

Calculation of Population in the COHYST Study Area: 1997 and 2005

Although the U.S. Bureau of the Census only conducts a census every ten years, midyear population estimates are available for every year. Data are tabulated at national, state, and county levels, as well as for minor civil divisions (such as townships) and places (cities, villages, towns, etc.). Data are also tabulated for statistical units created by the census (division, tract, block group, block). The data used in this study are from the Census Bureau's estimates for 1997 and 2005.

Unfortunately, the boundary of the COHYST study area is not coincident with the boundaries of the units for which population data is tabulated. The COHYST boundary splits counties, townships, census tracts, and even cities and villages. For counties which lie completely within the COHYST boundary, we can simply use the estimates for the whole county. Finding the within-COHYST component of the population of counties that are split by the boundary is more complicated.

One way to deal with the split counties would be to determine the fraction of the county's area that is within the COHYST area and multiply the total county population by this fraction. This method is crude, however, and fails to account for the locations of concentrations of population within the county, since it assumes that population is spread evenly across the county. Using population estimates for units smaller than counties would yield more reliable results.

In this study we use populations of places (communities) in order to refine the population calculation within the COHYST area. We considered minor civil divisions (townships and some municipalities), which also would have been appropriate, except that only a handful of COHYST counties are broken into townships. For the majority of the study area, no minor civil division figures are tabulated. For this reason, we decided to use only places (communities) in refining the calculations. Using population of places is adequate since this method directly addresses the need to account for concentrations of population within counties, as virtually all named communities in every county are included in the census tabulations.

Technical Methods

The handling of population data and the calculation of results were done in Microsoft Excel, and spatial analysis was done with ESRI's ArcMap and ArcToolbox.

Population figures were obtained from the website of the U.S. Bureau of the Census. Each time the Census releases new estimates, the estimates for past years back to the most recent decennial census are updated based on new information. Therefore, the 1997 estimates used in this study are from the 1999 set of estimates. The 2005 estimates are the original 2005 estimates ("Vintage 2005"), and are not updated from 2006 information, because 2006 estimates had only been partially released (national, state, and county levels) at the time of this analysis. Boundary files for census places also came from the Census website, and were current for the 2000 census.

COHYST counties were divided into two major categories using "select by location" in ArcMap: 1) those completely within the study area, and 2) those partially in the study area. For the first category, a sum of total county populations for each year, 1997 and 2005, was calculated and would contribute eventually to the grand totals. Those counties partially in the study area required further analysis.

In each county split by the COHYST boundary, we considered population in terms of its geographic components. Each place was regarded as a distinct unit with its population distributed evenly within the place's boundary. The population of the county outside the enumerated places (the county balance) was considered as being distributed evenly across the county. The county balance population was tabulated by the Census in the 1997 data, but it was not in the 2005 data. Therefore, we calculated the 2005 county balance populations for each county by subtracting the sum of the county's places' populations from the total county population.

The calculation of county balance populations was complicated slightly by the fact that some places crossed county lines, requiring the total population of the place to be split into components by

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county. Again, this data was tabulated in the 1997 data, but not in the 2005 data. Ratios of each county's respective portion of a place's population were calculated from 1999 data (the latest year for which the separate county portions were tabulated) and were used to assign the 2005 component populations.

We used another "select by location" command to determine all census places in Nebraska which intersected (at least partially overlapped) the COHYST study area. From this set we extracted those places which were in counties that were split by the COHYST boundary, since only those places in split counties had to be considered (the populations of places within those counties fully within the study area are included in the total county populations). Finally, within this new (places within split counties) set, places which were themselves crossed (split) by the COHYST boundary were separated from those completely within the study area.

Next, the "identity" tool was used between the COHYST boundary and the COHYST places crossed by the boundary. This resulted in a set of polygons which were the portions of the split places that are inside the study area boundary. This process was used also for counties, to create a set of polygons which were the portions of the split counties lying within the COHYST area.

The "calculate areas" tool was used to find the areas of features in four distinct sets of polygons: 1) counties crossed by the COHYST boundary; 2) the within-COHYST components of the split counties; 3) places crossed by the COHYST boundary; 4) the within-COHYST components of the split places. The populations of split places were multiplied by the ratio, [area of polygon in set 4 / area of polygon in set 3], to estimate each place's population component within the study area. The county balance populations of split counties were multiplied by the ratio, [area of polygon in set 2 / area of polygon in set 1], to estimate the component of the county balance population inside the COHYST area.

