

310. On the assumption of 105 male per 100 female births, it is estimated that there were 98,239 male and 93,561 female births during the period 1950-1955. The numbers of survivors aged 0-4 and 5-9 in 1955 are then computed as shown in table 38.

311. The estimates of the Costa Rican population by sex and age groups for 1955 now remain to be brought into conformity with the official estimate of total population for that year. With the new estimates for age groups 0-4 and 5-9 derived in table 38, the provisional estimates made, up to this point, add to a total of 948,924, whereas the official estimate of total population, as of mid-year 1955, amounts to 951,093. The figures for the various sex-age groups are pro-rated to the latter total as shown in table 39.

TABLE 39. FINAL ESTIMATE OF POPULATION OF COSTA RICA, MID-YEAR 1955, BY SEX AND AGE, AS BASIS FOR THE POPULATION PROJECTION

Age in years	Provisional estimate <sup>a</sup>		Final estimate <sup>b</sup>	
	Males	Females	Males	Females
All ages . . . . .	474,559	474,365	475,644	475,449
0-4 . . . . .	85,497	83,101	85,692	83,291
5-9 . . . . .	68,583	66,377	68,740	66,529
10-14 . . . . .	56,195	54,865	56,323	54,990
15-19 . . . . .	48,450	48,301	48,561	48,411
20-24 . . . . .	41,325	43,581	41,419	43,681
25-29 . . . . .	35,734	38,187	35,816	38,274
30-34 . . . . .	28,867	30,125	28,933	30,194
35-39 . . . . .	23,767	24,289	23,821	24,345
40-44 . . . . .	21,627	22,024	21,676	22,074
45-49 . . . . .	17,872	18,012	17,913	18,053
50-54 . . . . .	13,864	13,662	13,896	13,693
55-59 . . . . .	10,815	10,629	10,840	10,653
60-64 . . . . .	7,888	7,748	7,906	7,766
65-69 . . . . .	5,975	5,769	5,989	5,782
70-74 . . . . .	4,057	3,822	4,066	3,831
75-79 . . . . .	2,200	2,135	2,205	2,140
80-84 . . . . .	1,097	1,031	1,100	1,033
85 and over . . . . .	746	707	748	709

<sup>a</sup> Ages 10 and over according to table 9; ages 0-4 and 5-9 according to table 38.

<sup>b</sup> Pro-rated to total of 951,093.

### 3. Assumption as to future fertility trend

312. For the projection of the population of Costa Rica, beginning with the year 1950, which was included

in the United Nations report, *The Population of Central America (including Mexico), 1950-1980*, the following assumptions as to fertility were made:

"High": Calculated rate, 1940-1945, remaining constant;

"Medium": Rate decreasing after 1950 by 5 per cent each quinquennium;

"Low": Rate decreasing after 1950 by 10 per cent each quinquennium.

These assumptions were formulated largely with a view to achieving comparability of results for the entire group of countries composing the region.

313. For a projection beginning in 1955 and taking into account the newly available statistics of registered births by year of occurrence for 1950-1954, it appears advisable to include an assumption of higher fertility in view of the upward trend of the recorded birth rates in the last years. As a "high" assumption therefore the future maintenance of an age-sex adjusted birth rate of about 50 per 1,000 is assumed, corresponding to the general level of the rates calculated from adjusted vital statistics for the period since 1948.

314. As a "medium" assumption, it is assumed that the rate of 44.93 per 1,000 calculated for 1940-1945 by reverse survival of age group 5-9 in the 1950 census, will be maintained from 1955 to 1975. Birth rates have been remarkably constant over a long period of the past. Contacts with areas of lower fertility are comparatively slight. Severe population pressure, forcing a decrease in fertility, will not necessarily arise in the near future.

315. Nevertheless, the possibility of a fertility decrease should not be disregarded. Social changes connected with urbanization, industrialization, and increased education may tend to modify attitudes towards the raising of families in this direction. A gradual decline, such as by 5 per cent of the last previous value in every five-year period, is possible. This is treated as the "low" assumption.

