

Precise Eggshell Thickness Measurements to Inform Bird Ecology and Mercury Monitoring

In a study published in the journal *Ecology and Evolution*, USGS biologists provide precise eggshell thickness measurements for 12 species of birds that breed in the San Francisco Bay Estuary.

Eggshell thickness is important for physiological, ecological, and ecotoxicological studies of birds. Prior studies have found that eggshell thickness is related to gas exchange, contaminant exposure, embryonic development, and egg survival. Eggshell thickness is also one of several key variables used to calculate mercury concentrations in bird eggs, making accurate and precise measurements critical to mercury monitoring efforts. However, the role of eggshell thickness in ecophysiology can vary among species, and empirical eggshell thickness measurements are limited for many species and regions.

USGS biologists used a relatively new scientific instrument (a Hall effect thickness gauge) to measure eggshell thickness comprehensively and precisely for 12 San Francisco Bay species and compared the results to prior eggshell measurements. They also monitored nests to examine the relationship between eggshell thickness and egg development and survival in three species, American avocet (*Recurvirostra americana*), black-necked stilt (*Himantopus mexicanus*), and Forster's tern (*Sterna forsteri*).

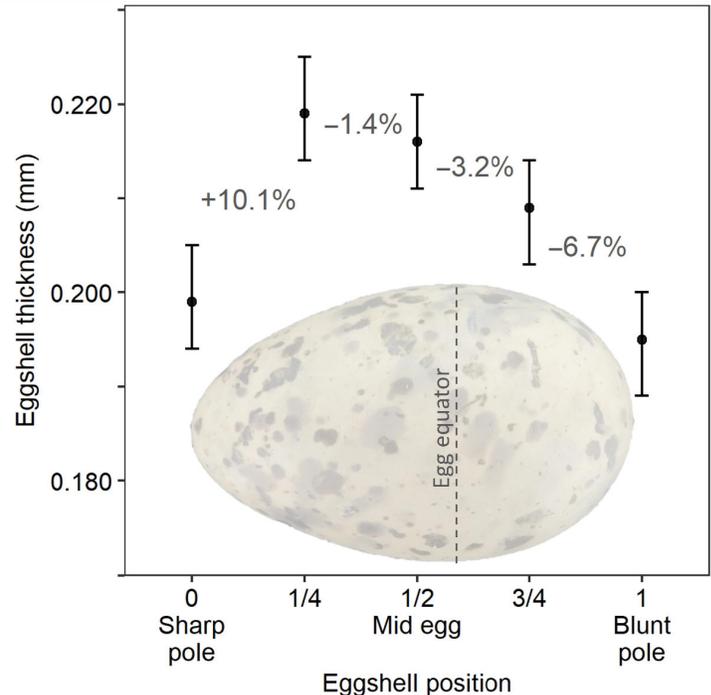
The biologists measured eggshell thickness for species representing a range of female body masses. One of the smallest species of birds in this study, California least tern (*Sternula antillarum browni*), had the thinnest eggshells in this study. The largest species in this study, double crested cormorant (*Phalacrocorax auratus albociliatus*), had the thickest eggshells. Eggshell thickness varied not only among species and individual birds but also within individual eggs: the eggshells studied were generally 5% thicker at the central portion of the egg (egg equator) than the 'bottom' (sharp egg pole) and 'top' (blunt egg pole) of the egg, highlighting the importance of using standardized eggshell measurement methods. The study found no relationship between eggshell thickness and incubation age or total mercury contamination of the egg content.

USGS biologists previously showed that accurately calculating contaminant concentrations in bird eggs relies on accounting for eggshell thickness. Specifically, incorporating eggshell thickness results in fresh wet weight egg contaminant concentrations that are 6-13% more accurate than when the eggshell is ignored. These eggshell thickness measurements provide current, precise data that can be incorporated into calculations of mercury concentrations in locally breeding waterbirds, helping managers better monitor wildlife and ecosystem health.

This spotlight refers to the following publication and data release:

Peterson, SP, JT Ackerman, MP Herzog, MS Toney, B Cooney and CA Hartman. 2020. **Avian eggshell thickness in relation to egg morphometrics, embryonic development, and mercury contamination.** *Ecology and Evolution*. <https://doi.org/10.1002/ece3.6570>

Peterson, S.H., and Ackerman, J.T., 2020, **Avian eggshell thickness for 12 species in the western U.S. from 2014 to 2018:** U.S. Geological Survey data release, <https://doi.org/10.5066/P981OW6T>.



Mean eggshell thickness at 5 different equally spaced positions on Forster's tern eggshells (n = 40). Eggshells studied were thicker at the egg equator than the 'bottom' and 'top' of the egg.

MANAGEMENT IMPLICATIONS

- Contaminant monitoring programs can use new eggshell thickness measurements to more accurately estimate egg content concentrations.
- Newer technology (a Hall effect thickness gauge) provides a more precise and repeatable thickness measurement than analog micrometers that have been used in many previous studies.
- Variable thickness measured at different points of the eggshell highlight the importance of using standardized eggshell measurement methods.

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