Mathematical model of population growth for Florida Leafwing butterfly.

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Butterfly populations are in decline in Florida, including the Florida leafwing, Anaea floridalis (Nymphalidae) which is now restricted to Everglades National Park (ENP) [1]. For butterflies and many other insect herbivores, at least one developmental stage in the life cycle is completely dependent on a food plant for its environment and nutrition [2]. Butterflies develop through multiple larval stages during which they feed exclusively on foliage. Following complete metamorphosis, adult butterflies emerge and either subsist on stored resources obtained as larvae or feed on liquid, sugar-rich sources available in their environment, e.g. flowers or tree sap. Conservation strategies for butterflies must therefore address the interaction of caterpillars and food plants. In this work we focus on a stage-structured model for a theoretical leafwing population that incorporates larval plant-dependent stages, and adult plant-independent stages. Leafwing caterpillars feed exclusively on plants in the genus Croton, which generally occur in fire-maintained landscapes. The effects of fire and food plant on leafwing population growth are mediated through the larval stages. Leafwing butterflies feed on a variety of non-floral foods including tree sap, rotting fruit, and dung, which may contribute to their longevity as adults relative to other butterflies. Leafwing (Anaea andria) is a closely related species that occur in temperate habitats. In southern tropical ranges, leafwing have as many as three broods, or overlapping broods. Matrix entries in our general model can be manipulated to reflect the effects of fire, different food plants, and differing numbers of broods each year. The resulting matrices can then be analyzed for population growth and stability given each hypothetical scenario.

A discrete control system is used to model leafwing population growth. One of the main differences between this model and classical stage-structured models is that in the current model we can alter the number of adults contributing to produce eggs. This allows us to control the population. The solution of the problem is obtained using invariant formulations of positive periodic systems. Some results on stability are given.

References

[1] U.S. Fish and Wildlife Service. 2009. Species assessment and listing priority assignment form. U.S. Fish and Wildlife Service, Atlanta, Georgia.

[2] Jaenike, J. 1990. Host specialization in phytophagous insects. Annual Review of Ecology and Systematics 21: 243-273.