316. It will be understood that this assessment is highly tentative. Greater familiarity with conditions in the country might provide a basis for more realistic assumptions. The present assumptions result in the following future sex-age adjusted birth rates:

	1955-60	1960-65	1965-70	1970-75
"High" . . . . .	50.00	50.00	50.00	50.00
"Medium" . . . . .	44.93	44.93	44.93	44.93
"Low" . . . . .	43.81 <sup>a</sup>	41.62 <sup>b</sup>	39.54 <sup>b</sup>	37.56 <sup>b</sup>

<sup>a</sup> 2½ per cent decline from 44.93, assumed up to 1960.

<sup>b</sup> 5 per cent decline from value for last previous quinquennium.

## VI. COMPUTATION OF THE POPULATION PROJECTION: THE EXAMPLE OF COSTA RICA

317. The computations for the population projection begin with the base estimate of population by sex-age groups for the starting date and proceed by successive multiplication of each cohort by the appropriate survival ratios, survivors of future births being added in. These calculations can be conveniently carried out with worksheets of the type illustrated with the figures for Costa Rica in tables 40 and 41. The first worksheet consists of alternating columns for the numbers of individuals in the various sex-age groups at each date and the sur-

vival ratios for the interval between that date and the next. The other worksheet, illustrated by table 41, is used to compute the future numbers of births, on the given assumptions as to future trends of the sex-age adjusted birth rate, from the estimated future numbers of women of childbearing ages.

318. The method of calculation is explained below with the Costa Rican figures as an illustration, under each of the three chosen hypotheses with respect to future fertility.

TABLE 40. CALCULATION OF SURVIVORS OF THE COSTA RICAN POPULATION, 1955-1975

*Males and females*

<i>Sex and age (x) in years</i>	<i>Estimated population, 1955</i>	<i>Survival ratio (P<sub>b</sub>), 1955-60</i>	<i>Estimated survivors, 1960</i>	<i>Survival ratio (P<sub>b</sub>), 1960-65</i>	<i>Estimated survivors, 1965</i>	<i>Survival ratio (P<sub>b</sub>), 1965-70</i>	<i>Estimated survivors, 1970</i>	<i>Survival ratio (P<sub>b</sub>), 1970-75</i>	<i>Estimated survivors, 1975</i>
<b>Males</b>			(P <sub>b</sub> = 0.8877)	(P <sub>b</sub> = 0.9070)	(P <sub>b</sub> = 0.9262)	(P <sub>b</sub> = 0.9438)			
0-4.....	85,692	0.9648	101,335	0.9708	118,676	0.9765	139,437	0.9818	166,266
5-9.....	68,740	0.9924	82,676	0.9937	98,376	0.9949	115,887	0.9963	136,899
10-14.....	56,323	0.9933	68,218	0.9947	82,155	0.9960	97,874	0.9972	115,458
15-19.....	48,561	0.9899	55,946	0.9920	67,856	0.9940	81,826	0.9957	97,600
20-24.....	41,419	0.9860	48,071	0.9886	55,498	0.9911	67,449	0.9934	81,474
25-29.....	35,816	0.9834	40,839	0.9861	47,523	0.9886	55,004	0.9911	67,004
30-34.....	28,933	0.9792	35,221	0.9822	40,271	0.9849	46,891	0.9874	54,514
35-39.....	23,821	0.9728	28,331	0.9762	34,594	0.9794	39,663	0.9822	46,389
40-44.....	21,676	0.9629	23,173	0.9669	27,657	0.9700	33,881	0.9737	38,957
45-49.....	17,913	0.9483	20,872	0.9529	22,406	0.9569	26,827	0.9607	32,900
50-54.....	13,896	0.9232	16,987	0.9289	19,889	0.9341	21,440	0.9387	25,773
55-59.....	10,840	0.8869	12,829	0.8939	15,779	0.9003	18,578	0.9060	20,126
60-64.....	7,906	0.8398	9,614	0.8478	11,468	0.8552	14,206	0.8619	16,832
65-69.....	5,989	0.7678	6,639	0.7775	8,151	0.7864	9,807	0.7947	12,244
70-74.....	4,066	0.6697	4,598	0.6805	5,162	0.6907	6,410	0.7003	7,794
75-79.....	2,205	0.5531	2,723	0.5642	3,129	0.5748	3,565	0.5848	4,489
80-84.....	1,100		1,220		1,536		1,799		2,085
85+.....	748	0.3328	615	0.3404	625	0.3473	751	0.3537	902
Born before 1955.....	475,644		458,572		443,699		428,187		411,573
Born after 1955.....	—		101,335		217,052		353,198		516,223
TOTAL MALES.....	475,644		559,907		660,751		781,385		927,796
<b>Females</b>			(P <sub>b</sub> = 0.9036)	(P <sub>b</sub> = 0.9208)	(P <sub>b</sub> = 0.9380)	(P <sub>b</sub> = 0.9535)			
0-4.....	83,291	0.9669	98,246	0.9731	114,754	0.9791	134,500	0.9844	159,990
5-9.....	66,529	0.9932	80,534	0.9948	95,603	0.9962	112,356	0.9972	132,402
10-14.....	54,990	0.9947	66,077	0.9960	80,115	0.9971	95,240	0.9978	112,041
15-19.....	48,411	0.9920	54,699	0.9940	65,813	0.9956	79,883	0.9968	95,030
20-24.....	43,681	0.9882	48,024	0.9908	54,371	0.8930	65,523	0.9948	79,627
25-29.....	38,274	0.9852	43,166	0.9879	47,582	0.9904	53,990	0.9925	65,182
30-34.....	30,194	0.9811	37,708	0.9842	42,644	0.9868	47,125	0.9893	53,585
35-39.....	24,345	0.9766	29,623	0.9798	37,112	0.9828	42,081	0.9854	46,621
40-44.....	22,074	0.9702	23,775	0.9737	29,025	0.9678	36,474	0.9796	41,467
45-49.....	18,053	0.9602	21,416	0.9642	23,150	0.9678	28,352	0.9700	35,730
50-54.....	13,693	0.9416	17,334	0.8467	20,649	0.9515	22,405	0.9558	27,501
55-59.....	10,653	0.9125	12,893	0.9194	16,410	0.9256	19,648	0.9314	21,415
60-64.....	7,766	0.8716	9,721	0.8800	11,854	0.8880	15,189	0.8951	18,300
65-69.....	5,782	0.8037	6,769	0.8141	8,554	0.8240	10,526	0.8328	13,596
70-74.....	3,831	0.7060	4,647	0.7185	5,511	0.7304	7,048	0.7411	8,766
75-79.....	2,140	0.5914	2,705	0.6048	3,339	0.6171	4,025	0.6288	5,223
80-84.....	1,033		1,266		1,636		2,060		2,531
85+.....	709	0.3552	619	0.3629	684	0.3699	858	0.3762	1,098
Born before 1955.....	475,449		460,976		448,449		435,187		420,642
Born after 1955.....	—		98,246		210,357		342,096		499,463
TOTAL FEMALES.....	475,449		559,222		658,806		777,283		920,105
TOTAL, BOTH SEXES.....	951,093		1,119,129		1,319,557		1,558,668		1,847,901

