CALCULATIONS TO ESTIMATE POPULATION AFTER 10 YEARS

<table>
<thead>
<tr>
<th>Cohort</th>
<th>Age group</th>
<th>$P_{t_0}$</th>
<th>Survival Rate</th>
<th>$S_{t_0 + 10}$</th>
<th>Birth Rate</th>
<th>Births</th>
<th>Net Migration</th>
<th>$P_{t_0 + 10}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0 - 9</td>
<td>3,900</td>
<td>0.989</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>5</td>
<td>425</td>
</tr>
<tr>
<td>2</td>
<td>10 - 19</td>
<td>3,200</td>
<td>0.999</td>
<td>3857</td>
<td>0.011</td>
<td>35</td>
<td>0</td>
<td>3,857</td>
</tr>
<tr>
<td>3</td>
<td>20 - 29</td>
<td>3,300</td>
<td>0.998</td>
<td>3197</td>
<td>0.081</td>
<td>267</td>
<td>50</td>
<td>3,247</td>
</tr>
<tr>
<td>4</td>
<td>30 - 39</td>
<td>2,800</td>
<td>0.998</td>
<td>3293</td>
<td>0.038</td>
<td>108</td>
<td>35</td>
<td>3,328</td>
</tr>
<tr>
<td>5</td>
<td>40 - 49</td>
<td>1,700</td>
<td>0.996</td>
<td>2794</td>
<td>0.007</td>
<td>12</td>
<td>10</td>
<td>2,804</td>
</tr>
<tr>
<td>6</td>
<td>50 - 59</td>
<td>1,800</td>
<td>0.991</td>
<td>1693</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1,693</td>
</tr>
<tr>
<td>7</td>
<td>60 - 69</td>
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<td>0.975</td>
<td>1764</td>
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<td>-20</td>
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<tr>
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<td>70 - 79</td>
<td>550</td>
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<td>0</td>
<td>0</td>
<td>0</td>
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<tr>
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<td>200</td>
<td>0.88</td>
<td>691</td>
<td>0</td>
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<td>0</td>
<td>691</td>
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</tbody>
</table>

TOTAL: 18,550

CALCULATIONS TO ESTIMATE POPULATION AFTER 20 YEARS

<table>
<thead>
<tr>
<th>Cohort</th>
<th>Age group</th>
<th>$P_{t_0 + 10}$</th>
<th>Survival Rate</th>
<th>$S_{t_0 + 20}$</th>
<th>Birth Rate</th>
<th>Births</th>
<th>Net Migration</th>
<th>$P_{t_0 + 20}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0 - 9</td>
<td>425</td>
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<td>3,857</td>
<td>0.999</td>
<td>3857</td>
<td>0.081</td>
<td>263</td>
<td>50</td>
<td>3,903</td>
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<tr>
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<td>20 - 29</td>
<td>3,328</td>
<td>0.998</td>
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<td>0.038</td>
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<td>-20</td>
<td>1,678</td>
</tr>
<tr>
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<td>50 - 59</td>
<td>1,764</td>
<td>0.975</td>
<td>1720</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1,720</td>
</tr>
<tr>
<td>7</td>
<td>60 - 69</td>
<td>1,073</td>
<td>0.936</td>
<td>1612</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1,612</td>
</tr>
<tr>
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<td>70 - 79</td>
<td>691</td>
<td>0.88</td>
<td>1,612</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1,612</td>
</tr>
<tr>
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<td>19,169</td>
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</table>

TOTAL: 18,882


<table>
<thead>
<tr>
<th>Cohort</th>
<th>Age group</th>
<th>$P_{t_0}$</th>
<th>$P_{t_0 + 10}$</th>
<th>$P_{t_0 + 20}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0 - 9</td>
<td>3,900</td>
<td>425</td>
<td>456</td>
</tr>
<tr>
<td>2</td>
<td>10 - 19</td>
<td>3,200</td>
<td>3,857</td>
<td>3,903</td>
</tr>
<tr>
<td>3</td>
<td>20 - 29</td>
<td>3,300</td>
<td>3,247</td>
<td>3,276</td>
</tr>
<tr>
<td>4</td>
<td>30 - 39</td>
<td>2,800</td>
<td>2,804</td>
<td>3,311</td>
</tr>
<tr>
<td>5</td>
<td>40 - 49</td>
<td>1,700</td>
<td>1,693</td>
<td>2,793</td>
</tr>
<tr>
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<td>50 - 59</td>
<td>1,100</td>
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<tr>
<td>7</td>
<td>60 - 69</td>
<td>550</td>
<td>1,073</td>
<td>1,720</td>
</tr>
<tr>
<td>8</td>
<td>70 - 79</td>
<td>200</td>
<td>691</td>
<td>1,612</td>
</tr>
<tr>
<td>9</td>
<td>80+</td>
<td>691</td>
<td>1,612</td>
<td>1,612</td>
</tr>
</tbody>
</table>

TOTAL: 18,550

<table>
<thead>
<tr>
<th>Change over previous period</th>
<th>$+332$</th>
<th>$+287$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Due to natural change (births - deaths)</td>
<td>$+252$</td>
<td>$+207$</td>
</tr>
<tr>
<td>Due to net migration (immigration - outmigration)</td>
<td>$+80$</td>
<td>$+80$</td>
</tr>
</tbody>
</table>

UP504    Prof. Scott Campbell    April 2, 2003
EXAMPLE OF POPULATION FORECASTING USING THE COHORT SURVIVAL METHOD

NOTES:
1. This is a simple example of cohort survival. It makes a few simplifying assumptions (which may be altered in more detailed cohort survival calculations): (a) 10-year cohorts rather than 1-year cohorts (to keep the number of cohorts small); (b) no differentiation between men and women (hence using birth rates rather than fertility rates directly tied to the number of women); (c) all people at the beginning of a cohort are "at risk" of having a baby, regardless of whether they survive through the entire 10-year period (this will lead to a slight overestimate of births); (d) migrants enter the cohort at the end of the period and are thus not "at risk" of having a baby until the next cohort (leading to a slight underestimate of births); (e) age-specific survival rates, birth rates and absolute migration levels are constant over time (in reality, these assumptions become more problematic the further in the future we go).
2. The example has unusually low birth rates -- far below replacement. This will lead, over time, to a dramatic reduction in population. It will take, however, many decades for the population to stabilize at a new, lower level.
3. Rounding techniques: there are several ways to deal with fractions (e.g., estimated fractional births and fractional deaths). In this example I simply rounded the numbers to the nearest whole number at each stage.

source of data: I used and modified data from: Norbert Offenheim, 1980. APPLIED MODELS IN URBAN AND REGIONAL ANALYSIS. Englewood Cliffs, NJ: Prentice-Hall. (Ch. 2 "Demographic Models"). I used Excel for the calculations, and then saved as an Adobe .pdf file.