Background information:
Western prairie fringed orchid (WPFO) is a wetland species once locally common west of the Mississippi River in tallgrass prairie. >80% of the original prairie has been converted to agriculture or developed, and many wetlands have been drained. The WPFO is gone from 75% of counties in which it was originally documented. A few areas are managed for WPFO protection, but in most places orchids grow where there are multiple uses (hay meadow, nearby row crops, burning, draining).

Life history:
The Western prairie fringed orchid is a perennial, surviving from one year to another as an underground stem. In any given year a living plant can be dormant (stay underground as a stem), vegetative (non-flowering, <15cm tall) or flowering (up to 1.2 m tall). Plants can go back and forth between these three states (e.g., flowering one year, dormant the next etc.) or remain in a given state for several years. To produce seed, a flower must be pollinated, probably by sphinx moths. In a given year seeds can either germinate to produce a seedling, stay a seed, or die. Seedlings either become vegetative or flowering in the next year, or die. New plants may grow for many years before producing flowers.

Your task:
Take the information provided above, and carry out a population viability analysis for the WPFO. You should use this analysis to

1. Describe the current state of the population (growing or shrinking),
2. Predict the future trend in population size and time to extinction
3. Determine which stages of the orchid’s life history should be targeted for management intervention
4. Recommend one of several management options based on your analysis.
Instructions:
DUE DATE IS FRIDAY MARCH 18th

We use the program populus version 5.3, it works on macintosh, linux, and windows computers and can be downloaded from http://www.cbs.umn.edu/populus/

Draw a life-cycle diagram for the WPFO: Start by listing the stages to be included in your model. Draw the diagram, including arrows for the possible transitions between stages. Now enter your diagram into Populus (don’t worry about transition values yet).

Include a drawing (by hand or from Populus) of your life-cycle diagram in your report.

Briefly describe how you might collect the data you need to build your model.

Calculating transition values:
You have data available in the Table below. Use the data to determine
• the average probability that a vegetative plant observed in one year,
• will flower in the next year.
• Calculate the number of viable seeds produced per flowering plant.
• etc.

Fill in all the transition values on your life-cycle diagram in Populus, and assign initial numbers of plants in each stage. These numbers can be arbitrary.

Examine your projection matrix and initial stage distribution vector to make sure they include the right numbers.

Include the projection matrix and initial stage distribution vector in your report.

Determine current status:
Is the population growing or shrinking? To support your conclusion, provide the lambda for the first year (current lambda). Is the population at its stable stage distribution? How can you tell? Choose and provide an appropriate graph to support your answer. Can you always infer the long-term behavior of a population based on only a few years of calculating lambda as N_t/N_{t-1}? Why or why not?

Determine future status:
What will this population do in the future? To support your conclusion, provide the long-term average lambda. Choose a quasi-extinction threshold (minimum population size you will tolerate). If the population will go quasi-extinct, roughly how long will that take? Provide a graph of total number in the population over time (long enough to show extinction if it is expected) to support your conclusion. Hint: you can overlay a grid on your graphs using the “options” menu at the top of the graph page.

Determine which life-stages should be targeted for management:
Calculate and report the elasticity for each stage (i.e. for each stage in turn change all elements by 5% and calculate the elasticity). Recall that elasticity is calculated as:

\[ E_{r_i} = \frac{\lambda_{\text{new}} - \lambda_{\text{original}}}{\lambda_{\text{original}}} \frac{r_i,\text{new} - r_i,\text{original}}{r_i,\text{original}} \]
were \( r_i \) is the transition rate to stage \( i \). If there are more transitions into a state we can calculate the denominator of the elasticity value as the average. For example if the transition rate from stage 1 to 2 is 0.3 and the transition rate from stage 2 to stage 2 is 0.5 and we increase both values by 5% we would calculate the denominator as the average of the two transition rate ratios \(((1.05 \times 0.3 - 0.3)/0.3 + (10.5 \times 0.5 - 0.5)/0.5)/2\)

**Which stage(s) should be the focus of management?**

**Management options**

There is pressure from local citizens to make use of the areas where the WPFO grows. **For example,**

1. Use the field as a hay field, which means mowing each year. This results in cutting leaves off of plants, which decreases flowering and vegetative plant survival.
2. Allow spraying of nearby crops with insecticides to reduce agricultural pests, knowing that these sprays will reduce the number of pollinating moths (moths are killed by the insecticide).
3. Drain the field, which will dry out the soil and reduce seed viability and the chances of seed germination.

**Which of the above management options seems least harmful to the WPFO? Provide data** from your analysis to back up your recommendation.

**How might you deal with conflicts that could arise with citizens whose activities might have to be curtailed** (e.g. if you chose to allow spraying but not haying)?

**What are some possible weaknesses of the model you used for this PVA, and how might they affect your conclusions?**

**What additional data or analyses might allow you to make a better recommendation for management of this species?**

If you have problems with parts of this assignment please see me or email me at beerli@csit.fsu.edu. I will stop answering questions concerning this assignment Wednesday March 17th, 5pm, so plan ahead.

(Spring 2004 Nora Underwood, changed in Fall 2004, and in Spring 2005 Peter Beerli)
Data for orchid lab:
The following data are from a study conducted over 5 years at 16 sites in North Dakota (Sieg and King 1995). Vegetative and flowering plants were marked in 1990, and each year the status (flowering, vegetative, dormant) of each plant was recorded, newly germinated plants were marked, and fruits were counted. In this species, an average fruit produces 21,618 seeds, of which 53% are viable, and each plant produces an average of 1.2 fruits. Roughly 50% of seeds do not germinate but remain viable (alive) in the soil from year to year.

<table>
<thead>
<tr>
<th>Year 1 - year 2</th>
<th># vegetative plants flowering in year 1</th>
<th># vegetative plants flowering in year 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>1990-1991</td>
<td>74</td>
<td>0</td>
</tr>
<tr>
<td>1991-1992</td>
<td>54</td>
<td>10</td>
</tr>
<tr>
<td>1992-1993</td>
<td>154</td>
<td>53</td>
</tr>
<tr>
<td>1993-1994</td>
<td>361</td>
<td>12</td>
</tr>
</tbody>
</table>

From the data in the study, the following transition rates have been calculated:

- Seeds to seedlings: 0.0015
- Seedlings to vegetative: 0.0301
- Seedlings to flowering: 0.0099
- Vegetative to vegetative: 0.2806
- Vegetative to dormant: 0.5783
- Dormant to vegetative: 0.0815
- Dormant to dormant: 0.1015
- Dormant to flowering: 0.0299
- Flowering to vegetative: 0.2106
- Flowering to dormant: 0.6968
- Flowering to flowering: 0.1025