The Santa Cruz River Preservation Trust (SCRIPT) has received a grant of $20 million to purchase land in the vicinity of the river to enhance the ecological integrity of the river. There are two species of particular concern in the vicinity of the river: the Least Bell's Vireo (LBV) and the Toasty-throated Frog (TTF). Some locales are better than others for these species. A number of parcels are available for purchase (in whole or part) and you have been hired to make a recommendation about which parcels to buy. (For related real examples, see Bren Group Projects from 2000 and 2003).

In a map of the river below, these parcels have been indicated along with the values of C (cost per hectare in thousands of dollars), L (LBV habitat index) and F (TTF habitat index). Each parcel is 100 hectares in size (1km$^2$ = 100 hectares). The habitat indices may take on a value of 0, 1, 2 or 3, with 3 being the most suitable habitat. The probability of a species surviving is proportional to the square-root of the weighted sum of the amount of hectares preserved (bought), with the weights being the habitat quality index. Assume that if all land is purchased, the probability of survival of each of the two species is exactly equal to 1. The big problem is, you don't know which species is more important. Your staff biologist is no help because she tells you that both species are equally important. You will need to set up the problem mathematically (for example, using SOLVER in EXCEL). Remember: probabilities are always between 0 and 1.

a) Suppose LBV is your sole concern. Before conducting a formal analysis, “guess” how much of which parcels should be purchased and why did you make this guess? Where is the tension in this problem? (10 pts)

b) Again, LBV is your sole concern. Write mathematically the problem of determining how much of which parcels should be purchased? Solve this problem (using a computer). What are the probabilities of survival for the two species? (20 pts)

c) How much of which parcels should be purchased if the TTF is your sole concern? (10 pts)

d) Not knowing which species is more important, trace out the efficient frontier of attainable survival probabilities for both species. [Hint: There are several ways of doing this. One is to maximize the probability of survival of the LBV given your budget and constrained such that the probability of survival of the TTF is at least y. Then let y vary from 0 to 1. Alternatively, maximize the weighted sum of the probabilities of survival of the two species and let the weights vary from 0 to 1. These weights are not the same as in calculating probabilities.]. (20 pts)

e) If you knew how society was willing to trade off TTF viability vs. LBV viability (i.e. with an indifference curve), how would you decide how much of which parcels to protect? (10 pts)

f) Compare the optimal land purchases in part (b), part (c) and when the two goals are equally weighted in (d). (10 pts)

g) Write a one page memo recommending action to the Secretary of the Interior (20 pts)