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ILLUSTRATIVE EXAMPLES OF TWO METHODS OF ESTIMATING THE CURRENT POPULATION OF SMALL AREAS*

The illustrative examples of methods of estimating population for small areas presented in this report have been developed to supplement the brief procedural descriptions set forth in "Suggested Procedures for Estimating the Current Population of Counties,"[1] a report of the Bureau of the Census published more than a year and a half ago in response to requests from many persons who needed up-to-date population estimates. Since that time there has been a relatively heavy demand for copies of the report, about 2,000 copies having already been distributed. Although the methods set forth there have been widely used, there have been frequent suggestions that detailed illustrative examples would enhance the usefulness of the earlier report for many persons.

Each of the two estimating techniques illustrated in this report is based on the following formula: The civilian population of an area at the close of a period is equal to its population at the start of the period plus natural increase (the excess of births over deaths) during the period, plus the net migration during the period, minus the net loss of population to the armed forces. The total population is equal to the civilian population plus the number of persons in the armed forces stationed in the area. If the net migration is outward, it is subtracted rather than added in this formula. The sole difference between the two methods lies in the procedure used to estimate the net migration component. As may be seen from the detailed analysis below, the procedure designated Method I in the earlier report is simpler in operation; the procedure in Method II is simple in conception but somewhat more laborious to carry out.

At the time the earlier report was prepared, neither method had been tested in a sufficient number of instances to warrant evaluation of one against the other. The most that could then be said was that "on a priori grounds, either should yield better estimates than would a mechanical projection of past changes in total population." It has now been established, however, that Method II on the average may be expected to yield more accurate estimates than Method I, and that on the average either may be depended upon to yield more accurate estimates than would arithmetic projection based on figures from the last two censuses, or the apportionment method formerly used by the Bureau of the Census.[2]

Because of the indicated superiority of Method II, an illustrative example of its use is given here in full detail. The illustrative example of Method I has been limited to those of its steps that are not common to both methods.

[1] U. S. Bureau of the Census, Population--Special Reports, Series P-47, No. 4, April 30, 1947.

[2] Henry S. Shryock, Jr., and Norman Lawrence: The Current Status of State and Local Population Estimates in the Census Bureau (to be published in Journal of the American Statistical Association, 1949).

* These illustrative examples were prepared by Norman Lawrence and Benjamin Greenberg. The general methods have been developed in the Population Division of the Bureau of the Census over the past fifteen years.

ILLUSTRATIVE EXAMPLE OF THE ESTIMATION OF THE CURRENT POPULATION OF A CITY BY METHOD II, POPULATION--SPECIAL REPORTS, SERIES P-47, NO. 4

Summary for City X in State Y — Estimate Date: November 1, 1946

Item 1.	Total population on April 1, 1940, the date of the last census	770,816
Item 2.	Natural increase between census date (April 1, 1940) and estimate date (November 1, 1946)	32,414
Item 3.	Estimated net migration for the same period	-33,301
Item 4.	Estimated population including persons away in the armed forces on November 1, 1946 (Item 1 plus Item 2 plus Item 3)	769,929
Item 5.	Estimated number of persons away in the armed forces on November 1, 1946	12,484
Item 6.	Estimated civilian population on November 1, 1946 (Item 4 minus Item 5)	757,445
Item 7.	Estimate of military personnel stationed in the city on November 1, 1946	15,450
Item 8.	Estimated total population on November 1, 1946 (Item 6 plus Item 7)	772,895

DETAILED PROCEDURE

Item 1.	Total population of city X on April 1, 1940, the date of the last census (Source: 1940 Census Reports, Population, Volume 1)	770,816
Item 2.	Natural increase in city X, April 1, 1940, to November 1, 1946	32,414

TABLE 1

Month and year	Resident births		Resident deaths		Adjusted natural increase
	Registered	Adjusted for under-registration	Registered	Adjusted for under-registration	
	(a)	(b)	(c)	(d)	(e)
1940 (April to December)	12,429	12,529	10,167	10,208	1,741
1941	12,708	12,810	9,613	9,652	3,158
1942	15,087	15,209	9,753	9,792	5,417
1943	15,393	15,517	10,545	10,587	4,930
1944	14,487	14,604	9,933	9,973	4,631
1945	13,790	13,901	9,778	9,817	4,084
1946 (January to October)	19,600	19,758	9,576	9,614	8,453
Total	103,494	104,328	69,365	69,643	32,414

Note: For the purpose of this illustration it has been assumed that vital statistics for the year preceding the estimate date (in this case 1946) were not yet available when the estimate was being prepared. Such a situation will often be the case where current estimates of population are being developed.

