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## **LONG-TERM EFFECTS OF PONDS, CLIMATE, AND UPLAND HABITATS ON PRAIRIE-NESTING DUCKS**

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North American mid-continental breeding duck populations have historically demonstrated extreme annual variability, typically attributed to variation in annual spring

pond numbers. However, strengths of these relationships have not remained constant over time or space for some species. Possible explanations for changes in duck/pond associations include reduced quality of wetlands and reduced quantity or quality of upland habitats. Therefore, I hypothesized that changes in the associations between ducks and ponds could be attributed to spring precipitation, temperature, and upland habitats. I modeled observed duck numbers using random coefficient models structured to represent Gompertz population growth with environmental covariates. Varying modeled intercepts and slopes identified segment specific variation in carrying capacity and limiting environmental factors, respectively. I compared models of alternative a priori hypotheses describing duck abundances relative to various combinations of ponds, climate, and upland habitat using an information-theoretic approach.

Including additional climate and upland habitat covariates produced superior models to pond-only models when predicting duck abundances. Best models identified segment varying differences in the strengths of relationships between ducks and environmental covariates, implying spatial variability in factors limiting abundances. Top models were consistent with my hypothesis that climate and upland habitats provide additional information regarding duck population changes. Knowledge of important environmental covariates that improve spatio-temporal models provides waterfowl managers with opportunities to target management programs in areas with the greatest benefits, or to protect specific habitat components where they are most limiting. Identifying areas with different levels of population response can potentially identify interesting new explanatory variables.