TABLE 41. CALCULATION OF ESTIMATED NUMBERS OF BIRTHS IN COSTA RICA, 1955-75, UNDER "MEDIUM" FERTILITY ASSUMPTION

	1955	1960	1965	1970	1975	Weight
<i>Estimated female population</i>						
Age in years:						
15-19.....	48,411	54,699	65,813	79,883	95,030	1
20-24.....	43,681	48,024	54,371	65,523	79,627	7
25-29.....	38,274	43,166	47,582	53,990	65,182	7
30-34.....	30,194	37,708	42,644	47,125	53,585	6
35-39.....	24,345	29,623	37,112	42,081	46,621	4
40-44.....	22,074	23,775	29,025	36,474	41,467	1
WEIGHTED SUM	922,714	1,061,544	1,212,821	1,404,022	1,658,154	
MEAN WEIGHTED SUM (INTERVENING PERIODS)	992,129	1,137,182	1,308,422	1,531,088		
<i>Sex-age adjusted birth rate</i>						
Assumed annual rate.....	44.93	44.93	44.93	44.93		
Quinquennial rate*						
Males.....	115.06	115.06	115.06	115.06		
Female.....	109.59	109.59	109.59	109.59		
<i>Estimated number of births</i>						
Male.....	114,154	130,844	150,547	176,167		
Female.....	108,727	124,624	143,390	167,792		

\* Calculated on the assumption of 105 male per 100 female births.