Column (a): In this column is entered the number of registered births for each calendar year, 1941 through 1945, based on the residence of the mother of the child at the time of birth. The entry for the period April-December, 1940, represents 9/12 of the number of registered births in 1940. Similarly, the entry for the period January-October, 1946, is obtained by proration and represents 10/12 of the number of registered births in 1946. Figures for each year, 1940 to 1945, for counties and urban places of 10,000 or more population have been published by the National Office of Vital Statistics in their annual reports, Vital Statistics of the United States. Figures for smaller urban places may be available, by residence, in State Health Departments or Vital Statistics offices. If such figures are not available for smaller urban places, they may have to be estimated from data compiled by place of occurence.

Final figures for 1946 were not yet available when these estimates were made, but provisional figures for five large cities were available on an occurrence basis in the Monthly Vital Statistics Bulletin of the National Office of Vital Statistics. For city X these have been converted to a residence basis by the use of the ratio of resident births to births by occurrence that prevailed in 1945. For all counties and

most cities, recent data on births by residence will have to be estimated in a similar manner from provisional data which may be available in State Health Departments or Vital Statistics offices.

Column (b): In this column is entered the quotient obtained by dividing the number in column (a) by a factor representing the completeness of registration of births. These factors are available for States, counties, and urban places of 10,000 or more population in Vital Statistics--Special Reports, Volume 17, No. 18, copies of which may be obtained from the National Office of Vital Statistics. The factors will be found in the column headed "Percent of records matched." The factor for completeness of birth registration in city X for the period December 1, 1939, to March 31, 1940, is .992. The figures in column (b) are estimates of the total number of resident births during each year.

In city X births were virtually completely registered during the period from December 1, 1939, to March 31, 1940. In this case any improvement in the completeness of birth registration would be negligible. In many areas, however, birth registration during the period from December 1, 1939, to March 31, 1940, was not nearly so complete. Where there is room for much improvement in the completeness of registration of births, it is necessary to allow for it to have taken place. It is suggested that if the completeness of birth registration in 1940 was .99 or greater the extra labor of computing the improvement, if any, in completeness of registration, is not warranted. In Vital Statistics--Special Reports, Volume 23, No. 10, there appear in table 1 estimates of completeness of birth registration by State for each year, 1940 to 1944. Suppose that the area for which the population estimate is being made is a county in Georgia, having .751 completeness of birth registration in 1939-1940. Information for the State as a whole indicates that the completeness of birth registration rose from .809 in 1940 to .850 in 1944. This is equivalent to stating that whereas 19.1 percent of all births were not registered in 1940, only 15.0 percent were not registered in 1944. The ratio 15.0 to 19.1 is a measure of the improvement of birth registration in the State which may be applied to the percentage not registered in the county (1.000 - .751 = .249). The product: $\frac{15.0}{19.1}$ (.249) = .206, is an estimate of the proportion of births not registered in the county in 1944. The complement, .794, is the estimated completeness of registration in 1944.

The same method should be used to compute the estimated percentage of completeness of birth registration for 1941, 1942, and 1943, using the figures for those years in Vital Statistics--Special Reports, Volume 23, No. 10. Similar figures are not available for 1945 or subsequent years. In making estimates for years after 1944, one should use the estimated completeness of birth registration in 1944 for each subsequent year, in the absence of other information.

Column (c): In this column is entered the number of registered deaths for each calendar year, 1941 through 1945, based on the place of residence of the deceased rather than the place in which the death occurred. The entries for the periods April-December, 1940, and January-October, 1946, are obtained by proration, as was the case for the entries in column (a) (births). The data needed for this column may be obtained from the same sources set forth above in the discussion of data on births. (See column (a), above.)

Column (d): In this column is entered the quotient obtained by dividing the number in column (c) by a factor representing the completeness of registration of deaths. A crude estimate of the completeness of death registration is equal to the estimate of the completeness of birth registration plus one-half the difference between it and 1. Thus in city X where .992 is the proportion of all births that are registered, the factor representing completeness of death registration is .992 plus one-half of 1 - .992, or .992 plus .004, or .996.

An alternative method of adjusting deaths for underregistration may often give slightly better results. It assumes that all deaths among persons one year old or over are completely registered and that infant deaths are underregistered to the same extent as births. Data on infant deaths for each year, 1942 to 1945, for counties and urban places of 10,000 or more population have been published by the National Office of Vital Statistics in their annual reports, Vital Statistics of the United States. For all counties and most cities data on infant deaths by residence for 1940 and 1941 and for recent dates will have to be estimated from provisional data which may be available in State Health Departments or Vital Statistics offices.