Results

As shown in the table below, the final totals for each year were a sum of two subtotals. The first is the sum of the total county populations in counties completely within the study area. The second is the sum of the within-COHYST components of split counties. The subcomponents of this category are the sum of populations of places completely within the study area, the sum of the within-COHYST components of split places, and the sum of the within-COHYST components of county balance populations.

| | 7/1/1997 | 7/1/2005 | Change |
|--------------------|----------------|----------------|--------------|
| Full Counties | 220,557 | 225,035 | 4,478 |
| Split Counties | 146,174 | 149,333 | 3,159 |
| -Full Places | 114,364 | 116,405 | 2,041 |
| -Split Places | 1,383 | 1,286 | -97 |
| -Balance of County | 30,427 | 31,642 | 1,215 |
| Totals | 366,731 | 374,368 | 7,637 |

The table below shows the components of the total COHYST population inside and outside of cities and villages.

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| | 7/1/1997 | 7/1/2005 | |
|--|----------------|----------------|--------------|
| Population in Cities and Villages | 275,071 | 281,481 | 6,410 |
| Population Outside Cities and Villages | 91,660 | 92,887 | 1,227 |
| Totals | 366,731 | 374,368 | 7,637 |

The following tables the population figures for each place and for each county in the COHYST area.

COHYST Population Tabulated by Natural Resource Districts

The process of tabulating the COHYST study area's population by Natural Resource District relied required no new census data beyond the data used for the original calculation of the region's total population. The process only required a reworking of the same numbers. It also involved the same assumptions, that (1) the population of a place is distributed evenly within the boundaries of the place and that (2) the portion of the population of the county outside of the county's tabulated places (the "county balance" population) is distributed evenly within the county's boundary. The population value for each NRD for each year being studied (1997 and 2005) was found by adding all component pieces within the NRD. These components were all of one of the following types: populations of counties, populations of places, populations of portions of counties, populations of portions of places. For the latter two of these four types, area was used as the criterion for assigning a population value to either side of a split geographic unit, per the two assumptions listed above. The resulting values in the table on the next page represent the "COHYST portion" of each NRD's population.

While determining in which NRD(s) a particular COHYST county's population would be considered as a component, there were four possible cases a COHYST county could fall into:

1. For a county that lies completely within one NRD, and completely within the COHYST study area, the entire county's population was included as a component of the population of the NRD which contains it.
2. For a county that is split by the COHYST boundary, but whose within-COHYST portion lies completely within one NRD, the previously calculated "COHYST portion" of the county's population was included as a component of the population of the NRD which contains it.
3. For a county that lies completely within the COHYST study area, but is split by an NRD boundary, the population of each particular place within the county was included as a component of whichever NRD the place lies within*. Next, the "county balance" population (portion of the population of the county that is outside of tabulated places) was split and a component assigned to each NRD's population according to the respective fraction of the entire county's area that lies within the NRD.
4. For a county that is split by the COHYST boundary, and is split by an NRD boundary, the population of each particular place (or the population of the COHYST portion of a place that is split by the COHYST boundary) within the COHYST portion of the county was included as a component of whichever NRD the place lies within. Next, the COHYST portion of the county's "county balance" population was split and a component assigned to each NRD's population according to the NRD's respective fraction of the area of the COHYST portion of the county.

*In one case, that of the city of Hastings in Adams County, a place was split by NRD boundaries. In this case, the population of the city was split and a component assigned to each NRD's population according to the respective fraction of the city's total area that lies within the NRD.

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Within-COHYST Population: Natural Resource Districts, 1997 and 2005

| NRD | NRD Name | 1997 | 2005 | Change | % Change |
|-----|----------------------|---------------|---------------|-------------|-------------|
| 1 | Upper Big Blue | 34173 | 34018 | -155 | -0.45 |
| 5 | Little Blue | 34818 | 37470 | 2652 | 7.62 |
| 6 | Upper Loup | 669 | 567 | -102 | -15.25 |
| 7 | Lower Loup | 5007 | 5661 | 654 | 13.06 |
| 11 | Upper Niobrara White | 11849 | 10271 | -1578 | -13.32 |
| 14 | North Platte | 45088 | 44928 | -160 | -0.35 |
| 15 | South Platte | 15597 | 15779 | 182 | 1.17 |
| 16 | Twin Platte | 40351 | 41835 | 1484 | 3.68 |
| 17 | Central Platte | 121977 | 129586 | 7609 | 6.24 |
| 18 | Lower Platte North | 3 | 3 | 0 | 0.00 |
| 20 | Upper Republican | 6526 | 6069 | -457 | -7.00 |
| 21 | Middle Republican | 16512 | 16078 | -434 | -2.63 |
| 22 | Lower Republican | 15227 | 13860 | -1367 | -8.98 |
| 23 | Tri-Basin | 18934 | 18243 | -691 | -3.65 |
| | Totals | 366731 | 374368 | 7637 | 2.08 |

