Homework 5

due February 11, 2015

Do these problems, and email the results (if you can, in a PDF or else in Word .DOC or .DOCX format). Like all of the weekly homeworks this one totals 25 points and is due at the end of that day (at midnight).

1. (13 points) Suppose that we have two populations, of large and equal size. Each receives migrant from the other, but the first population has a fraction $2m$ of its adults be new immigrants, and the second has a fraction $m$ of its adults be new immigrants. Owing to density-dependent population size regulation, the two populations remain equal in size.

For an allele $A$, suppose that the gene frequencies in the two populations are respectively $p_1$ and $p_2$.

(i) Show the equations for what $p'_1$ and $p'_2$ will be in terms of $p_1$, $p_2$ and $m$.

(ii) Will $p_1$ and $p_2$ approach the same equilibrium value?

(iii) If so, will this be the simple arithmetic average of the initial values of $p_1$ and $p_2$? (Hint: calculate a weighted average $\alpha p_1 + (1 - \alpha)p_2$ and try to find a value of $\alpha$ that results in this weighted average being the same in all generations)

(iv) Can $p_1 - p_2$ be simply expressed in terms of its value in the previous generation? What does this say about how quickly the equilibrium gene frequencies are approached?

2. (12 points) Suppose that a stream has a large resident population of rainbow trout (that remain there and do not run to the sea). They are fixed for a locally-favored allele $A$ at a locus that would have fitnesses of $AA$, $Aa$, and $aa$ of 1 : 0.9 : 0.81 in that stream. A hatchery is suddenly set up next door and as a result of straying from the hatchery in each generation trout that are all $aa$ enter the stream and breed with the locals, the newly-arrived hatchery fish arriving as adults and constituting 5% of all parents in each generation.

(i) What will be the ultimate fate of allele $A$? Is this case covered by any of the equations in the text?

(ii) Make some calculation that gives us a good sense for how rapidly this ultimate state is approached, and describe why the calculation conveys that.