Column (e): In this column is entered the difference between the entries in column (b) and column (d). The sum of the figures in column (e) is the estimate of natural increase in city X between April 1, 1940, and November 1, 1946.

Item 3. Net migration to or from city X, April 1, 1940, to November 1, 1946.... -33,301

(a) School enrollment statistics: Figures on enrollment as of October 1 of each year in the elementary grades (1 through 8) of the private and parochial schools of city X, obtained from school authorities in city X, are as follows:

Year	Number enrolled
1939.....	100,313
1940.....	97,096
1941.....	94,190
1942.....	91,849
1943.....	90,082
1944.....	88,240
1945.....	86,298
1946.....	83,738

These figures include the pupils in grades 7 and 8 of the Junior High Schools of city X and also the pupils in ungraded classes on the elementary level. Kindergarten pupils are excluded, however.

(b) Enrollment, April 1, 1940:
- (1) Enrollment, October 1, 1939....100,313
- (2) Enrollment, October 1, 1940.... 97,096
- (3) Enrollment, April 1, 1940. This figure is obtained by linear interpolation between (1) and (2), viz:
  1/2 (100,313) + 1/2 (97,096).... 98,705

(c) Enrollment, November 1, 1946:
- (1) Enrollment, October 1, 1945.... 86,298
- (2) Enrollment, October 1, 1946.... 83,738
- (3) Enrollment, November 1, 1946. This figure is obtained by linear extrapolation of (1) and (2), viz:
  13/12 (83,738) - 1/12 (86,298).. 83,525

(d) Expected population of elementary school age, assuming no migration, November 1, 1946:
- (1) On April 1, 1940, the estimated elementary school enrollment in city X was 98,705. The age group 7 to 15 years old, comprising 107,240 persons on that date, was closest in size to the elementary school enrollment and is therefore used as the population of elementary school age in the following computations.
- (2) The population of city X, 0 to 9 years of age on April 1, 1940, as presented in the 1940 Census Reports, Population, Volume IV, is distributed by single years of age, color, and sex, as follows:

TABLE 2

Age	White		Nonwhite	
	Male	Female	Male	Female
Under 1 year..	4,618	4,596	151	157
1 year.....	4,727	4,492	135	144
2 years.....	5,145	4,946	181	178
3 years.....	4,903	4,859	174	149
4 years.....	5,061	4,770	166	154
5 years.....	5,079	4,814	189	163
6 years.....	5,017	4,834	179	166
7 years.....	5,446	5,206	181	195
8 years.....	5,532	5,281	162	187
9 years.....	5,548	5,327	172	172

These figures are required to obtain an estimate of the population 7 to 15 years old for city X on November 1, 1946, who were living in city X on April 1, 1940. (If figures by single years of age are not available for an area for which this method of estimation is used, it will be necessary to compute estimates of the single-year-of-age distribution by splitting the available 5-year age totals from the census in proportion to the survivors of births in the appropriate years before the census.)

(3) It is a common experience in census taking to fail to enumerate a sizable number of persons under 5 years of age. On the other hand, underenumeration is not believed to be a very important factor for the age range 7 to 15 years which roughly corresponds to the population of elementary school age. Since the population 7 to 15 years of age on November 1, 1946, includes the survivors of the population born between November 1, 1931, and November 1, 1939, and many of these persons were enumerated in the age range under 5 years on April 1, 1940, it is important to adjust the figures for that age range to take account of underenumeration. If this is not done, the survivors of the 1940 population on November 1, 1946, would be substantially lower than the number that would be enumerated in a census on that date. The adjustment for underenumeration of the population of city X under 5 years of age on April 1, 1940, is explained in table 3.

TABLE 3

Line code	Age	White		Nonwhite	
		Male	Female	Male	Female
	ENUMERATED				
A	Under 5 years	24,454	23,663	807	782
B	Under 1 year	4,618	4,596	151	157
C	1 year	4,727	4,492	135	144
D	2 years	5,145	4,946	181	178
E	3 years	4,903	4,859	174	149
F	4 years	5,061	4,770	166	154
	ADJUSTED FOR UNDERENUMERATION				
G	Under 5 years	25,823	24,987	852	826
H	Under 1 year	5,148	5,124	168	175
J	1 year	4,927	4,680	141	150
K	2 years	5,363	5,152	189	186
L	3 years	5,110	5,062	181	155
M	4 years	5,275	4,969	173	160

Lines A through F: On these lines are inserted the enumerated population from the table in (d) (2), above.

