Tracking the Spotted Owl – Part II

Earlier, we examined a mathematical model of the population dynamics of the northern spotted owl. As in most population dynamic models, we assume a 1:1 ratio of males and females and count only the females. Recall the model that we used:

- k = years from the beginning of the observation period;
- a_k = the number of adult female northern spotted owls at year k; and
- j_k = the number of female juveniles at year k.
- The average birth rate per adult female is 66%, of which 50% are female. Thus, in any year, the number of juvenile females is about 33% of the number of adult females the previous year.
- 60% of the juvenile females survive to become adults the next year.
- 78% of the adult females survive to the next year.

The ecologists were not happy with the first model developed by the mathematicians: They said that it actually took two years for a juvenile to reach adulthood, and that some *subadult* owls were lost in the middle year. So the mathematicians looked at the data again and developed the following model:

- k = years from the beginning of the observation period;
- a_k = the number of adult female northern spotted owls at year k;
- s_k = the number of subadults (1-year-old) female northern spotted owls at year k; and
- j_k = the number of female juveniles at year k.
- The average birth rate per adult female is 66%, of which 50% are female. Thus, in any year, the number of juvenile females is about 33% of the number of adult females the previous year.
- 18% of the juvenile females survive to become subadults the next year.
- 71% of the subadult females survive to become adults the next year.
- 94% of the adult females survive to the next year.

Use the second model above to answer the following questions:

1. Write equations for the values of j_{k+1}, s_{k+1}, and a_{k+1} based on the information given in the new model.

2. Let $\mathbf{x}_k$ be a vector with entries j_k, s_k, and a_k. Now find a matrix A such that $A\mathbf{x}_k = \mathbf{x}_{k+1}$

   Use your matrix to calculate juvenile, subadult, and adult populations in the rest of the questions. Assume that in 1990 (Year 0), there were 1000 adults, 200 subadults and 310 juveniles (so $a_0 = 1000$, $s_0 = 200$ and $j_0 = 310$) (Remember, we always talk about females in this model, assuming the numbers are half of the total population at each life stage.

3. How many adults should there have been at the end of 1991? How many subadults? How many juveniles? What are the ratio of adults to subadults, and to juveniles?

4. How many adults should there have been at the end of 1992? How many subadults? How many juveniles? What are the ratio of adults to subadults, and to juveniles?

5. How many adults will there be at the end of 2020? How many subadults? How many juveniles? What will be the ratio of adults to subadults, and to juveniles?

6. How many of each stage would there be at the end of 2050 if the initial 1990 population was 7000 adults, 5000 subadults and 2700 juveniles? What would be the ratio of adults to subadults, and to juveniles?

7. Is there an initial population of adults, subadults and juveniles that would not change from year to year? (I.e. $\mathbf{x}_{k+1} = \mathbf{x}_k$)

8. Suppose the model is reasonably accurate far into the future.

   (a) According to this model, what do you think will happen to the *number* of adults, subadults, and juveniles far into the future?

   (b) According to this model, what do you think will happen to the *ratio* of adults to subadults and to juveniles far into the future?

   (c) Do your answers to the questions above depend on the initial population of owls?

Developed by Martha Wallace, inspired by a deer SLAP originally prepared by Jill Dietz.