Plant Disease Epidemiology (Winter 2006)

Test #2

(Open book, open notes, but work ALONE)

Name: ____

1. Dutch elm disease (caused by the fungus *Ophiostoma ulmi* [*Ceratocystis ulmi*]) is a devastating disease of elms in the U.S. and many other countries. In the 20th Century, elms disappeared in many mid-west cities because of mortality caused by this pathogen. This is a polycyclic disease, and infections occur in more than one way, but primarily through transmission by beetles and through root grafts. Epidemiology can play a major role in the control of this disease. Consider two similar mid-west cities where the disease was discovered about the same time. The cities took two different approaches to disease control, starting in the same year (call this time 0). In year 0, 1.5% of the trees were diseased in city A, and 0.5% were diseased in city B. City A decided to apply aerial applications of insecticides throughout the city every year (to control the vector population) and to remove dead and decaying trees and branches (that harbor the vector and the pathogen). City B decided to control the disease just with yearly application of a systemic fungicide injected into all trees. After 5 years, 15.6% of the trees were diseased in city A and 9.2% were diseased in city B. The data are summarized here:

	City A	City B
t	*y*=	*y*=
0	0.015	0.005
5	0.156	0.092

Based on these results, **city B declared that their approach to control was successful and that systemic fungicide was better than use of insecticides and rouging (removal) of inoculum produced during the epidemic.** However, from an epidemiological perspective, this conclusion is completely wrong! In fact, the control program used by City B is definitely inferior to the program used by City A. (We assume here for this test that other conditions [environment, etc.] are the same in each city).

a. Assuming that disease intensity increases logistically (which has been shown by Merrill for this disease), show that Dutch elm disease incidence is actually increasing faster in city B. (Since the controls are taking place during the epidemic, all controls affect the secondary infections (if they work at all)).

b. What is different about the two epidemics that resulted in the wrong conclusion by the city administration? (That is, what other epidemiological parameter is different, and how does this affect the results seen between years 0 and 5?).

c. Assuming that disease increases in the same logistic manner for many years, when will 90% incidence ($y = 0.9$) be reached in *each* city?

d. Draw a graph of y^* vs. t for the two epidemics (both lines on the same graph). Make sure you label all axes and the two lines, and draw with enough accuracy so that one can see the essential differences between the two epidemics.

e. Based on these results, do you think either control program is satisfactory? Explain your answer.

f. If city A had the goal of having no more than 50% of the trees diseased after 25 years (20 years from year 5), how low would the logistic rate parameter have to be? (That is, assume that observed y at year 5 is the new initial disease incidence. Solve for the value of r_L that gives $y = 0.5$ for $t = 20$). Draw this new epidemic situation on the same y^* graph above (label it C).

(In all of your calculations above, you can assume K=1).

2. Tomato spotted wilt (caused by tomato spotted wilt virus) is generally considered a monocyclic disease of tomatoes. This is because adult thrips (vectors) can transmit the virus to multiple plants, but do not acquire the virus from infected tomato plants. Thus, infected tomato plants do not lead to more infections in a single growing season. Suppose that the following data were obtained for a single field.

t (day)=	y=
0	0.001
7	0.100

a. Assuming that the epidemic is of the monomolecular type, what is r_M (assume K=1)?

b. What is the estimated (predicted) y at t = 35 days, assuming that the rate parameter is unchanged over time?

c. Now assume that sanitation was used, namely reducing the vector population entering the field throughout the growing season. (Note: with no secondary infection, all controls involve sanitation for monocyclic diseases). If the sanitation ratio (SR) is 10, what would r_M equal?

d. With SR=10, what is y at t = 35 days?