Line G: On this line is inserted the population under 5 years of age, adjusted for underenumeration. Measures of completeness of enumeration for this age group as a whole are available, for States and for the urban, rural-nonfarm, and rural-farm parts of States, in table A-2, page 33, of the 1940 Census Report, Standardized Fertility Rates and Reproduction Rates. Since measures of completeness of enumeration for cities are not available, it is necessary to use, as an approximation, the figures for the urban portion of State Y in which city X is located. In this area the enumeration of children under 5 years of age was estimated to be 94.7 percent complete in 1940. Each figure on line A was divided by .947 and the quotient entered on line G. For States with relatively large nonwhite population these measures of completeness of enumeration are available for both the white and nonwhite population. Had this been so for the State in which city X is located, the figures for whites on line A would have been divided by one factor and those for nonwhites by a different factor. As it is, however, the factor for the white population only was taken to represent the total population.

Line H: On this line is entered the quotient obtained by dividing the figure on line B by an estimate of the completeness of enumeration of the population under 1 year of age. This statistic is available only for the United States as a whole and must be estimated especially for city X. In this illustration, it was estimated on the hypothesis that the proportion of the population under 1 year old not enumerated bore the same relation to the proportion of the population under 5 years old not enumerated for city X and the United States as a whole. Data for the United States as a whole indicate that the proportion of the population under 1 year old not enumerated was about .148, while the corresponding proportion for the population under 5 years old was about .076. The former proportion was thus 1.947 times as great as the latter. For city X (i.e., the urban part of State Y), the proportion of the white population under 5 years old not enumerated was .053. According to the hypothesis stated above, the proportion of children in city X under 1 year old not enumerated is estimated to be .103. Hence the factor for completeness of enumeration of children under 1 year old is estimated to be .897 (1.000 - 0.103).

Measures of completeness of enumeration of children under 5 years old are available by color only for areas in which there was a substantial proportion of nonwhites. When measures of completeness of enumeration of children under 5 years old, by color, are available for an area, the computation of the factor for completeness of enumeration of children under 1 year old should be done separately, by color, in the manner illustrated in the preceding paragraph. Because the number of nonwhites in city X is small, the inability to compute measures of underenumeration by color will not have a serious effect on the ultimate population estimate.

Lines J through M: In each column, the difference between the entry on line G and that

on line H represents an estimate of the population 1 to 4 years of age adjusted for underenumeration. The sum of the entries on lines C through F is the enumerated population in the same age group. The ratio of the enumerated population to the population adjusted for underenumeration is an estimate of the completeness of enumeration of the population 1 to 4 years of age. (Actually this completeness varies somewhat with age, but measures are not available.) For city X this estimate proved to be .9594 for white males, .9599 for white females, .9591 for nonwhite males, and .9601 for nonwhite females. The figures on lines C through F were divided by the estimate of completeness of enumeration for the same sex-color group and the quotients entered on lines J through M.

(4) The number of survivors on November 1, 1946, of the population under 10 years of age on April 1, 1940, is estimated in the following table.