A. ESTIMATES ASSUMING "MEDIUM" FERTILITY

319. The calculations for the "medium" fertility assumption are shown in tables 40 and 41. The base population estimates by sex and age for mid-year 1955, from table 39, are entered in the first column of table 40. Survival ratios for future time-periods, from table 22,

are entered in the appropriate columns. The results obtained by means of these figures alone are those which appear below the solid line, for each sex, in table 40. They refer to individuals born before mid-year 1955. They are obtained by multiplying each number with its survival ratio and entering the product in the column

TABLE 42. CALCULATION OF ESTIMATED NUMBERS OF BIRTHS IN COSTA RICA, 1955-75, UNDER "HIGH" AND "LOW" FERTILITY ASSUMPTIONS

	1955-60	1960-65	1965-70	1970-75
<i>"High" assumption</i>				
Mean weighted sum of female population 15-44.....	992,129	1,137,182	1,308,422	1,536,448
Sex-age adjusted birth rate:				
Assumed annual rate.....	50.00	50.00	50.00	50.00
Quinquennial rate:*				
Male.....	128.05	128.05	128.05	128.05
Female.....	121.95	121.95	121.95	121.95
Estimated number of births:				
Male.....	127,042	145,616	167,543	196,742
Female.....	120,990	138,679	159,562	187,370
<i>"Low" assumption</i>				
Mean weighted sum of female population 15-44.....	992,129	1,137,182	1,308,422	1,529,900
Sex-age adjusted birth rate:				
Assumed annual rate.....	43.81	41.62	39.54	37.56
Quinquennial rate:*				
Male.....	112.20	106.59	101.26	96.19
Female.....	106.85	101.51	96.44	91.61
Estimated number of births:				
Male.....	111,317	121,212	132,491	147,161
Female.....	106,009	115,435	126,184	140,154

\* Calculated on the assumption of 105 male per 100 female births.

for the next date, on the line for the next-higher age group.

320. For example, initially there are 85,692 males aged 0-4 years. Multiplication of this figure by the survival ratio  $P_{0-4}$  for 1955-1960 (0.9648) results in the estimate of 82,676 male survivors aged 5-9 years in 1960. Multiplication of the latter figure by the survival ratio  $P_{5-9}$  for 1960-1965 (0.9937) yields 82,155 males aged 10-14 years in 1965, and so forth.

321. In table 41, the numbers of women in age groups 15-19 to 40-44 are copied from table 40. At the stage of calculations described so far, all of these age groups are available except for women aged 15-19 years in 1975, who are themselves the survivors of future births. At this stage, therefore, weighted sums for each date

can be derived only up to 1970. Averaging these, mean weighted sums are derived for the periods 1955-1960, 1960-1965, and 1965-1970. The annual sex-age adjusted birth rate, for the "medium" assumption, is 44.93 per 1,000, or 224.65 in a five-year period. If there are 105 male per 100 female births, the rates for five-year periods are 115.06 male births to 109.59 female births per 1,000 of the weighted sum. Multiplying the mean weighted sums of women for each period by these rates yields the estimates of numbers of births of each sex up to 1970.

322. These estimated numbers of births are multiplied by the survival ratios ( $P_b$ ) for the corresponding periods and the resulting estimate of survivors aged 0-4 years at the end of each period is entered in table

TABLE 43. CALCULATION OF ESTIMATED NUMBERS OF SURVIVORS IN 1960-1975 FROM BIRTHS IN 1955-1975, FOR COSTA RICA, ACCORDING TO "HIGH" AND "LOW" FERTILITY ASSUMPTIONS

