

FEATURE ARTICLES

**VARIATION IN THE STABLE-HYDROGEN ISOTOPE COMPOSITION OF
NORTHERN GOSHAWK FEATHERS: RELEVANCE TO THE STUDY OF
MIGRATORY ORIGINS**

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Abstract. The analysis of stable-hydrogen isotope ratios in feathers (δD_f) allows researchers to investigate avian movements and distributions to an extent never before possible. Nonetheless, natural variation in δD_f is poorly understood and, in particular, its implications for predictive models based on stable-hydrogen isotopes remain unclear. We employed hierarchical linear modeling to explore multiple levels of variation in the stable-hydrogen isotope composition of Northern Goshawk (*Accipiter gentilis*) feathers. We examined (1) inter-individual variation among goshawks from the same nest, and (2) intra-individual variation between multiple feathers from the same individual. Additionally, we assessed the importance of several factors (e.g., geographic location, climate, age, and sex characteristics) in explaining variation in δD_f . Variation among individuals was nearly eight times the magnitude of variation within an individual, although age differences explained most of this inter-individual variation. In contrast, most variation in δD values between multiple feathers from an individual remained unexplained. Additionally, we suggest temporal patterns of δD in precipitation (δD_p) as a potential explanation for the geographic variability in age-related differences that has precluded the description of movement patterns of adult raptors using δD_f . Furthermore, intra-individual variability necessitates consistency in feather selection and careful interpretation of δD_f -based models incorporating multiple feather types. Finally, although useful for describing the movements of groups of individuals, we suggest that variability inherent to environmental and intra-individual patterns of δD_p and δD_f , respectively, precludes the use of stable-hydrogen isotopes to describe movements of individual birds.

Key words: *Accipiter gentilis, feathers, hierarchical linear model, hydrogen, migration, stable isotope, variation.*