Section I.
Invasive and Emerging Pests

A MODEL ESTIMATING SPOTTED WING DROSOPHILA OVERWINTERING MORTALITY

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A model that estimates overwintering mortality of the spotted wing Drosophila (SWD), *Drosophila suzukii*, based upon chilling degree-days (DDs), is undergoing active development, and is intended to be used for varying climates and habitats. Recent laboratory cold temperature mortality studies (Dalton et al. 2012) used 5 constant temperatures with no freeze interval and recorded survival for up to 84 days. These data were converted to chilling DDs using thresholds from 10.6 to 12.8 degrees C (51 to 55F). After a lowest error (C.V.) comparison, a threshold of 11.7C (53F) was selected to compute chilling DDs. These results were then fitted to an exponential saturation function (Fig. 1) to allow estimation of a given mortality rate for a given accumulation of chilling DDs. The model was then confronted with data from: a) the same study with an added 7-day freeze; and b) field monitoring data from the mid-Willamette Valley and Hood River, Oregon (Fig. 3). The model gave a reasonable fit to these data, once a factor was included for the field data to account for SWD behavior seeking rural and human/urban related refuges from winter cold temperatures. This refuge factor (Rf) was developed from 800 meter resolution GIS data, NOAA stable lights 2010 (Fig. 2), which provides a continuous range of nighttime light intensity. We adapted these data as a proxy for the tendency of SWD to seek shelter from the cold over a range from rural (open space with minimal protection, Rf=0.15) to human/urban influences (with maximal protection, Rf=0.60). These preliminary refuge factors were estimated in part from the data from the field data as shown in Fig. 3, and from a general failure to trap flies before June or July in most rural/open areas in 2011 in Hood River and Wasco Counties and other cold winter regions. With the resulting model, we developed maps for the Pacific Northwest (Fig. 4) and for CONUS USA that predict average SWD overwintering mortality rates. The model is intended to serve as a test of our current understanding and data on differential winter mortality and resulting spring population incidence levels. One use of the model could be to help determine springtime monitoring efforts for a given location. This model, once it is further refined and tested in particular to improve refuge factor estimates for a range of habitat types, should also be useful as a component within other models predicting SWD population dynamics.

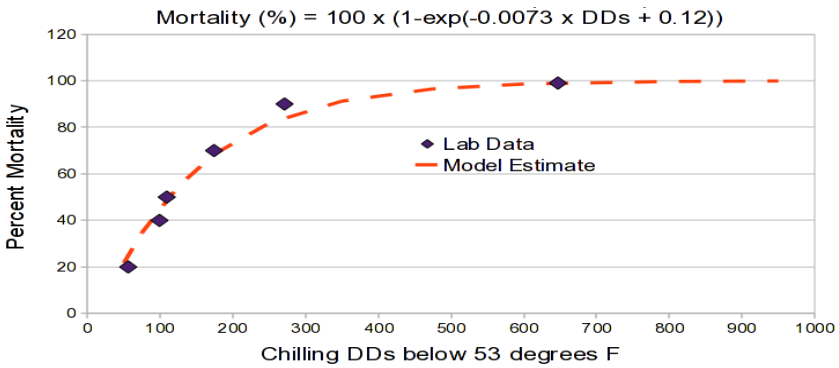

Fig. 1. A model of SWD overwintering mortality developed from constant temperature laboratory data based on accumulation of chilling degree-days (DDs).

