

IPPC Synthesis – July 26, 2011 1st draft – Len Coop

Pine Shoot Beetle Swarming Activity Heat Unit Model: *Tomicus piniperda*
attacks Scots Pine Coleoptera: Scolytidae

developed by request of USDA APHIS PPQ

Model based on this publication:

Saarenmaa, H. 1989. A model for the timing of swarming of *Tomicus piniperda*. Holarct. Ecol. 12:441-444

Model summary: biofix Jan 1 Tlow 54 F Thi 70 F (12.2 and 21.1 C)

Heat Unit Calculation: $DD = T_{max} - 54$ F (if $T_{max} > 70$ F then set T_{max} to 70)

Heat Units	% swarm	Description
0	0	Start
2	3	Initial swarming activity
13	53	Peak swarming
25	81	Majority of swarming ended
60	96	Late swarming activity
120	99	Final swarming activity

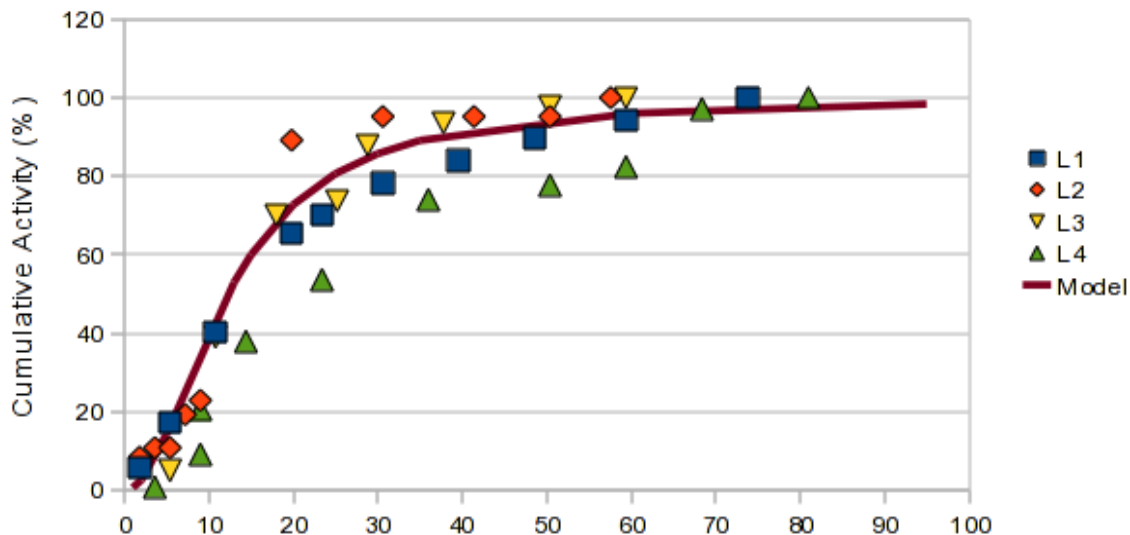
Based on the Sigmoid function: $\% \text{ swarming} = 100 / (1 + 150 \times \text{cumDD}^{-2.0})$

