Modeling Range Limits for the Red Imported Fire Ant (*Solenopsis invicta*) in Hawaii.

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Future potential range of the red imported fire ant (RIFA) was predicted by Dr. M. Korzukhin following the methods of Korzukhin et al. (2001). The method used in the Hawaii study deviated from that in Korzukhin et al. (2001) only in that regressions used to convert air temperature to soil temperature were generated using Hawaii climate data.

Temperature records at 129 stations in Hawaii were obtained from NOAA's National Climatic Data Center, and HaleNet (http://webdata.soc.hawaii.edu/climate/HaleNet). At each station, a colony was allowed to grow, and lifetime female alate (i.e. queen) production calculated. To find range limits, the results were compared to those at five calibration sites located at the current most northerly range of RIFA (see Korzukhin et al. 2001). Using average alate production at these calibration sites, zones of colony proliferation (certain, possible, and improbable) were defined as follows (where A = female alate production): certain, $A > 3900$; possible, $2100 < A \leq 3900$; improbable, $0 \leq A \leq 2100$. Alate production calculated for each weather station site in Hawaii was mapped according to these colony proliferation definitions. It is important to note that the predicted potential Hawaii range of RIFA presented here is a conservative forecast, since it is based on the current fire ant range, and on average alate production. If fire ants continue invading colder climates, the model might need to be recalibrated and the results recalculated.

As per Korzukhin et al. (2001), a precipitation threshold of 510mm/yr was used to indicate regions where arid conditions may prohibit colony growth in areas without supplemental water sources, such as irrigation, stock ponds, streams, lakes, etc. This precipitation threshold corresponds to a semiarid region in southern Texas where fire ants have been reported to survive in natural mesquite scrublands.

The results of this study show that RIFA has the potential to colonize much of Hawaii. Exceptions occur at very high elevations where temperatures are low. Also, in a few leeward areas rainfall is considered insufficient for providing the moisture needed for colony survival. Many of these sites, however, occur in areas with man-made sources of water that would provide more than adequate moisture for colony establishment and proliferation.

Variable results at higher elevations on east Maui are primarily due to varying daily minimum temperatures (Tmin.s) recorded at different weather stations. RIFA colony dynamics have been shown to be affected primarily by temperature (Markin et al. 1973; Porter and Tschinkel, 1987; Porter, 1988; Tschinkel, 1993). Previous model runs using continental data show that daily fluctuations in the direction of low temperatures can have substantial effects: at a given weather station, just a few days of low Tmin results in a considerable decrease is colony size, and, consequently, in colony alate production. The reasons for differing Tmins at relatively close weather stations may be due to a variety of factors, including micro-climate in which weather stations are placed, and the time period over which the data were taken (there are differences from year to year, including trends towards warmer temperatures at night, when Tmin usually occurs).

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Citations:

Korzukhin, M.D., Porter, S.D., Thompson, L.C., and S. Wiley. 2001. Modeling temperture-dependent range limits for the fire ant *Solenopsis invicta* (Hymenoptera: Formicidae) in the United States. Environ. Entomol. 30: 645-655.

Markin, G.P., Diller, J.H., and H.L. Collins. 1973. Growth and development of colonies of the red imported fire ant, *Solenopsis invicta*. Ann. Entomol. Soc. Am. 66: 803-808.

Porter, S.D. 1988. Impact of temperature on colony growth and development rates of the ant, *Solenopsis invicta*. J. Insect Physiol. 34: 1127-1133.

Porter, S.D., and W.R. Tschinkel. 1987. Foraging in *Solenopsis invicta* (Hymenoptera: Formicidae): effects of weather and season. Eniron. Entomol. 16: 802-808

Tschinkel, W.R. 1993. Sociometry and sociogenesis of colonies of the fire ant, *Solenopsis invicta* during one annual cycle. Ecol. Monogr. 63: 425-457.