TABLE 4

Age on April 1, 1940, color, and sex	Population, April 1, 1940	Computation of survival factors				Survivors on November 1, 1946	Age on November 1, 1946 (years)
		L_x	L_{x+6}	L_{x+7}	$\frac{L_{x+6\ 7/12}}{L_x}$		
(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)
WHITE							
Male:							
Under 1 year	5,148	9,668	9,487	9,475	.9806	5,048	6 7/12
1 year	4,927	9,574	9,475	9,465	.9890	4,873	7 7/12
2 years	5,363	9,549	9,465	9,455	.9906	5,313	8 7/12
3 years	5,110	9,530	9,455	9,444	.9915	5,067	9 7/12
4 years	5,275	9,513	9,444	9,435	.9922	5,234	10 7/12
5 years	5,079	9,499	9,435	9,425	.9926	5,041	11 7/12
6 years	5,017	9,487	9,425	9,415	.9928	4,981	12 7/12
7 years	5,446	9,475	9,415	9,403	.9929	5,407	13 7/12
8 years	5,532	9,465	9,403	9,398	.9931	5,494	14 7/12
9 years	5,548	9,455	9,398	9,388	.9930	5,509	15 7/12
Female:							
Under 1 year	5,124	9,742	9,586	9,578	.9835	5,039	6 7/12
1 year	4,680	9,663	9,578	9,570	.9907	4,636	7 7/12
2 years	5,152	9,640	9,570	9,563	.9923	5,112	8 7/12
3 years	5,062	9,623	9,563	9,555	.9932	5,028	9 7/12
4 years	4,969	9,609	9,555	9,548	.9940	4,939	10 7/12
5 years	4,814	9,596	9,548	9,541	.9946	4,788	11 7/12
6 years	4,834	9,586	9,541	9,534	.9949	4,809	12 7/12
7 years	5,206	9,578	9,534	9,526	.9949	5,179	13 7/12
8 years	5,281	9,570	9,526	9,521	.9951	5,255	14 7/12
9 years	5,327	9,563	9,521	9,512	.9951	5,301	15 7/12
NONWHITE							
Male:							
Under 1 year	168	9,450	9,122	9,108	.9644	162	6 7/12
1 year	141	9,267	9,108	9,095	.9820	138	7 7/12
2 years	189	9,217	9,095	9,083	.9860	186	8 7/12
3 years	181	9,186	9,083	9,051	.9867	179	9 7/12
4 years	173	9,161	9,051	9,038	.9871	171	10 7/12
5 years	189	9,137	9,038	9,024	.9883	187	11 7/12
6 years	179	9,122	9,024	9,008	.9883	177	12 7/12
7 years	181	9,108	9,008	8,988	.9877	179	13 7/12
8 years	162	9,095	8,988	8,941	.9853	160	14 7/12
9 years	172	9,083	8,941	8,915	.9827	169	15 7/12
Female:							
Under 1 year	175	9,573	9,292	9,279	.9698	170	6 7/12
1 year	150	9,427	9,279	9,268	.9837	148	7 7/12
2 years	186	9,381	9,268	9,259	.9874	184	8 7/12
3 years	155	9,349	9,259	9,227	.9883	153	9 7/12
4 years	160	9,323	9,227	9,216	.9891	158	10 7/12
5 years	183	9,307	9,216	9,204	.9895	181	11 7/12
6 years	166	9,292	9,204	9,189	.9896	164	12 7/12
7 years	195	9,279	9,189	9,170	.9891	193	13 7/12
8 years	187	9,268	9,170	9,107	.9854	184	14 7/12
9 years	172	9,259	9,107	9,077	.9817	169	15 7/12

Column (b): The figures in this column for the population under 5 years of age on April 1, 1940, have been computed in Item 3 (d) (3), above. The figures for the population 5 to 9 years of age are shown in Item 3 (d) (2), above.

Columns (c) through (f): To estimate the proportion of the population at a given age who will be alive at a date in the future, it is necessary to compute a survival factor which reflects mortality trends prevailing during the period. The L_x column of a standard life table, which presents the age distribution of a stationary population subject to the mortality rates existing at the date to which the life table refers, and to an annual 10,000 births, may be used to compute these survival factors. An estimate of the proportion of the population aged x years at the start of a period who will still be alive y years later is $\frac{L_{x+y}}{L_x}$. In this illustration, y is the number of years between April 1, 1940, and November 1, 1946, or 6 7/12 years. An estimate of $L_{x+6\,7/12}$ may be computed by linear interpolation between L_{x+6} and L_{x+7}.

The values of L_x in column (c), L_{x+6} in column (d), and L_{x+7} in column (e) were obtained as follows:

(1) Values of L_0 through L_4 were obtained from "United States Abridged Life Tables, 1939, Urban and Rural, by Regions, Color and Sex," Vital Statistics--Special Reports, Volume 23, No. 15, published by the National Office of Vital Statistics, United States Public Health Service. The figures used for city X are those which apply to cities of 100,000 or more population in the North.

(2) Values of L_x for x = 5 or more years are not available by single years. However, the same report does present figures showing the sums of the L_x values for ages 5 to 9, 10 to 14, and 15 to 19 years. Each of these sums was distributed by single years of age according to the single-year-of-age distribution of L_x in the United States Life Tables and Actuarial Tables, 1939-1941, published by the National Office of Vital Statistics, United States Public Health Service. To illustrate, the regional life table for cities of 100,000 or more population in the North does not have values of L_5, L_6, L_7, L_8, or L_9. It does show 47,381 as the value of $\sum_5^9 L$ for white males. This is equal to the sum of the individual quantities L_5, L_6, ... L_9. The United States life tables for 1939 to 1941 show for white males:

L_5: 94,085
L_6: 93,962
L_7: 93,850
L_8: 93,747
L_9: 93,649

The sum of these values, 469,293, represents $\sum_5^9 L_x$ from this life table. The quotient of 47,381 divided by 469,293 is the factor (.100963) which is multiplied by each of the given values of L_5, L_6, ... L_9, in order to scale them down. By this process L_5 for white males is computed to be 9,499, L_6 to be 9,487, and so forth. The sums of the L_x values used for city X are those which apply to cities of 100,000 or more population in the North.

