songs in the golden-cheeked warbler. Significant changes were detected for all note types. Inset shows the difference between the number of buzz notes per songs between the two time periods.

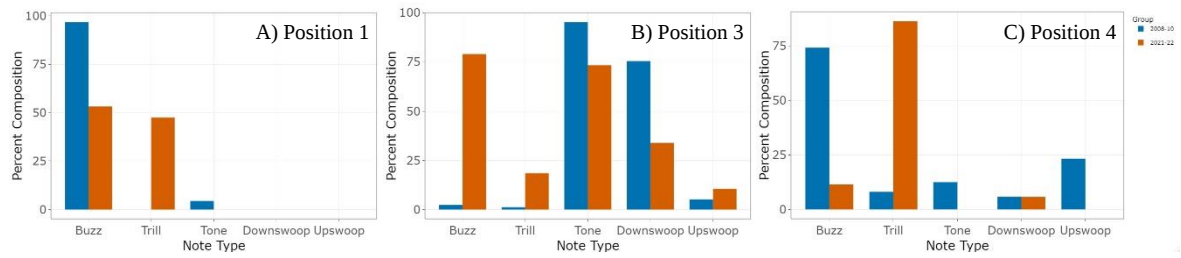


Figure 3. The composition of notes in golden-cheeked warbler B songs for position A) one, B) three, and C) four

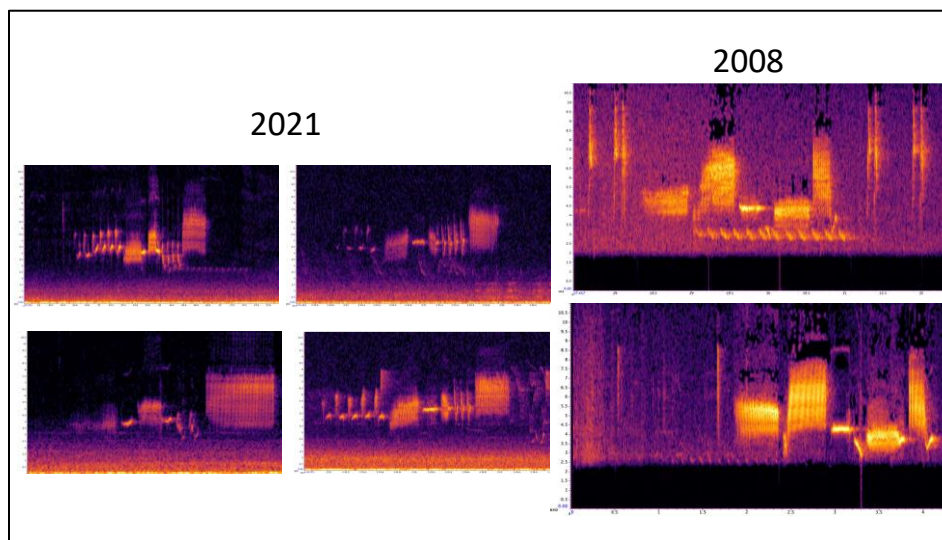


Figure 4. Visual comparison of 2008 and 2021 golden-cheeked warbler B songs.