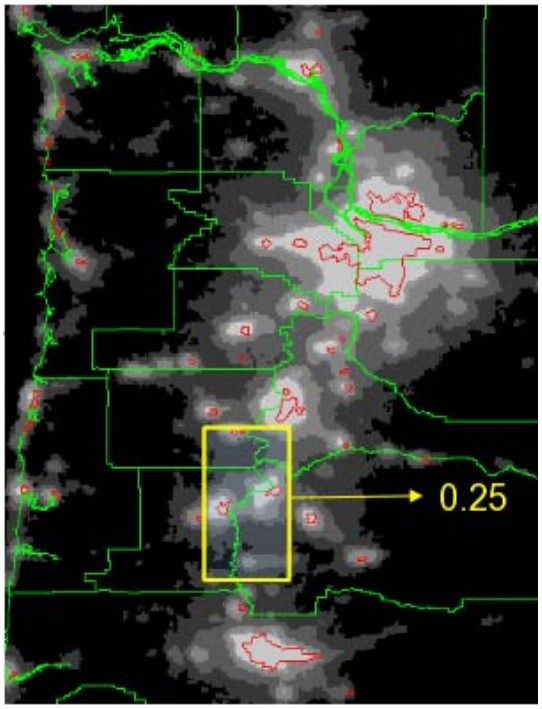

Fig. 2. NOAA Earth Observation Data Center "2010 Stable Lights" calibrated to represent potential SWD overwintering refuges based on urban/human caused development, currently varying from 0.15 (most exposed or rural, darkest) to 0.60 (most protected or urban, lightest). Shown for NW Oregon with a) urban boundary data (red), and b) yellow box around region monitored for data displayed in Fig. 3, Left. Within this area, the average refuge factor is 0.25, used to reduce chilling DDs by 25%.

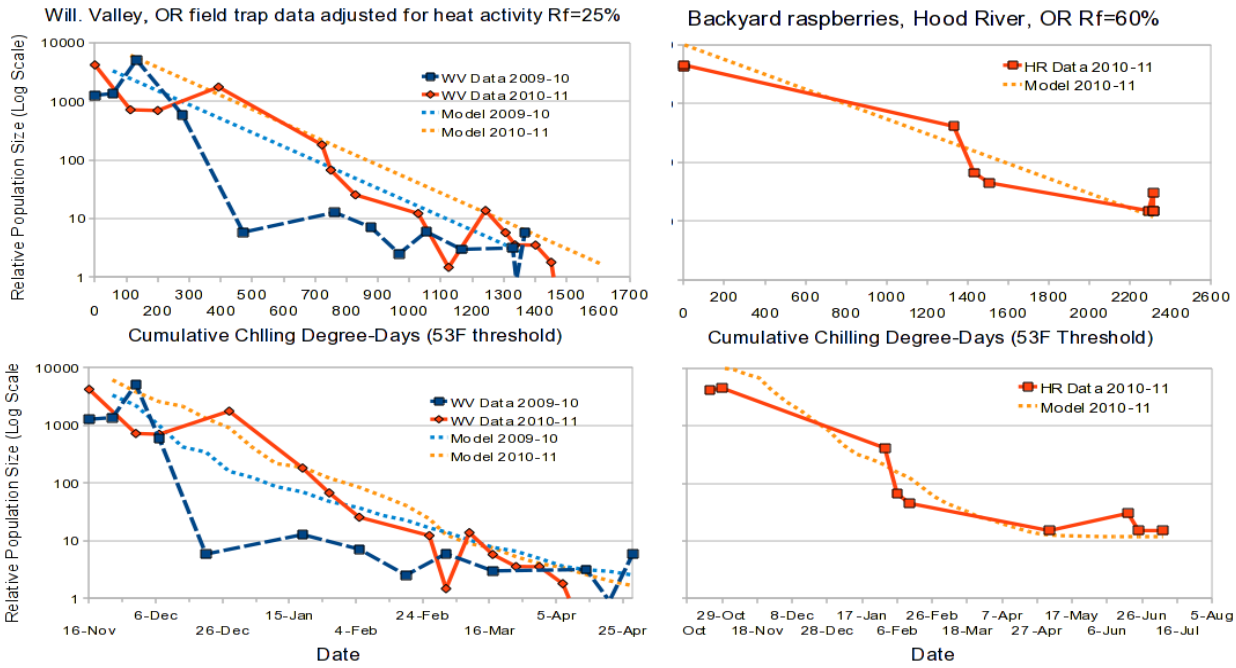

Fig. 3. SWD overwintering mortality model estimates vs. mid-Willamette Valley (WV) and Hood River (HR) winter-long adult monitoring data, Left side: WV 2009-10 and 2010-11, adjusted to relative initial population sizes, with model refuge factor (Rf) of 0.25 (see Fig. 2). Right side: HR 2020-11 with model Rf of 0.60 (urban), for backyard raspberries. Monitoring data adjusted slightly for relative outdoor temperatures affecting SWD adult activity.