The values of $\frac{L_{x+6\,7/12}}{L_x}$ shown in column (f) were computed by taking 5/12 of L_{x+6} plus 7/12 of L_{x+7} and dividing the sum of these products by L_x.

Column (g): The figures in this column are the products of the populations in column (b) by the survival factors in column (f). They represent the expected number of survivors at each year of age shown in column (h) on November 1, 1946. For example, on November 1, 1946, the estimated number of white male survivors who were at least 6 years and 7 months of age but less than 7 years and 7 months of age is 5,048.

(5) The figures in column (g) of table 4 represent the expected population of city X at each given year of age if there was no migration of persons in this age range between April 1, 1940, and November 1, 1946. On the assumption of a rectangular distribution of population within each year of age shown in column (h) of table 4, the expected population 7 to 15 years old on November 1, 1946, may be computed by adding the figures in column (g) of table 4, and subtracting from the sum 5/12 of the survivors 6 7/12 but less than 7 7/12 years of age and 7/12 of

the survivors 15 7/12 but less than 16 7/12 years of age. The sum of the results for all sex-color groups, or 94,622, represents the expected population 7 to 15 years of age on November 1, 1946, assuming no migration.

(e) Estimated population of elementary school age (7 to 15 years) on November 1, 1946 (including effect of migration)

(1) Population 7 to 15 years of age on April 1, 1940..... 107,240
(2) Number enrolled on April 1, 1940: Item 3 (b)..... 98,705
(3) Ratio: (107,240)/(98,705).... 1.08647
(4) Number enrolled on November 1, 1946: Item 3 (c)..... 83,525
(5) Estimated population 7 to 15 years of age on November 1, 1946: (1.08647) x (83,525). 90,747

(f) Net change in population in this cohort due to migration

The difference between the 90,747 persons 7 to 15 years of age on November 1, 1946, Item 3 (e), and the estimated 94,622 survivors of the same ages, Item 3 (d) (5), represents a net change of -3,875 persons, or a net loss of population in this age range imputed to net migration.

(g) Migration rate for this cohort, April 1, 1940, to November 1, 1946

(1) Net out-migration for the cohort: Item 3 (f)..... -3,875
(2) Size of the cohort on April 1, 1940:
(a) The cohort comprises persons 5/12 to 8 5/12 years of age on April 1, 1940. On the assumption of a rectangular distribution of population within each year of age shown in column (a) of table 4, the size of the cohort may be computed by adding the figures in column (b) of table 4, and subtracting from the sum 5/12 of the population 0 years of age and 7/12 of the population 9 years of age. The sum of the results for all sex-color groups equals the size of the cohort on April 1, 1940..... 95,392
(3) The migration rate for the period between April 1, 1940, and November 1, 1946, is equal to (-3,875)/(95,392).....-0.0406219

(h) Estimated total net migration, April 1, 1940, to November 1, 1946

(1) Population of city X on April 1, 1940 (Item 1)..... 770,816
(2) 1/2 births during the period (Item 2)..... 48,952
(3) Population base for computing estimate of net migration at all ages: (770,816) + (48,952)..... 819,768
(4) Net migration at all ages: (-0.0406219) x (819,768).... -33,301

Note: This procedure allows for net migration among persons alive on the base date and also among persons born subsequently. It is assumed that births between the base date and the estimate date were evenly distributed throughout the period and that, on the average, the newly born persons were alive for only half the period and should therefore have experienced net migration at only half the computed rate. Since the product of the number of births by half the net migration rate is equal to the product of half the births by the entire net migration rate, the desired result, an estimate of net migrants for the total population, is achieved by adding the base date population and half of the subsequent births and by multiplying this sum by the estimated net migration rate from Item 3 (g) (3).

It is not necessary to account for deaths after the base date in determining the population base to which to apply the estimated rate of net migration. The rate of net migration is a measure of the relationship between the number of net migrants and the population of the area at the base date. If an individual in the base date population subsequently dies in the same area, it is obvious that he has not migrated. If he dies elsewhere, he is not subtracted from the population by virtue of death, since he is not included in the death statistics for his area of origin. He is, however, lost to the area by virtue of out-migration and is accounted for by this estimating process. On the other hand, an in-migrant who dies after migrating to the area is included in the death statistics and therefore is subtracted from a population in which he was not represented at the start of the period. Before he should be subtracted as a deceased person, he should first be added as an in-migrant.

This is also done by this estimating process. As a result no bias is introduced by neglecting deaths subsequent to the base date.

