Everglades Crayfish (*P. Alleni*)
Model Ecology Document

Rationale and Function

The Habitat Suitability Index (HSI) model for Everglades crayfish (*Procambarus alleni*) described here uses hydrologic data from the Everglades Depth Estimation Network (EDEN). Crayfish comprise a large fraction of the mid-trophic-level biomass in the Everglades ecosystem and have been linked by dietary importance to the success of wading birds and other fauna. The ability to predict the spatial and temporal dynamics of crayfish is important for scientists and managers to evaluate the potential hydrologic scenarios associated with the Comprehensive Everglades Restoration Plan (CERP).

The model is intended for use for Everglades crayfish inhabiting the EDEN geographic domain. The model has been most adequately validated and seems to work best in central Water Conservation Area 3A, and the ENP regions of Shark Slough, Marl prairies, and Taylor Slough. The model does not work well for Loxahatchee National Wildlife Refuge (WCA 1) where *P. alleni* are virtually absent, or in the Oligohaline region of southwestern Everglades National Park; therefore, the model should not be used in the two aforementioned areas. Suitability values for some untested regions (WCA 2A, 2B, 3B, northern WCA 3A, Big Cypress) should be considered tentative.

This document describes the ecological rationale for the Habitat Suitability Index model for the Everglades crayfish. This document is intended to serve as a reference for users of the model. The subsequent sections of the document are intended to complement and provide ecological context for the decision rules for each parameter described in the Everglades Crayfish (*P. alleni*) Model Requirements Document (last modified 22 Mar 10).

Hydroperiod

The hydroperiod parameter identifies the duration of flooded conditions that are acceptable for population growth consistent with suggestions in studies by Acosta and Perry (2000, 2002). This parameter looks forward in the water year to ask about the duration of the flooded period. We use the duration of the flooded period (in months) as a measure of the quality and quantity of the population growth conditions rather than a measure of drying disturbance. Acosta and Perry (2000, 2002) indicate that wet prairies with 7 - 9 flooded months have larger populations (and higher production rates) of *P. alleni* than similar habitats flooded < 7 months. Individual *P. alleni* also appear to grow faster in the longer hydroperiod marshes (Acosta and Perry 2000), possibly because food resources have accumulated for longer in those environments. However observations from the Big Cypress forested wetlands indicate that *P. alleni* can persist or even thrive in habitats with flooded periods of as little as 3 - 5 months (Dorn 2007, personal observations). For this model, hydroperiod is defined as the longest contiguous period with water depths > -10 cm. A negative cutoff value helps correct for microtopography in the landscape (e.g., rocky glades) where juvenile crayfish can be growing in small depressions even when most of the landscape is dry (N. Dorn, personal observations). Following Acosta and Perry (2002) and data from Dorn (2007) hydroperiods ≤ 1 months have a suitability = 0, hydroperiods = 2 months have a very low suitability (0.1) and suitability rises linearly to 0.5 with hydroperiods of 5 months. From 5 months suitability improves rapidly to a value = 0.9 at 7 months and 1 at 9 - 12 months.

Average Past Water Depths

To delineate a range of ideal average past water depths, empirical relationships between average depths over the previous six months (Dorn and Trexler, 2007; Dorn and Volin 2009) and *P. alleni* density in Taylor Slough (Everglades National Park) and the marl prairies were used. Work by Kushlan and Kushlan (1979) and Dorn and Trexler (2007) indicate that moderate water depths and fluctuating conditions can produce high densities of Everglades crayfish and that long stretches of relatively shallow water may be necessary for high *P. alleni* densities. This parameter looks back in time for each day of the current water-year and calculates the average depth experienced by the crayfish over the past half year, moderately low depths are good (i.e., the 'sweet spot') while high averages and very low averages are bad. This term incorporates both the low and high depth values averaged over a longer period of time putting annual drying and flooding levels on a continuum. This parameter is not completely correlated with either of the other two parameters in the model however this parameter is primarily softening some of the edges of Local Drying parameter. Annual average 180-day values between -20 and +15 have a suitability of > 0.9 while values ≤ -50 and ≥ 50 produce indices = 0.

Local Drying

This parameter identifies local drying events for both the current and previous year. If the water level in a cell drops to ≤ 0 cm for one week during a dry season then a drying event has occurred. The parameter is based on the observation that *P. alleni* are generally absent from sloughs that have not dried in the past year (Dorn and Trexler 2007, Hendrix and Loftus 2000) possibly because predator populations (e.g., fish) are increasingly abundant. Although a 5 centimeter water depth cutoff seems to be a good cutoff to delineate negative effects of drying for fish (Trexler et al. 2005), a more conservative cutoff of 0 cm was used here because there is likely more error in the EDEN (i.e., the DEM) model than in the localized hydrologic models calculated by ecologists working in particular sites (Trexler et al. 2005, Dorn and Trexler 2007). The parameter also accounts for differences in drying sequences with consecutive years of drying producing the highest indices (1.0), no drying for two years producing indices = 0 and other combinations producing intermediate indices.

HSI

The HSI for a given year is the geometric mean of the three parameters for a given year. Years are defined as water years, running from June 1 at the beginning of a water year, to May 31 of the following year (i.e., the HSI value for 2002 is the suitability from June 1, 2002 through May 31, 2003). The HSI values are calculated for the freshwater wetlands within the spatial extent of EDEN.

References

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