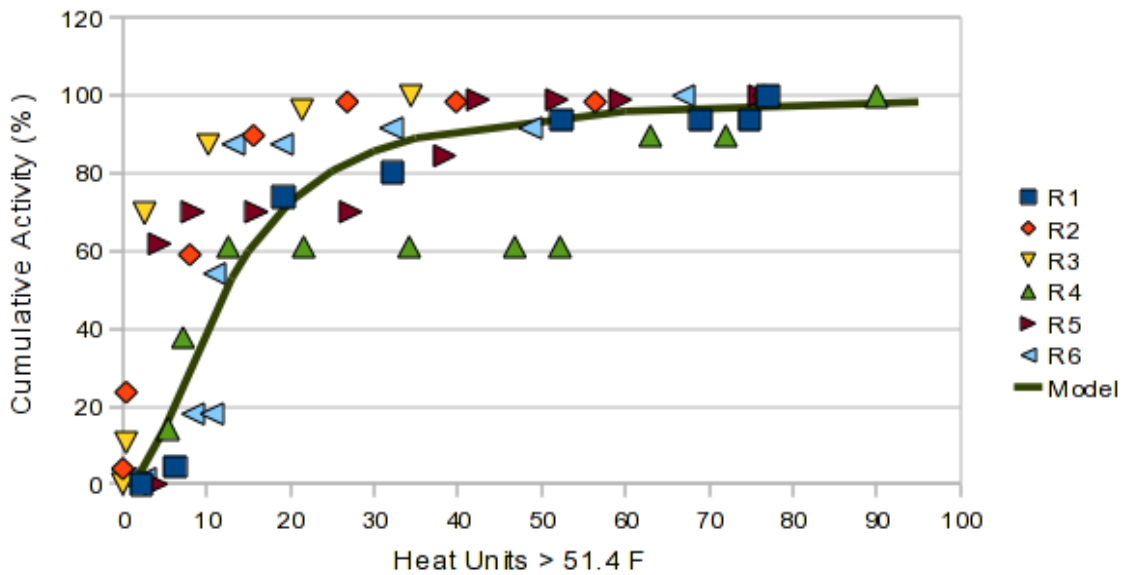
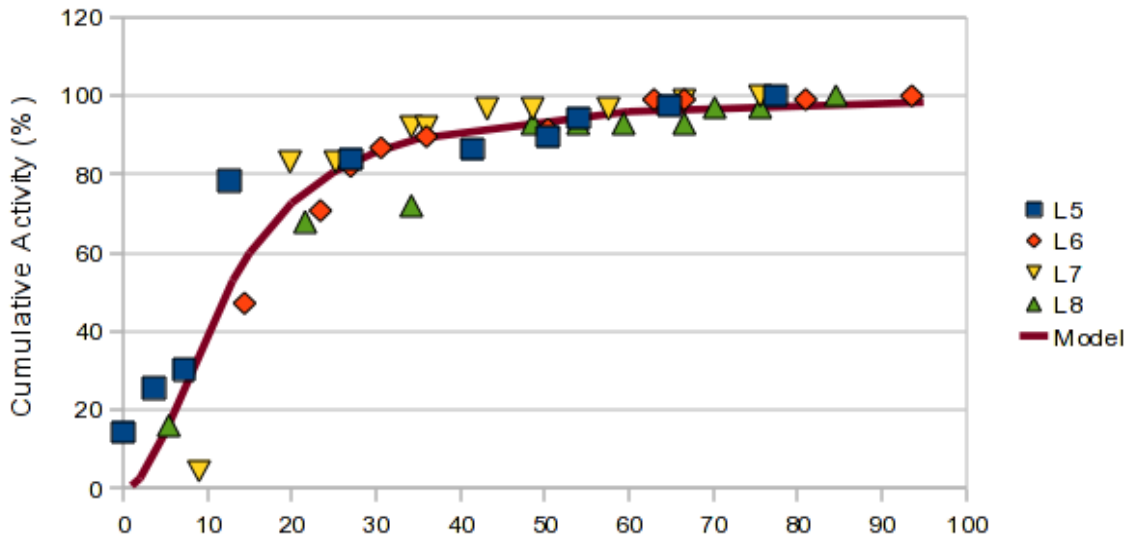
Notes on differences between Saarenmaa's and version implemented by IPPC:

- our model is simplified to using heat units from daily max (T_{max}) only
- they used two factors: daily air temp $>$ threshold (10.8 C = 51.4 F) and temp. sum $>$ threshold
- They used validation data (from Norway) which produced a threshold of 11.6 C (=52.88 F), and the orig. model was developed for N. Finland, whereas in the US a threshold of 12.2 C (=54 F) is used. We therefore continue to use 54 F as the threshold, since most areas of US are warmer and at lower latitude than either European study location. There may be errors associated with this differing threshold, with locally adapted populations, host tree species, etc.
- There is little evidence for whether an upper threshold should be used; it is more conservative to use one than to allow an unlimited temperature response; therefore a $Thi=70F$ is used

Pine Shoot Beetle

Swarming activity vs. heat units - based on Fig.2 Saarenmaa 1989





Notes on Figures:

Top: Model prediction initially greater than 1 case (L4), about same as 3 cases (L1, L2, L3)

Middle: Model prediction initially less than 1 case (L5), about same as 3 cases (L6, L7, L8)

Bottom: Model prediction initially less than 3 cases (R2, R3, R5), about same as 3 cases (R1, R4, R6)

Figure 2 (left side) from Saarenmaa (1989), horizontal lines added for interpretation of data.