It should be noted also that for simplicity this illustration does not take account of the institutional population of city X. In most real instances, however, there will have been some persons in institutions in the area on the base date. In these cases the figure to be used in line 1 should be the noninstitutional population rather than the total population. This suggestion is made because it appears more realistic to assume no net migration whatsoever for the institutional population than to attribute to it the rate of net migration estimated for the school age cohort. Figures for the 1940 institutional population 14 years old and over may be obtained in Bureau of the Census, 16th Census, Population, Special Report on Institutional Population 14 Years Old and Over, Government Printing Office, 1943.

Item 4. Estimated population including persons absent in the armed forces on November 1, 1946:

(a)	Total population on April 1, 1940 (Item 1)	770,816
(b)	Natural increase (Item 2)	32,414
(c)	Net migration (Item 3)	-33,301
(d)	Total population including persons absent in the armed forces on November 1, 1946: (770,816) + (32,414) - (33,301)	769,929

Item 5. Estimated population absent in the armed forces on November 1, 1946:

(a)	Number of 1-C Selective Service Registrants from city X on November 1, 1946 (Source: Office of Selective Service Records)	84,496
(b)	Number of 1-C Selective Service Registrants from State Y on November 1, 1946 (Source: Office of Seledtive Service Records)	471,365
(c)	Ratio of 1-C Selective Service Registrants in city X to those in State Y: (84,496)/(471,365)	0.17916
(d)	Proportion of United States armed forces strength with preservice residence in State Y (Source: Estimated distribution of World War II veteran population by State of preservice residence, Current Population Reports, Series P-25, No. 5).	.0347
(e)	Strength of the armed forces on November 1, 1946	2,008,000
(f)	Estimated number in the armed forces with preservice residence in State Y: (.0347) x (2,008,000)	69,678
(g)	Estimated population of city X absent in the armed forces on November 1, 1946: (0.17916) x (69,678)	12,484

This is one of several ways in which the population absent in the armed forces may be estimated. From time to time the several armed forces publish distributions of strength by State of preservice residence that may be used in place of steps (d), (e), and (f).

Item 6. Civilian population of city X on November 1, 1946:

(a)	Estimated population including persons absent in the armed forces (Item 4)	769,929
(b)	Estimated population absent in the armed forces (Item 5)	12,484
(c)	Estimated civilian population: (769,929) - (12,484)	757,445

Item 7. Estimate of military personnel stationed in the city on November 1, 1946:

	The number of military personnel stationed in the city generally can be obtained from the local Army, Air Force, Navy, Marine, and Coast Guard offices. (It cannot be supplied by the Bureau of the Census)	15,450

Item 8. Total population of city X on November 1, 1946, including members of the armed forces stationed in the city:

(a)	Estimated civilian population (Item 6)	757,445
(b)	Estimate of military personnel (Item 7)	15,450
(c)	Estimated total population: (757,445) + (15,450)	772,895

ILLUSTRATIVE EXAMPLE OF THE ESTIMATION OF THE CURRENT POPULATION OF A COUNTY BY METHOD I, POPULATION--SPECIAL REPORTS, SERIES P-47, NO. 4

Summary for County A in State B — Estimate Date: July 1, 1946

Item 1.	Estimated civilian population on November 1, 1943	56,400
Item 2.	Estimated number of persons away in armed forces on November 1, 1943	3,124
Item 3.	Estimated population, including persons away in the armed forces on November 1, 1943 (Item 1 plus Item 2)	59,524
Item 4.	Natural increase, November 1, 1943, to estimate date	2,879
Item 5.	Estimated net migration for the same period	1,537
Item 6.	Estimated population including persons away in armed forces on July 1, 1946 (Item 3 plus Item 4 plus Item 5)	63,940
Item 7.	Estimated number of persons away in the armed forces on July 1, 1946	903
Item 8.	Estimated civilian population on July 1, 1946 (Item 6 minus Item 7)	63,037
Item 9.	Estimate of military personnel stationed in the county on July 1, 1946	120
Item 10.	Estimated total population on July 1, 1946 (Item 8 plus Item 9)	63,157

Note: This illustration deals with the preparation of a population estimate for July 1, 1946, based on an estimate of civilian population for November 1, 1943, published in Population--Special Reports, Series P-44, No. 3. In general, the population base to be selected in using this method is the most recent fairly reliable population total available. For counties, the November 1, 1943, estimates based on War Ration Book registrations may be used. For smaller places, 1940 census figures will generally be the latest reliable figures. In some special instances, later figures from Census Bureau special censuses, Census Bureau sample surveys, or other sources, will be available. Pending the publication of the 1950 Census Reports, however, the base for most counties will have to be the November 1, 1943, estimates of civilian population, such as the base used in this illustration.

