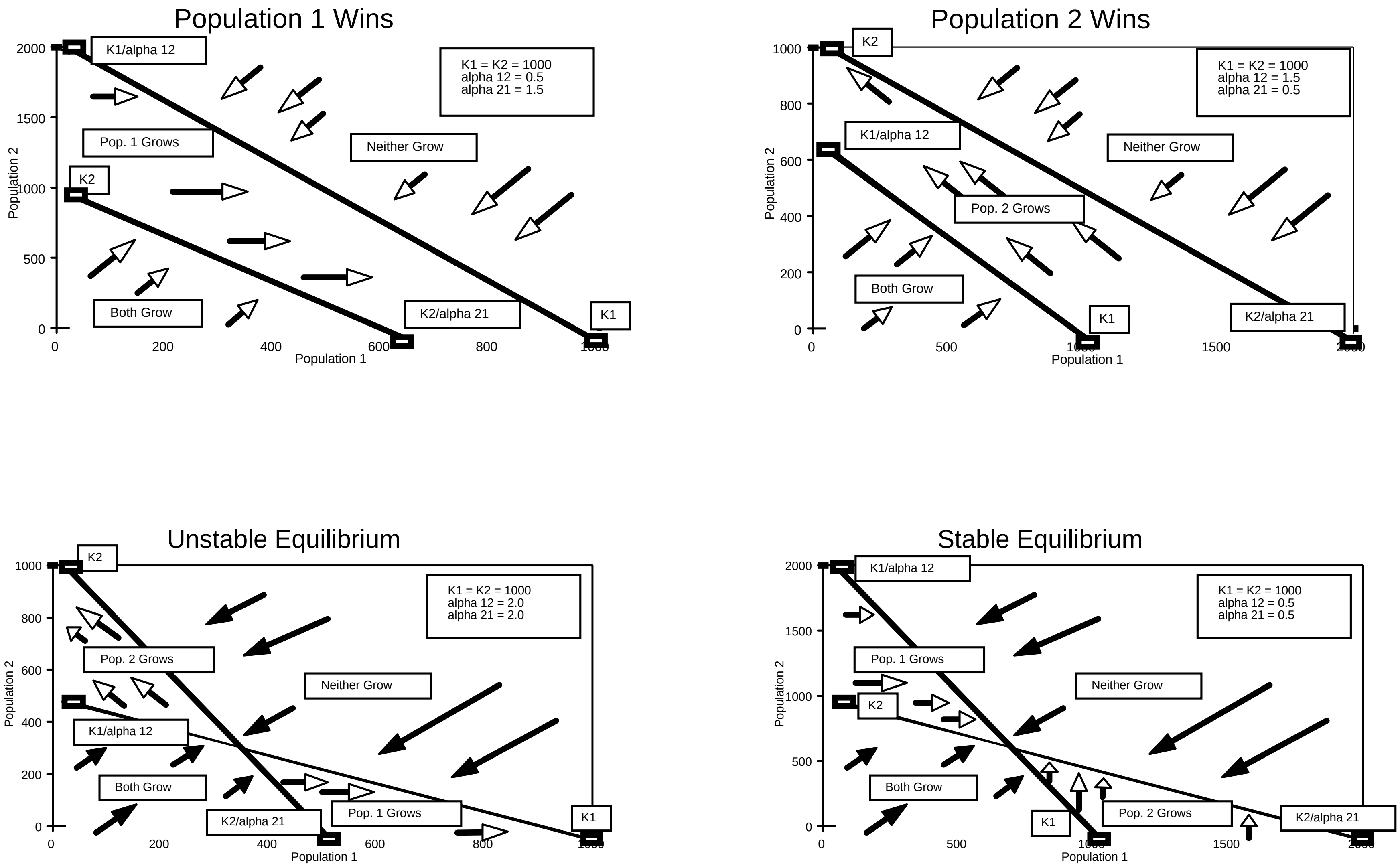
**Figure 1: Possible Outcomes of Competition**



## The theory of competition and coexistence:

Again, I find Ricklefs' notation hard to follow. Don't worry about this section in the text; instead, read the description of the competition model outlined below.

Key Equations: This model uses the logistic equation modified for two populations.

The basic logistic equation:

$$\Delta N = \frac{rN(K-N)}{K}$$

**Equation 34**

$\Delta$ (delta) means "change in"

is modified by adding a component to the numerator that accounts for the food (space, water, other resources) that the competing species "steals" from the first:

$$\Delta N_1 = \frac{r_1 N_1 (K_1 - N_1 - \alpha_{12} N_2)}{K_1}$$

**Equation 35**

The new term is $\alpha_{12}N_2$, where $\alpha_{12}$ (alpha) is a factor that measures the impact of population two on population one. For instance, if each member of population two consumed the resources of 2 individuals of population one, then alpha would equal 2; likewise, if the members of population 2 ate only 1/2 of what the members of population 1 did, then alpha would equal 0.5. Multiplying the alpha by the size of the second population yields a number which estimates the impact of the second population on the first, and is thus subtracted from $K_1$ just like the size of the first population is.

Since the model follows two populations, a second equation to track population two is needed:

$$\Delta N_2 = \frac{r_2 N_2 (K_2 - N_2 - \alpha_{21} N_1)}{K_2}$$

**Equation 36**

When this model is used, the path, or trajectory, that the population will take can be predicted from a graph drawn from the *K* and $\alpha$ values. Each population has an axis to show its size; traditionally population 2 is plotted on the vertical axis. Each population has a line drawn between its *K* value (on its own axis) and its *K* value divided by the effect its competitor has on it; this second value is plotted on the competitor's axis and a line is drawn between the *K* value and the $K/\alpha$ value. This is done for both populations. On the graph, any time a trajectory is **below** (vertically) or to the **left** of the line for a population, that population grows. If the lines do not cross, then a competitive situation exists where the competitor whose line falls above and to the right of the other competitor will win - see the top 2 graphs on the next page. If the lines cross, an equilibrium point exists at the crossing; if the trajectory comes to that point exactly the population sizes will not change. If competition is high (high $\alpha$ values), then the equilibrium is unstable; if perturbed the trajectory will move away from the equilibrium and one or the other population will eliminate the other depending on where the starting point lies. If the $\alpha$ values are low, a **stable equilibrium** exists and the population trajectory will always return to the equilibrium point. You can experiment with these values by using the ***EcoCyb*** program. It allows you to experiment with different initial points by plotting multiple 'runs'; shaded graph options and plots of the populations against time are also possible.