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Dissertation Abstract

Regulation of Bald Eagle (*Haliaeetus leucocephalus*) Productivity in the Great Lakes Basin: An Ecological and Toxicological Approach

The bald eagle population, within and adjacent to the Great Lakes Basin, constitutes the greatest single population within the contiguous United States. Bald eagles were largely extirpated from the Great Lakes by the mid-1960s, due to the effects of DDE. Eagles began to repopulate and raise young again along the shores of the Great Lakes, with the exception of Lake Ontario, by the 1980s.

The studies reported here focused on factors limiting bald eagle populations. Ecological factors investigated included food habits, nest tree use, winter habitat use, and the identification of potential nesting habitat. Bald eagles primarily foraged on fish (suckers, bullheads, northern pike, carp, and freshwater drum). Eagle nests were built primarily in white pines, but in cottonwoods near Lake Erie. Potential nesting habitat exists along the shorelines of all Great Lakes, primarily along Lakes Huron and Superior. Habitat availability, however, may limit the Lake Erie subpopulation, which has little unoccupied habitat and great density of nesting eagles.

Toxicological aspects investigated included monitoring concentrations of PCBs and p,p'-DDE in plasma, mercury and selenium in feathers. Hematological biomarkers were used to assess health of eaglets. Bill deformities in nestlings were also investigated. Concentrations of p,p'-DDE or PCBs, but not mercury or selenium, were significantly, and inversely correlated with regional reproductive productivity and success rates. Lesser reproductive productivity in some lesser contaminated areas are believed to be related to greater nesting density.

Reproductive productivity of bald eagles within this population is primarily regulated by concentrations of organochlorine compounds along the shorelines of the Great Lakes, and density dependant factors in the interior, relatively uncontaminated areas. The continuing recovery of this population will depend on maintaining greater productivity in interior areas to compensate for lesser fecundity and greater adult mortality along the shorelines of the Great Lakes.—
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Dissertation Abstract

Facultative Manipulation of Hatching Asynchrony in the American Kestrel (*Falco sparverius*)

The consequences of hatching asynchrony for nestling birds have been well studied, but the adaptive significance of hatching patterns is the subject of considerable controversy. My questions centered around the role of food in determining costs and benefits of asynchrony at different stages in the breeding cycle and in particular, whether American kestrels might practice individual optimization of hatching spans. I conducted experiments in both the pre-laying and brood-rearing stages and in the process, tested four hypotheses: 1) brood reduction, 2) sibling rivalry, 3) peak load, and 4) energetic constraints during laying.

I explored the costs and benefits of brood reduction from a theoretical perspective. I developed a model of facultative manipulation (individual optimization) of hatching based on the brood reduction hypothesis and the assumption that hatching patterns have different fitness payoffs in good and bad food years. When food resources during the nestling period were partly predictable from those during the pre-laying period, facultative manipulation of hatching seemed advantageous in many types of environments. Correlation analysis showed that small mammal numbers in summer were sometimes, but not always, predictable from those in spring.

Next, I examined the costs and benefits of asynchrony during the brood-rearing period. I measured growth and mortality of nestlings within four treatment groups (asynchronous, synchronous, food-supplemented, unsupplemented)

to test the brood reduction hypothesis. Fledging success did not differ between synchronous and asynchronous broods when food was poor, but consistent with the brood reduction hypothesis, nestlings died at a younger age in asynchronous broods. Asynchronous young did better in terms of growth when food was scarce but when food was more abundant, youngest nestlings in asynchronous broods still died despite apparently adequate food for the brood. Overall, the patterns of growth and mortality supported the brood reduction hypothesis for kestrels when food was limited, but not when it was abundant.

To test whether asynchrony affected parental effort, I measured provisioning rates to synchronous and asynchronous broods. Parents of synchronous broods made up to 31% more visits to the nest than parents of asynchronous broods by the time nestlings were 25-d old. Despite the higher provisioning rate, nestlings from synchronous broods weighed less at fledging. Patterns of food provisioning were consistent with the sibling rivalry hypothesis but not with the peak load hypothesis. Finally, I examined the proximate effect of food on asynchrony during the pre-laying period. In good food years, the hatching spans of clutches were more synchronous than in poor years. Similarly, parents on good territories and females in good physical condition had synchronous broods compared to parents with less food. Kestrels that were supplemented in the pre-laying period laid larger eggs and hatched those eggs more synchronously. These results were consistent with the hypothesis of facultative manipulation of hatching spans but not with the energetic constraint hypothesis. Kestrels seemed to "choose" an appropriate degree of asynchrony based on food levels in the pre-laying period.—**Karen L. Wiebe. 1993. Ph.D. dissertation, Department of Biology, University of Saskatchewan, Saskatoon SK, Canada S7N 0W0. Present address: Department of Forest Sciences, 2357 Main Mall, University of British Columbia, Vancouver, BC V6T 1Z4, Canada.**