

## FEATHER PB ISOTOPES REFLECT EXPOSURE HISTORY AND ALAD INHIBITION SHOWS SUB-CLINICAL TOXICITY IN CALIFORNIA CONDORS

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ABSTRACT.—Environmental lead exposure continues to hinder the recovery of the California Condor (*Gymnogyps californianus*) in the wild, but the full scope of exposures and their effects on condors is not well-characterized, in part due to the challenges associated with conducting comprehensive exposure assessments and the limited availability of biological markers of sub-lethal effects. While cases of severe lead poisoning resulting in clinical morbidity and mortality in condors are well understood, no data exist showing negative health effects in asymptomatic wild condors. Here we (1) validate the utility of lead concentration and stable isotopic measurements in growing condor feathers to reconstruct a comprehensive exposure history over the preceding months, and (2) demonstrate that lead-exposed condors are suffering sub-clinical toxicity, based on  $\delta$ -aminolevulinic acid dehydratase (ALAD) inhibition by lead. Growing flight feathers were sequentially sampled along the trailing margin and analyzed by ICP-MS for lead concentrations and stable isotopic compositions (n=5 condors). Two of these birds (# 306 and 318) were implicated in a well documented .22 caliber lead ammunition-exposure event from a discarded pig carcass. In addition, whole blood samples were collected from pre-release (n=4) and free-flying (n=5) condors and their lead concentrations, isotopic compositions, and ALAD activity determined. For condors 306 and 318, the lead concentration and isotopic composition of their feathers changed following the documented ammunition-exposure event, arriving at values that matched exactly the isotopic composition of recovered ammunition. Feather samples from the remaining condors analyzed to date (#'s 307, 336, 351) similarly evidence lead exposure events over the months prior to sampling. Preliminary results of nine condors with blood lead concentrations ranging between 1.9-64.0  $\mu\text{g}/\text{dL}$  show a significant inverse relationship between blood lead concentration and ALAD activity, indicating significant inhibition of ALAD at blood lead levels below those where clinical chelation treatment is indicated. Our research demonstrates that sequential analyses of growing feathers is a valuable tool to comprehensively reconstruct exposure histories, and that sub-lethal exposure results in measurable toxicity in condors.

PARMENTIER, K., R. GWIAZDA, J. BURNETT, K. SORENSON, S. SCHERBINSKI, C. VANTASSELL, A. WELCH, M. KOENIG, J. BRANDT, J. PETTERSON, J. GRANTHAM, R. RISEBROUGH, AND D. SMITH. 2009. Feather Pb isotopes reflect exposure history and ALAD inhibition shows sub-clinical toxicity in California Condors.

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