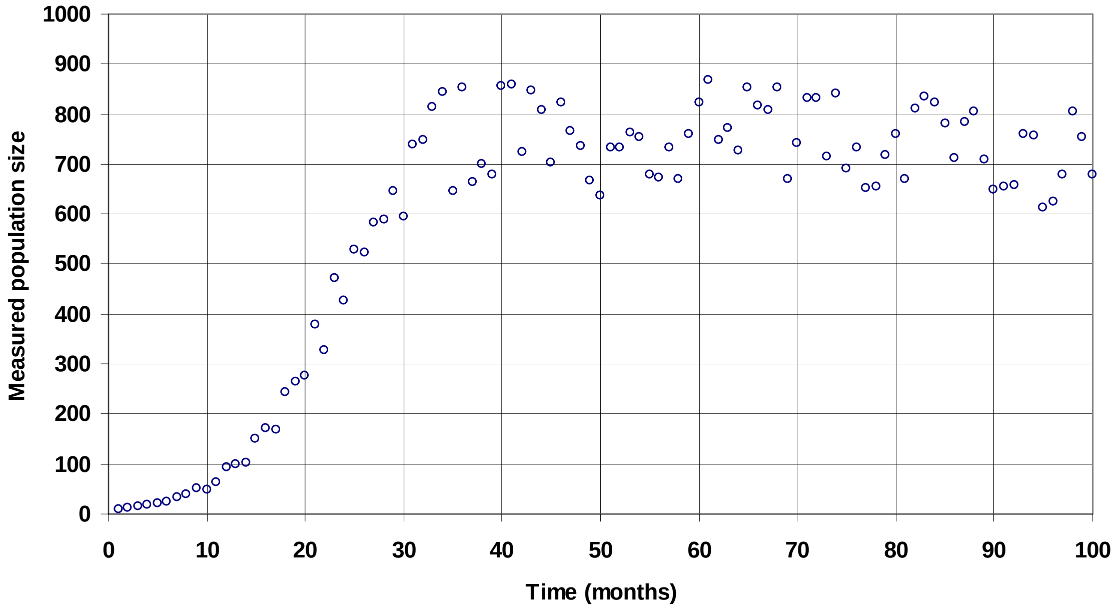
BIOE 107 Ecology Problem Set 2 Names:

1) After years of overfishing, a population of trout in a stream was allowed to recover. The recovering population was followed for 8.5 years and is shown in the graph below.




a. What is an approximate value for the carrying capacity K for this population? Explain.

b. In what month(s) is the total population growth rate the fastest? Explain.

c. What is the population growth rate dN/dt during the month(s) identified in answer (b)? (Hint, the slope of a line is change in Y/change in X).

d. Using the logistic population growth equation, $dN/dt = rN(1-N/K)$, estimate r for this population.

e. Previously 45 trout were being caught every month by fisherman. Does this explain why the population crashed? Explain by referring to the figure, your knowledge of population growth, MSY, and your answers to a-d.

f. If you only had data from Month 31-100 in the graph above, what parameters of the logistic model could you estimate?

Names:___________________

2) (True Story) In 2002, a species of native Hawaiian birds called the Po'ouli was reduced to 4 individuals (two females and two males).
   a. Assuming the birth rate was 0.6 female offspring surviving to adulthood/ female, and the survival rate was 0.75, what was the probability that this species would go extinct purely due to demographic stochasticity?

   b. If you were managing this population, and you could either raise 4 more individuals in captivity (2 males and 2 females) and release them into the wild (assume they have similar survival and birth rates as wild birds – admittedly a somewhat dubious assumption), or increase the survival of wild birds to 0.8, which would be a better strategy to avoid short term extinction? Show your work.

3) Make a model in excel of a population in discrete time with "density-dependent" or "logistic" population growth that uses the equation:

$$N_{t+1}=N_t+r_dN_t(1-N_t/K_{es})$$

For $K_{es}$ (short for environmental stochasticity), use the equation: $K_{es}$ = ($K_m$+rand) where $K_m$ is the mean of the carrying capacity, and "rand" is a "normally distributed" random number with mean 0 and standard deviation $\sigma$. For "rand" use: NORMINV(RAND(),0, $\sigma$), where $\sigma$ is the "locked" value of a cell with the standard deviation of the environmental variability. Start with a value of $r_d$=0.1 (10% growth/year), $K_m$ (mean carrying capacity) = 1000, and $\sigma$=50. "Simulate" 100 years of population growth by making 100 time steps with a starting population size of 1000. For each time step use the population model above to model the population in the next time step. Then use the $N_{t+1}$ population as the $N_t$ for the next time step. Use this model to answer these questions:

   a. Write down the minimum, maximum, and average (mean) population size over the 100 years in Run 1 of the table (round to the nearest whole number). Then make Excel generate new "random" numbers by selecting an "empty" cell in excel (one with nothing in it), and press the "delete" button (on a Mac you can just press the space bar and enter). Do this 10 times, total, and write down the minimum, maximum, and average (mean) population size over the 100 years for each "run" in the table below. Then increase $r_d$ to 0.4, and repeat 10 "runs" of the model and enter into the second table below.

| | R=0.1 | $\sigma$=50 | $K_m$=1000 | | | r=0.4 | $\sigma$=50 | $K_m$=1000 |
|---|---|---|---|---|---|---|---|---|
| Run | Minimum | Average | Maximum | | Run | Minimum | Average | Maximum |
| 1 | | | | | 1 | | | |
| 2 | | | | | 2 | | | |
| 3 | | | | | 3 | | | |
| 4 | | | | | 4 | | | |
| 5 | | | | | 5 | | | |
| 6 | | | | | 6 | | | |
| 7 | | | | | 7 | | | |
| 8 | | | | | 8 | | | |
| 9 | | | | | 9 | | | |
| 10 | | | | | 10 | | | |

b. What effect does increasing the population growth rate $r_d$ from 0.1 to 0.4 have on the variability of the population (the minimum, maximum, and average)? Why do you think it has this effect?

c. Now increase the environmental variability of the carrying capacity by increasing $\sigma$ to 200. Perform 10 "runs" again and again fill in the table below.

| | R=0.4 | $\sigma$=200 | $K_m$=1000 |
|---|---|---|---|
| Run | Minimum | Average | Maximum |
| 1 | | | |
| 2 | | | |
| 3 | | | |
| 4 | | | |
| 5 | | | |
| 6 | | | |
| 7 | | | |
| 8 | | | |
| 9 | | | |
| 10 | | | |

d. What effect does increasing $\sigma$ have on population variability? How does this affect the probability of the population dropping near or below 500 individuals (the "threshold" when genetic inbreeding may become a problem)? What does this suggest about endangered species that live in variable environments?