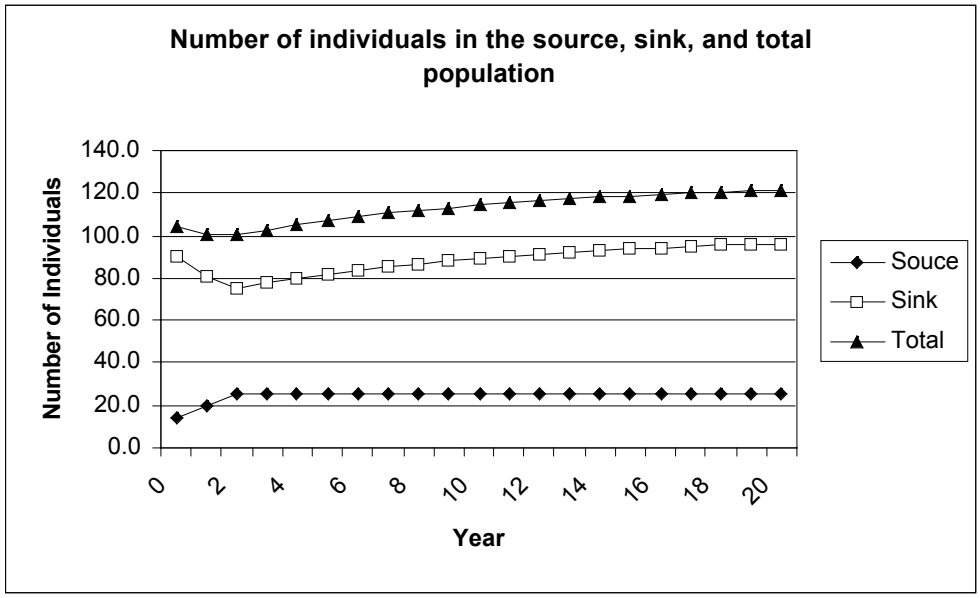
Answers to Exercise 21

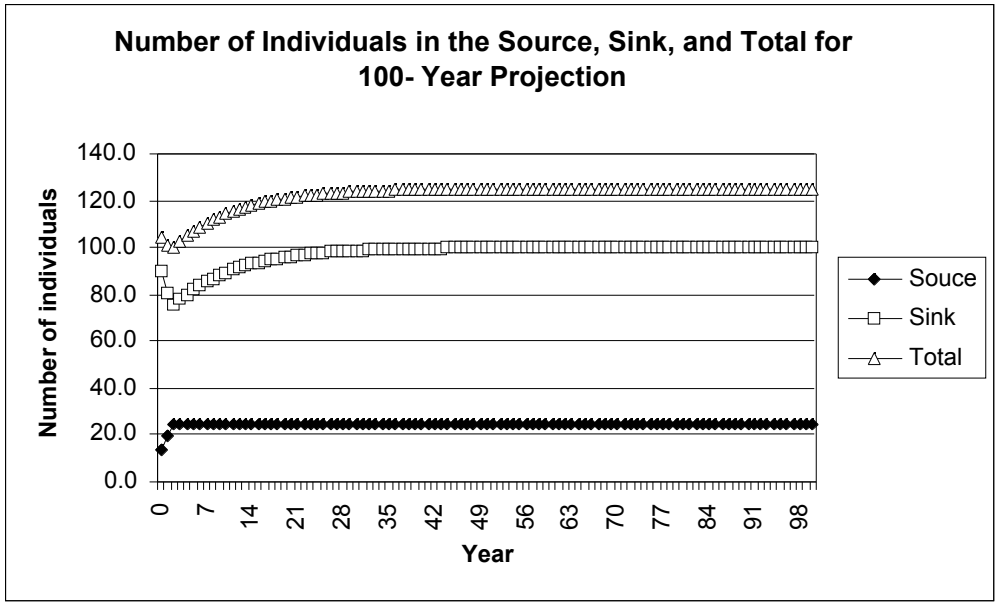
Source-Sink Dynamics

1. The source reaches an equilibrium number at year 3, when the carrying capacity (*K*) has been reached. The source population remains at *K* because excess individuals are forced to emigrate to the sink habitat. The sink does not reach equilibrium within 20 years and shows increased growth over time. This is because the source continues to produce an excess of emigrants—more than are needed to sustain the sink over time. As a result, the entire population grows.