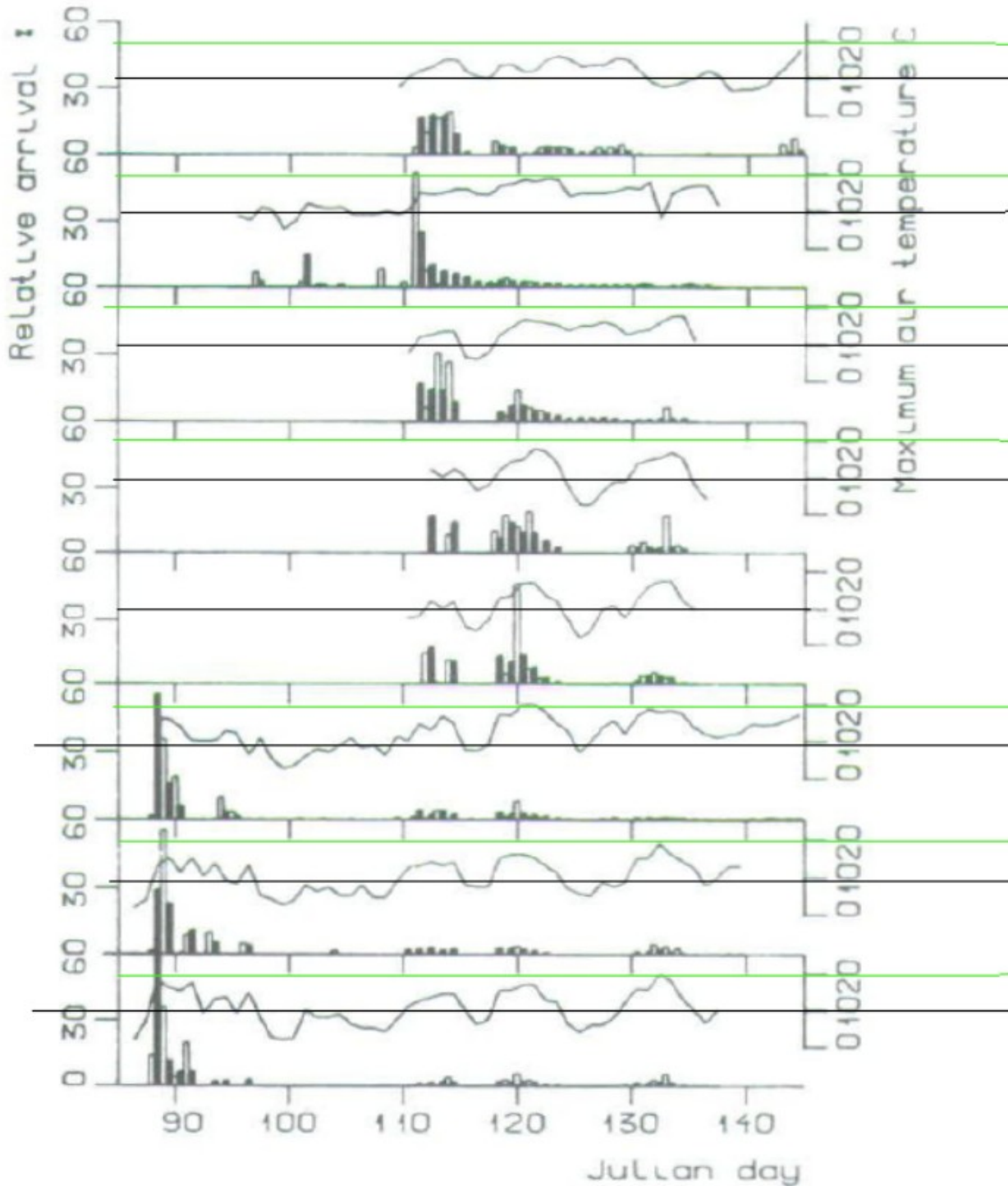
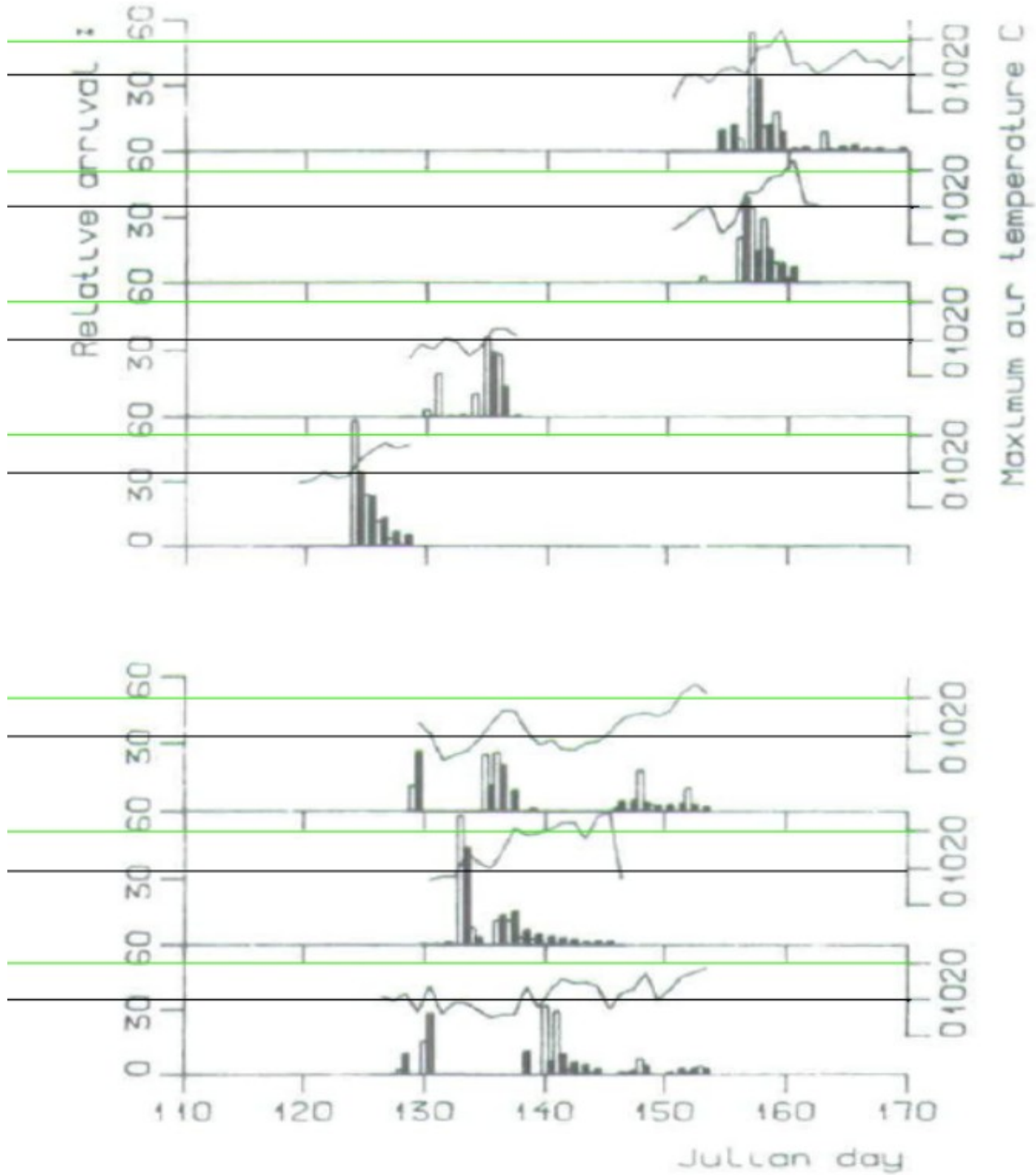


Fig. 2. Validation of the arrival model (2) against data of Bakke right, and Salonen (1973: Figs 2 and 3), third and fourth from above. Years 1980, 1981, and 1982 appear in the three lowermost plots simulated ones as filled. The curves above the histograms show

Figure 2 (right side) from Saarenmaa (1989), horizontal lines added for interpretation of data.



(1968: Fig. 15) on the left and two uppermost diagrams on the right. The calibration material from Rovaniemi in the middle and bottom diagrams on the right. Observed values are shown as open bars and the daily maximum air temperatures.