PLANT DISEASE EPIDEMIOLOGY -- Winter 2008
FINAL
Closed book and closed notes. You can use a calculator (if needed)

1. Define or explain 10 of the following 11 terms (leave one blank; your choice) [40 points].

   a. Multiple point crop loss model

   b. Point source of inoculum

   c. \( y_\infty = 1 - \exp(-R_0y_\infty) \)

   d. Secondary dispersal gradient
e. beta-binomial distribution

f. \( dy/ds \)

g. Latent period

h. coupled differential equations

i. sparse sampling
2. In spatial pattern analysis, two types of correlation are valuable indices of aggregation, the intra-cluster correlation ($\rho$; related to $\theta$ and $D$) and the 1st order spatial autocorrelation [$r(1)$]. Explain in words (equations are not needed) the meaning of these two measures of aggregation. Be thorough, and make sure the ideas of scale are incorporated in your answer. [12 points]
3. With regard to disease gradients, what is the difference between $a_P$ of the power model (with $\lambda=0$) and $a_E$ of the exponential model? Make sure you explain the biological or physical interpretation of these parameters. How would your answer change if you compared $a_E$ with $a_P$ of the modified power gradient model (i.e., with $\lambda>0$)? [12 points]

4. There is a well-known functional relationship between $R_0$ and $r_E$ (early in polycyclic epidemics). Complete the following text, by circling the correct words in each sentence. For instance, immediately below, circle either “big” or “small”. [12 points]

   It takes ____ big / small ____ changes in $R_0$ to give small changes in $r_E$, especially when $R_0$ is fairly large. When $R_0$ is fairly small (< 15), $r_E$ is ____ sensitive / insensitive ____ to small changes in $R_0$.

   Decreasing the latent period ____ increases / decreases ____ $r_E$ (at a fixed $R_0$). Decreasing the latent period (e.g., from 20 to 10 days) changes $r_E$ ____ less/more ____ when $R_0 = 20$ than when $R_0 = 200$. At large $R_0$, $r_E$ is determined mostly by ____ infectious / latent ____ period. Values of $R_0$ above 300 are ____ rare / common ____.
5. (a) What is the velocity of isopath movement (\(\partial s/\partial t\)) and how is it used? (b) Two popular and useful models for describing spatio-temporal dynamics of disease are the logistic-logistic and the logistic-power-logistic. How do these two models differ in terms of \(\partial s/\partial t\)? Explain why these two models give different behaviors for \(\partial s/\partial t\). (c) What does a graph of \(s\) (or \(s'\)) versus \(t\) look like for these two models? [14 points]

6. Draw a typical graph for progress of a polycyclic disease over time (for a situation with the basic reproduction number equal to about 5), showing \(H, L, I,\) and \(R\) versus \(t\). Also put \(Y\) on the same graph. Make sure you label all the curves and the axes. (At \(t = 0\), assume that \(I = 1, L = 0, R = 0,\) and \(H = 999\)). Start the graph at \(t = 0\), and continue the graph until there is no further increase in \(Y\). [12 points]
7. *BONUS (extra-credit)*: An investigator observed disease incidence in \( N = 100 \) sampling units, with \( n = 10 \) leaves per sampling unit. She calculated a variance of the proportions of \( s_y^2 = 0.075 \) (the “observed variance”), and a mean of \( \bar{y} = 0.5 \). What is the index of dispersion (\( D \)), and how do you interpret the magnitude of the value for this data set (in terms of spatial pattern)? [+4 points]
For background information (or if needed)…