Population Tabulated by Over Appropriated (OA) Areas

The process used to determine population distributions in the OA area were similar to those used to determine population distributions in the COHYST area. The same assumptions were used, that (1) the population of a place is distributed evenly within the boundaries of the place and that (2) the portion of the population of the county outside of the county's tabulated places (the "county balance" population) is distributed evenly within the county's boundary. The population value for each OA area for each year being studied (1997 and 2005) was found by adding all component pieces within the OA. These components were all of one of the following types: populations of counties, populations of places, populations of portions of counties, populations of portions of places. For the latter two of these four types, area was used as the criterion for assigning a population value to either side of a split geographic unit, per the two assumptions listed above. The resulting values in the table on the next page represent the "OA population of the listed Natural Resources Districts (NRDs)".

Technical Methods:

The first task was determining how the population is distributed between the cities and the rural areas within the counties that intersect the OA area.

The population of a county is composed of areas of concentrated population, cities, and areas of sparse population, or rural areas. ArcGIS was used to divide counties into homogeneous "population units" consisting of individual cities and county balance (rural) areas.

The Census reports, for each of the years of interest (1997 and 2005), population for individual cities and population for counties. The population of the county balance was determined by subtracting the sum of the city populations for a county from the total county population for that county.

ArcGIS was used to determine the fraction of each of the population units that resides in the OA area. The population of the population units inside the OA was determined by what fraction of the unit lay inside OA. The distribution of population was determined by adding up the city populations and the county balance populations within the OA area.

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The next step consisted of determining how the population is distributed between the cities and the rural areas among NRDs in the OA area. Overlay analysis was used to identify the NRD within which each of the population units reside. The distribution of population among NRDs within OA was determined by adding up the city populations and the county balance populations within these NRD population units.

Results:

As shown in the table below, the final totals for each year were a sum of two subtotals. The first is the sum of the total populations in cities completely within the OA area, arranged by NRD. The second is the sum of the people in cities in the OA area. The third table shows the population of people in the county balance areas.

| Total OA Pop by NRD | Pop 97 | Pop 05 | Change |
|----------------------------|---------------|---------------|---------------|
| Central Platte | 8155 | 8577 | 422 |
| North Platte | 37680 | 37600 | -80 |
| South Platte | 10762 | 10806 | 44 |
| Tri-Basin | 2918 | 2838 | -80 |
| Twin Platte | 36627 | 37796 | 1169 |
| Total OA Pop | 96142 | 97617 | 1475 |

| OA_City Pop by NRD | Pop 97 | Pop 05 | Change |
|--------------------------------|---------------|---------------|---------------|
| Central Platte | 6301 | 6676 | 375 |
| North Platte | 29445 | 29333 | -112 |
| South Platte | 10064 | 10095 | 31 |
| Tri-Basin | 1626 | 1618 | -8 |
| Twin Platte | 31712 | 32395 | 683 |
| Total City Pop (Inside) | 79148 | 80117 | 969 |

| OA_Rural Pop by NRD | Pop 97 | Pop 05 | Change |
|----------------------------------|---------------|---------------|---------------|
| Central Platte | 1854 | 1901 | 47 |
| North Platte | 8235 | 8267 | 32 |
| South Platte | 698 | 711 | 13 |
| Tri-Basin | 1292 | 1220 | -72 |
| Twin Platte | 4915 | 5401 | 486 |
| Total Rural Pop (Outside) | 16994 | 17500 | 506 |

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Detailed steps:

1. Select by location counties that intersect OA
2. Select by location cities that intersect counties that intersect OA
3. Identity “cities” and “county balance” – Result is a “population units” feature class with a 97 and 05 population for each polygon. County and City populations were obtained from census data. City populations were keypunched into the attribute table. “county balance” populations (rural areas) were calculated by subtracting the sum of the city populations for a specific county from that county’s population.
4. A population unit area attribute was added to each polygon and calculated
5. Clip county data by OA boundary
6. Add clip acres attribute & calc geometry
7. Calc OA fraction by dividing clip acres by population units acres
8. Calc clip97 and clip05 populations by multiplying OA fraction times 97 and 05 populations respectively
9. Identity OA county data with NRDs
10. Frequency OA_NRD_Identity by NRD, sum clip97 and clip05 populations