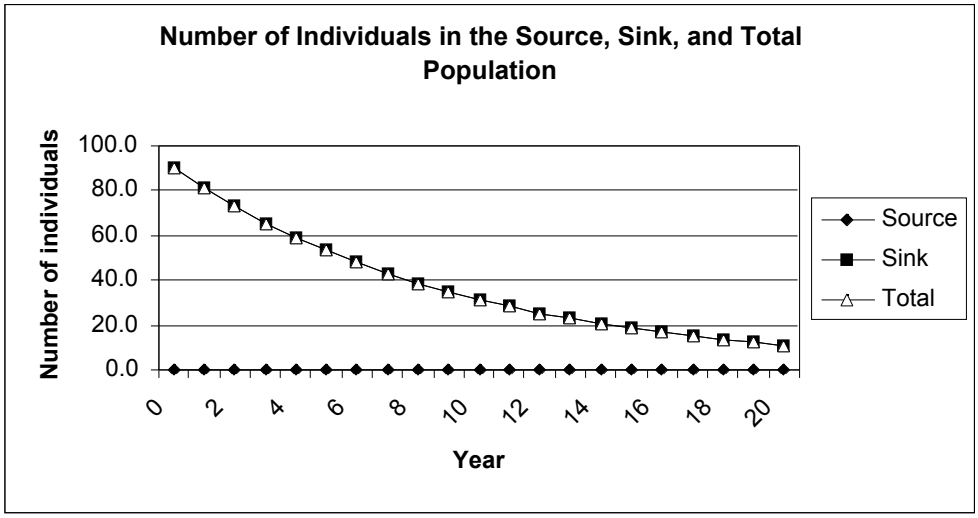


Because the global (source + sink) population is increasing over time, and because the source has a fixed carrying capacity, the proportion of the total population in the sink increases over time, while the proportion of the total population in the source decreases over time. Note that, for the current model inputs, that less than 25% of the population resides in source habitats, yet this is sufficient to maintain numbers in the entire source-sink system. This is an important consideration for populations in heterogeneous habitats: the numbers of individuals in each habitat type determines the overall growth rate.

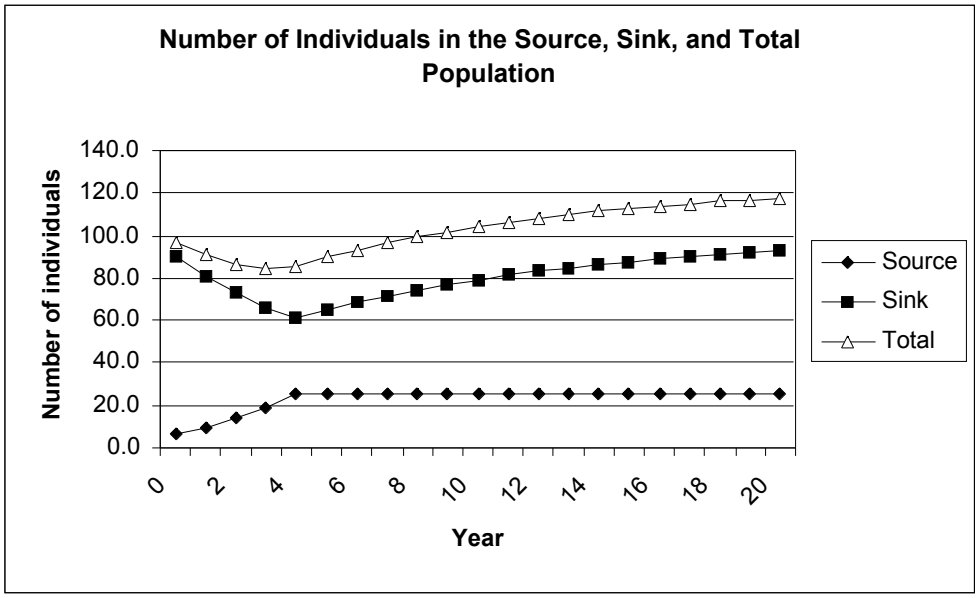
2. With a 100-year projection (graph on next page), the source sink system reaches equilibrium at 125 total individuals. The source has an equilibrium number of 25 individuals, as before. The sink reaches an equilibrium number of 100 individuals. Thus, the numbers of individuals in each habitat type, as well as the whole population, stabilize, because of dispersal between sources and sinks.



3. When the source is extirpated (locally extinct), the sink population indeed declines to extinction, as does the entire population.



4. Increasing and decreasing the numbers of individuals in the source population has little effect on the long-term equilibrium values of the system. However, it does affect the short-term growth in both the source and the sink, as well as the proportion of the total population occupying the various habitat types. Decreasing the number of individuals in the source to 5 causes a delay in the emigration of individuals to the sink because the source takes longer to reach its carrying capacity.



Increasing the number of individuals in the source causes earlier emigration from the source to the sink because the carrying capacity of the source is reached earlier in time. Increasing the survival rate of the source (lower the death rate) makes the source "stronger." Although its equilibrium numbers remain unchanged, the result is a greater capacity to sustain the sink, and a larger equilibrium value for the entire source-sink system. For example, decreasing d to 0.1 increases the equilibrium number of individuals in the system to 150 individuals (compared to 125 individuals with $d = 0.2$).

Increasing or decreasing K affects not only the equilibrium number of individuals in the source, but also the equilibrium number of individuals in the sink and in the whole system. An increase in K will increase both the sink and system equilibrium values because more individuals in the population are located within "prime" habitats for breeding. Similarly, a decrease in the K will decrease the equilibrium values. Enter a variety of values for K and examine your 100 year projection graphs.