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Mercury and drought along the lower Carson River, Nevada: IV. Snowy egret post-fledging dispersal, timing of migration and survival, 2002–2004

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ABSTRACT

This telemetry study is an extension of our 1997–2006 research on historical mercury contamination on snowy egrets (*Egretta thula*) up to ~ 20 days of age. Findings from initial studies at the mercury-contaminated Carson River colony at Lahontan Reservoir (LR) and a similar-sized reference (REF) colony on the Humboldt River included mercury-related physiological, biochemical, histopathological and reproductive effects up to ~20 days of age; with poor water years (2000–04), i.e., reduced prey availability, exacerbating effects. Herein, we compare timing of dispersal and migration at LR vs. REF, but the primary question now addressed is "whether survival of young mercury-exposed snowy egrets from LR would be further compromised beyond ~20 days of age? " Based upon telemetry signals until 90–110 days of age (including dead bird counts and survival rate estimates), we conclude that mercury did not further compromise survival. Dead bird counts and survival rate estimates included time in the colony when fed by adults, plus the critical period when young dispersed from the colony to forage independently. The extended drought during this 3-year study was most critical in 2002 when production of ~20 d old egrets at LR was only 0.24 young/nest. In 2002, survival rates were low at both colonies and we documented the highest counts of dead egrets for both colonies. We suggest the losses in 2002 beyond 20 days of age were more a function of prey availability influenced by drought than exposure to mercury, especially at LR, because higher mercury concentrations, higher survival rates and fewer dead birds were documented at LR in 2003 when water conditions improved. Furthermore, total mercury (THg) in blood in 2003 was more than double 2002 (geometric mean, 3.39 vs 1.47 μg/g wet weight (ww). This higher THg exposure at LR in 2003 was associated with a redistribution of parent and post-dispersal feeding activities upstream (where there was higher mercury from historic mining) related to slightly improved water levels. When comparing the 3-year telemetry findings based upon ~20 d old young at LR (blood THg, geo. means 1.47, 3.39 and 1.89 μg/g ww), we found no evidence that age at dispersal, Julian date at dispersal, timing of migration, or pre-migration survival (~20 to ~100 days post-hatch) were adversely affected by elevated mercury.

1. Introduction

An estimated 6.8×10^6 kg of elemental mercury were released in mill tailings along the Carson River and its tributaries below Virginia City during the Comstock Lode era of mining from 1859 to 1890 (Smith, 1943; Lawrence 2003). Erosion has since washed much of the contaminated tailings into the floodplains and wetlands of the Lower Carson River System (LCRS) (Fig. 1; Van Denburgh, 1973; Hoffman and Thomas, 2000). Since the 1915 completion of Lahontan Dam, the resultant 27-km long irrigation reservoir has served as a sink for most of the sediment-bound mercury washed downstream (Hoffman and Taylor, 1998). Though the reservoir has spared the agricultural and wetland areas of the Lahontan Valley from substantial mercury contamination for a century, mercury concentrations in some of the stream banks, floodplain sediments and biota of the Carson River Basin including Lahontan Reservoir (LR) are among the highest ever reported in a natural system (Wayne et al., 1996; Wentz et al., 2014).

The persistence and degree of mercury contamination of the LCRS led to placement of a portion of the basin, including Lahontan Reservoir, on the U.S. Environmental Protection Agency's (EPA) National Priorities "Superfund" list. Studies under this program showed high levels of mercury throughout key ecological components of the LCRS (Ecology and Environment, Inc. 1998). Elevated mercury begins near Brunswick Canyon just east of Carson City and on to the

