Climate Change on Crocodilians: Modeling the Effects of Phenological Shifts

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Climate change is causing precipitation and temperature patterns to change, and in response species are undergoing phenological shifts, changes in reproduction timing. To explore the effects of phenological shifts on the crocodilian response to climate change, a model was created using a novel adaptation of the Lotka-Volterra equations. The model uses a time step of months, and includes a crocodilian population and twelve other plant and animal species. Rainfall impacts the ecosystem through the plants, and temperature affects plant growth and animal energy needs and hatch rates. The model was validated by running with Louisiana rainfall and temperature data and comparing the model outputs with measured alligator nest count data. As a baseline, variations in the timing and magnitude of rainfall and temperature were examined. Populations increase when there is more rainfall overall or available during the growing season and decrease when there is less. Temperature changes mainly cause ectotherm populations to decrease due to suboptimal temperatures for hatching. The effects of phenological shifts on the response to rainfall and temperature changes were examined. Phenological shifts result in populations increasing if the reproduction occurs at a better time in terms of prey availability and predator populations. However, in general phenological shifts do not significantly alter the qualitative ecosystem response. Species-specific phenological shifts at different rates or based on different cues do not strongly affect other populations. Using the results of this model, a management program was designed with recommendations to protect crocodilians and their ecosystems from climate change.

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