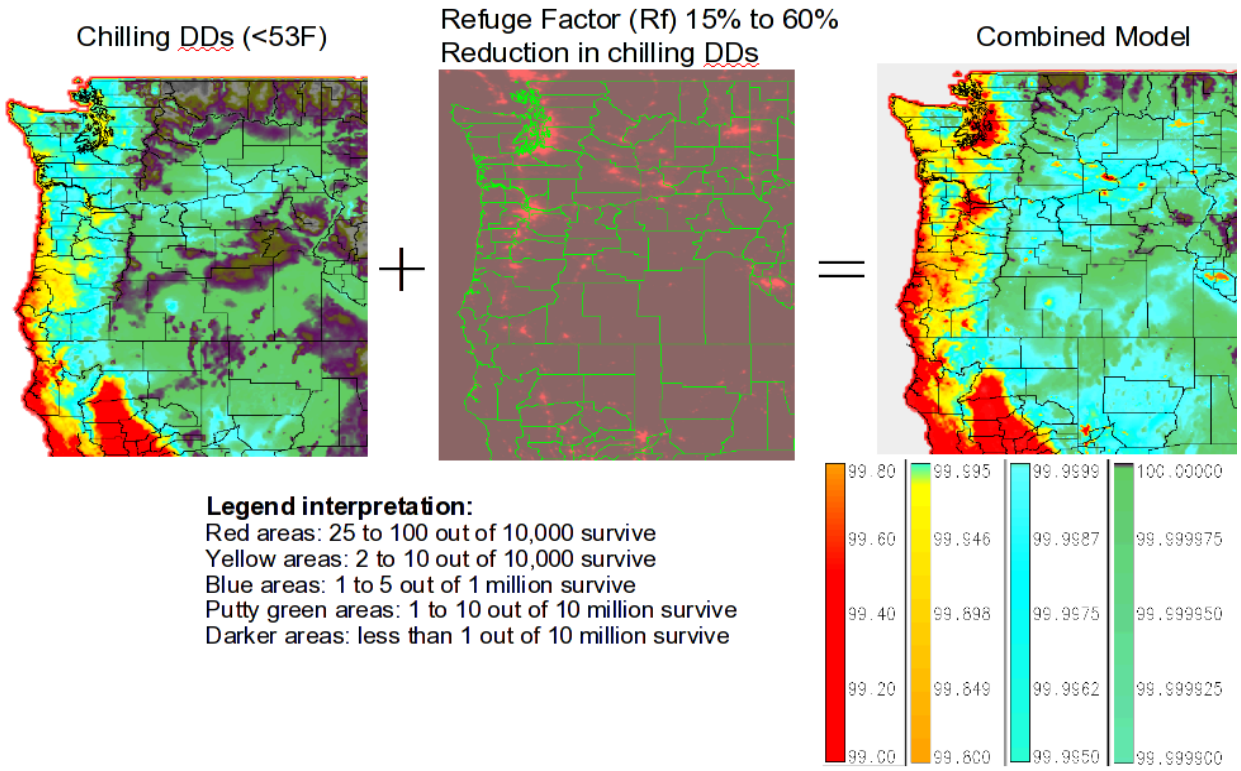

Fig. 4. SWD overwintering mortality model application to Pacific Northwest region. Upper left – SWD chilling DDs (53 degrees F threshold; derived from 1971-2000 PRISM 30 year average climate data), which reflects laboratory (no refuge) situation. Upper middle – NOAA 2010 Stable Lights, tinted reddish to show potential range of urban refuge/protection effects. Upper right – combined results showing currently estimated overwintering mortality values, ranging from 99% mortality (red areas) to nearly 100% mortality (darkest areas).