

# Summary of Isotope Analysis and Assignment to Origin of Birds Migrating Through Inglewood Bird Sanctuary

## Introduction

Recent developments in animal tracking use chemical signatures (e.g., stable isotopes) in animal tissues to provide an indication of an individual animal's origins (e.g., breeding, wintering). Bird feathers are particularly valuable for this type of work because they are chemically inert meaning that isotopes derived from a certain geographic area during moult (feather replacement) are 'locked' into the feather providing a chemical signature of that area. Isotope values from animal tissues, in combination with well-documented continental gradients in isotopes (e.g., hydrogen from precipitation), make it possible to determine an individual's potential areas of origin using innovative statistical techniques. Migration monitoring stations such as the one located in the Inglewood Bird Sanctuary (IBS) provide a valuable means to collect tissue samples from birds during non-breeding periods. This information can then be used to help answer questions about population trends and migratory connectivity.

## Methods

A single tail feather was plucked from target migrant bird species captured during fall 2003, 2004 and 2008, 2015 and spring 2008 banding periods at IBS for stable hydrogen isotope analysis ( $\delta^2\text{H}$ ). Age and sex was determined for each bird when possible after which birds were subsequently released. Isotope analysis for hydrogen ( $\delta^2\text{H}_f$ ) in feathers was conducted using a stable isotope-ratio mass-spectrometer at the Isotope Laboratory in Saskatoon, SK.

## Statistical analysis

Linear models were used to determine differences in isotopic composition of tail feathers ( $\delta^2\text{H}_f$ ) between age and sex classes and seasons for all species where sample size was sufficient (i.e. minimum 6 birds in each class). A spatially-referenced growing-season precipitation  $\delta^2\text{H}$  map ('isoscape') created for the world by (Bowen et al. 2005) was calibrated for each bird species based on their foraging guild (ground vs. canopy) and migration strategy (short vs. long-distance) from equations in Hobson et al. (2012). The resulting isoscape was 'clipped' to the breeding range of the species being analyzed within the upper 85% of the probability distribution representing directions considered as likely paths (from historic banding data) for birds migrating through the banding station (Van Wilgenburg and Hobson 2011; Hobson et al. 2015). Areas approximately west of the continental divide (i.e., Rocky Mountains) in British Columbia were also eliminated as possible origins because we assumed birds from this region would preferentially migrate north-south rather than cross the divide. Individual birds were then assigned to approximate geographic origins based on spatially explicit likelihood-based assignment methods (Hobson et al. 2015). Additional assignments were restricted to Canada east of the Rocky Mountains to depict potential origins within Canada. Normal probability density functions were used to assess the likelihood that each cell (pixel) in the map represented a potential origin for an individual bird. Depictions of potential origins for birds migrating through the IBS were generated from individuals assigned to the calibrated surface and using a spline function to determine the upper 67% of possible origins and coding them as '1' with all others as

'0' and were subsequently summed for all individuals (population) from a particular species. Feather isotope ( $\delta^2\text{H}_f$ ) values for 24 bird species were used in the assignment to origin analysis with a total of 74 depictions (e.g., overall, season).

## Interpreting Depictions

The depictions of origins show the number of birds caught at IBS that were potentially derived at a specific point on the landscape (based on the precipitation isoscape). The legend shows the number of individuals that possibly originated from a particular cell on the isoscape where red indicates the highest number of individuals caught at IBS possibly originating from that cell and blue indicates fewer birds possibly originating from that cell. Disjunct areas are a reflection of gradients in isotope values from the theoretical precipitation isoscape within the species' breeding range. Potential origins of individuals or populations often appear to originate from large areas because of the relative similarity in isotope values in large parts of the landscape and because of the probability value selected to estimate origins.

Potential origin was superimposed on political boundaries of course but also on Bird Conservation Areas (BCRs), ecologically distinct **regions** in North America with similar **bird** communities, habitats, and resource management issues. They are based on the scale-flexible hierarchical framework of nested ecological units delineated by the Commission for Environmental Cooperation (CEC). More information about BCRs is available at <https://www.ec.gc.ca/mbc-com/default.asp?lang=En&n=1D15657A-1>.

## Literature Cited

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