Discrete Models of Newt Population Declines Due to Severe Drought and Invasive Crayfish

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Abstract

We introduce discrete mathematical models for studying the population dynamics of the California newt (Taricha torosa), a species of special concern in California. Recent declines and local extinctions of native California newt populations in Santa Monica Mountain (SMM) streams motivate our investigation of the impact of drought and invasive crayfish (Procambarus clarkii) on newt population sizes. Multiple studies predict Californias severe drought conditions currently underway will persist and even increase in duration and severity. In addition, invasive crayfish have decimated native newt reproduction in SMM streams. We construct two nonlinear systems of discrete equations that include demographic parameters such as survival rates for newt life stages and egg production, which depend upon habitat availability and rainfall. We estimate these demographic parameters using 15 years of stream survey data collected from Cold Creek in the SMM. Our models capture the observed decline of the studied newt population and replicate crayfish trapping data. The first model makes predictions about how the length and severity of drought can affect the likelihood of persistence and the time to critical endangerment of a newt population. With our second model, we evaluate the persistence or the time to extinction for newt populations under crayfish trapping regimes when varying the quantity of trapping resources, frequency of trapping implementation, and susceptibility of the crayfish population to trapping. Predictions made with both models inform restorative efforts and crayfish management.