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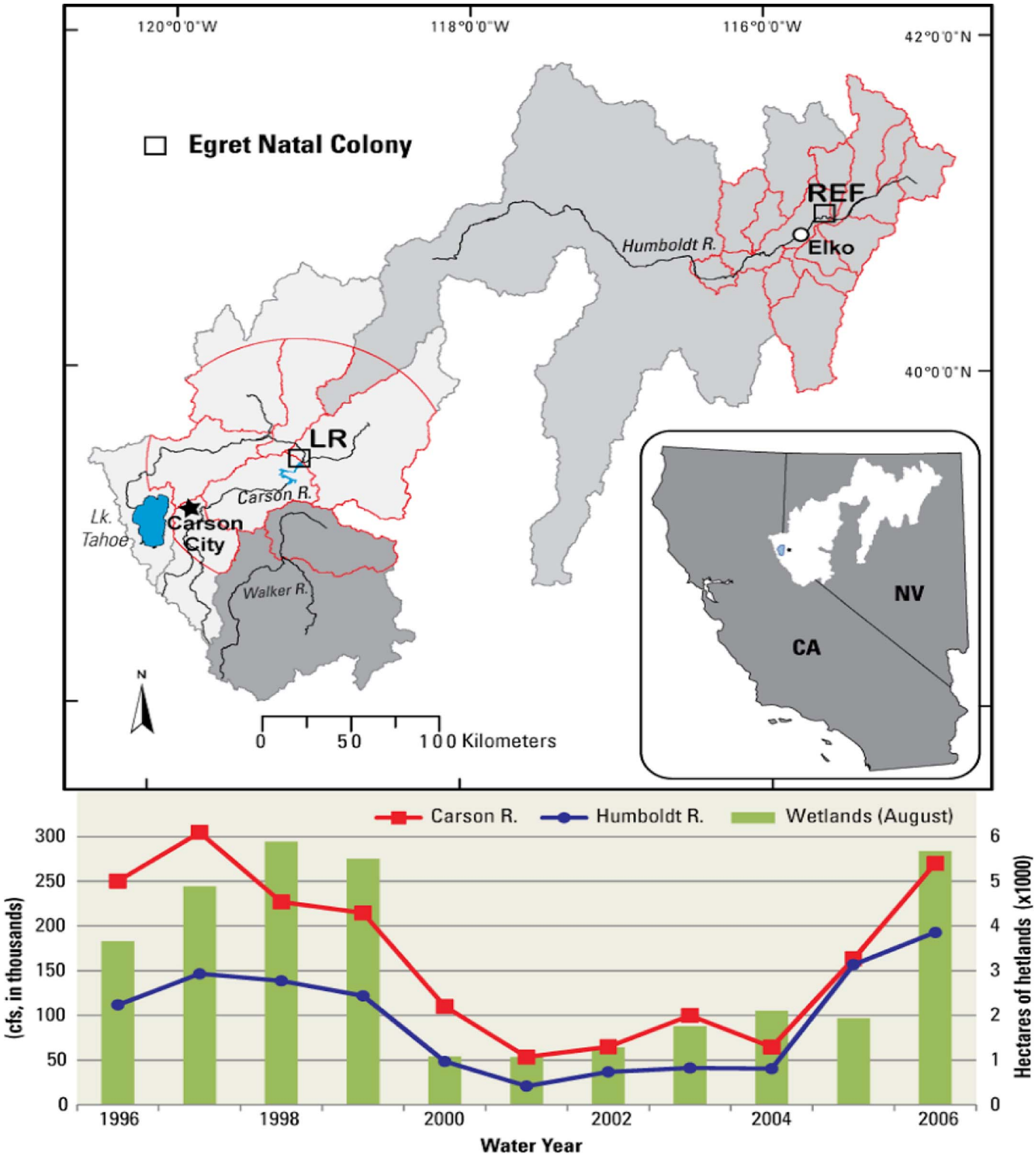

Fig. 1. Locations of the two snowy egret nesting colonies studied on Lahontan Reservoir (LR) and Humboldt River (REF) with total annual water discharge (water years 1996–2006) on Carson River at Fort Churchill, and Humboldt River near Elko, Nevada (USGS Water Resources Data, Carson City, NV), and hectares of wetlands at Stillwater NWR Complex in August 1996–2006 (Bill Henry, USFWS, Complex files, Fallon, NV).

river's terminus in a network of wetlands about 120–130 km downstream in Lahontan Valley, i.e., through the Middle Carson (high mercury) and Carson Desert (lower mercury) Hydrologic Units (HUs); (collectively the LCRS).

Potential toxicity of these mercury concentrations to piscivorous birds was demonstrated in 1997-98 through detection of cellular damage (histopathologic and physiologic) in the nervous, immune, hepatic, and renal systems of young snowy egrets (*Egretta thula*), black-crowned night-herons (*Nycticorax nycticorax*) and double-crested cormorants (*Phalacrocorax auritus*) (Henny et al., 2002). Adult snowy egrets in that study contained high total mercury (THg) concentrations in their livers (geometric; hereafter geo. mean 43.7 μg/g