DETAILED PROCEDURE

Item 1. Civilian population of county A on November 1, 1943 (Source: Population--Special Reports, Series P-44, No. 3) 56,400

Item 2. Persons away in the armed forces on November 1, 1943:

(a) Estimated civilian population of county A on April 1, 1940 (Source: Population--Special Reports, Series P-44, No. 3) 41,000

(b) Proportion of civilian population of the United States on April 1, 1940, serving in the armed forces on November 1, 1943 (Source: Population--Special Reports, Series P-47, No. 4) ..... .076

(c) Estimated number of persons from county A in armed forces on November 1, 1943: (41,000) x (.076) 3,124

Note: Sometimes this figure is available from local records and need not be estimated. If it must be estimated either the procedure illustrated here or that shown in Item 5 of Method II may be used.

Item 3. Estimated population of county A including persons away in the armed forces on November 1, 1943 (Item 1 plus Item 2) 59,524

Item 4. Natural increase, November 1, 1943, to July 1, 1946 2,879

(See Item 2 of Method II, above, for illustration of detailed procedures)

Item 5. Net migration to or from county A, November 1, 1943, to July 1, 1946:

(a) School enrollment statistics: Figures on enrollment in the elementary grades (1 through 8) of the private and parochial schools of county A as of January 1 of each year, obtained from school authorities in county A, are as follows:

Date	Number enrolled	Date	Number enrolled
January 1, 1940	5,810	January 1, 1944	7,390
January 1, 1941	6,320	January 1, 1945	7,490
January 1, 1942	6,840	January 1, 1946	7,610
January 1, 1943	7,300	January 1, 1947	7,740

m 5. Net migration to or from county A, November 1, 1943, to July 1, 1946--Con.

(b) Percentage change in school enrollment, November 1, 1943, to July 1, 1946:

(1)	Enrollment, January 1, 1947	7,740
(2)	Enrollment, January 1, 1946	7,610
(3)	Estimated enrollment, July 1, 1946: 1/2 (7,740) + 1/2 (7,610)	7,675
(4)	Enrollment, January 1, 1943	7,300
(5)	Enrollment, January 1, 1944	7,390
(6)	Estimated enrollment, November 1, 1943: 2/12 (7,300) + 10/12 (7,390)	7,375
(7)	Estimated percentage change, November 1, 1943, to July 1, 1946: (7,675)/(7,375) - (100.0)	+4.1

Note: This method of computing the percentage change in school enrollment depends on linear interpolation between successive annual school enrollment figures to obtain estimates of enrollment for the terminal dates of the period of estimation. From these estimates the estimated percentage of change may be readily computed. In our release, Series P-47, No. 4, a different approach is proposed, namely, that the monthly average change in school enrollment between two dates (roughly spanning the period of estimation) for which school figures are available be taken as applying to the period of estimation even though the terminal dates are not necessarily the same. The two methods should give reasonably close results; the method illustrated above is somewhat simpler in computation.

(c) Percentage change in population attributable to net migration, November 1, 1943, to July 1, 1946:

(1)	Percentage change in school enrollment: Item 5 (b) (7)	+4.1
(2)	Percentage change in number of children 6 to 13 years of age, for the United States (Series P-47, No. 4)	+1.6
(3)	Estimated percentage change due to net migration: (4.1) - (1.6)	+2.5

(d) Estimated net migration, November 1, 1943, to July 1, 1946:

(1)	Total population including persons away in the armed forces, November 1, 1943 (Item 3)	[1] 59,524
(2)	One-half number of births between November 1, 1943, and July 1, 1946, corrected for underregistration (See Item 2 of Method II, above, for illustration of detailed procedures to compute this estimate)	[2] 1,959
(3)	(59,524) + (1,959)	61,483
(4)	Estimated net migration: (61,483) x (2.5%)	+1,537

Item 6.	Estimated total population of county A, including persons away in the armed forces, July 1, 1946 (Item 3 plus Item 4 plus Item 5)	63,940
Item 7.	Estimated number of persons from county A absent in the armed forces, July 1, 1946 (See Item 5 of Method II, above, for illustration of detailed procedures to compute this estimate)	[2] 903
Item 8.	Estimated civilian population of county A on July 1, 1946 (Item 6 minus Item 7)	63,037
Item 9.	Estimated number of persons in armed forces stationed in county A on July 1, 1946.	120
Item 10.	Total population in county A on July 1, 1946 (Item 8 plus Item 9)	63,157

[1] If the county has a large institutional population it should be excluded from Item 5 (d) (1).
[2] The data from which this estimate was computed are not shown in this illustration.

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