Age in years	Estimated survivors, 1960	Survival ratio ( $P_a$ ), 1960-65	Estimated survivors, 1965	Survival ratio ( $P_a$ ), 1965-70	Estimated survivors, 1970	Survival ratio ( $P_a$ ), 1970-75	Estimated survivors, 1975
<i>High assumption</i>							
<i>Males</i>							
0-4.....	112,775	0.9708	132,074	0.9765	155,178	0.9818	185,685
5-9.....			109,482	0.9949	128,970	0.9963	152,354
10-14.....					108,924	0.9972	128,493
15-19.....							108,619
Born before 1955	458,572		443,699		428,187		411,573
Born after 1955	112,775		241,556		393,072		575,151
TOTAL MALES	571,347		685,255		821,259		986,724
<i>Females</i>							
0-4.....	109,327	0.9731	127,696	0.9791	149,669	0.9844	178,657
5-9.....			106,386	0.9962	125,027	0.9972	147,334
10-14.....					105,982	0.9978	124,677
15-19.....							105,749
Born before 1955	460,976		448,449		435,187		420,642
Born after 1955	109,327		234,082		380,678		556,417
TOTAL FEMALES	570,303		682,531		815,865		977,059
TOTAL, BOTH SEXES	1,141,650		1,367,786		1,637,124		1,963,783
<i>Low assumption</i>							
<i>Males</i>							
0-4.....	98,816	0.9708	109,939	0.9765	122,713	0.9818	138,891
5-9.....			95,931	0.9949	107,355	0.9963	120,480
10-14.....					95,442	0.9972	106,958
15-19.....							95,175
Born before 1955	458,572		443,699		428,187		411,573
Born after 1955	98,816		205,870		325,510		461,504
TOTAL MALES	557,388		649,569		753,697		873,077
<i>Females</i>							
0-4.....	95,790	0.9731	106,293	0.9791	118,361	0.9844	133,637
5-9.....			93,213	0.9962	104,071	0.9972	116,515
10-14.....					92,859	0.9978	103,780
15-19.....							92,655
Born before 1955	460,976		448,449		435,187		420,642
Born after 1955	95,790		199,506		315,291		446,587
TOTAL FEMALES	556,766		647,955		750,478		867,229
TOTAL, BOTH SEXES	1,114,154		1,297,524		1,504,175		1,740,306

40. For example, the estimate of 114,154 male births in 1955-1960 is multiplied by  $P_b$  for 1955-1960 (0.8877) to obtain the estimated number of males aged 0-4 in 1960 (101,335). By applying the appropriate survival ratios for successive time periods, the estimates of survivors for all age groups above the solid line in table 40 can now be computed, except the group 0-4 years old in 1975.

323. The estimate of female survivors aged 15-19 years in 1975 so obtained is now entered in table 41, and the calculations of births are completed for the 1970-1975 period, so that the estimates of survivors aged 0-4 in 1975 can be entered in table 40, completing the projection.

#### B. ESTIMATES ON ALTERNATIVE FERTILITY ASSUMPTIONS

324. In addition to the "medium" fertility assumption, projections are desired, in accordance with the last section of chapter V, on the "high" assumption of a constant sex-age adjusted birth rate of 50 per 1,000 and on the "low" assumption of a continuous decline from the rate of 44.93 per 1,000. These alternative assumptions affect only the numbers of survivors from births occurring after 1955.

325. The alternative estimates of births are obtained by a modification of table 41, as shown in table 42. The weighted sums of women of childbearing age remain unchanged whatever fertility is assumed, up to the period 1970-1975, when new weighted sums must be calculated to take account of the larger or smaller estimates of female births in 1955-1960, 15-19 years old in 1975.

326. The estimated future number of births from table 42 are multiplied by the  $P_b$  ratios and the results inserted in table 43 in order to compute the corresponding numbers of survivors at ages 0-4 in 1960, 0-9 in 1965, 0-14 in 1970, and 0-19 in 1975. Table 43 represents a substitute for that segment of table 40 which is above the solid line.

327. The survivors from the population born before 1955, obtained in table 40, are unaffected by the alternative assumptions of future fertility. Thus, the future total population figures under each of the two alternative assumptions are obtained by addition of survivors born before 1955 to the alternate estimates of survivors from future births. On the "medium" assumption, the projection yields a total population of about 1,850,000 by 1975. The results of the "high" and "low" assumptions imply that the 1975 figure might exceed 1,900,000 or fall somewhat below 1,800,000. It seems unlikely, unless unforeseeable events should occur, that the population would be either more than, say, 1,950,000 or less than 1,750,000.

## VII. MIGRATION

328. Many population projections are computed with reference only to the factors of fertility and mortality and without regard to any changes which may be brought about by immigration or emigration. Such projections are adequate where there is little reason for expecting migration to play an important part during the period covered by the projection. International migration has in fact had relatively little influence on the trends of population in the majority of countries during recent times, and in most cases it may be plausible to assume that its effect will continue to be minor. However, where such an assumption does not appear to be realistic, it is important so far as possible to introduce the factor of migration into the calculations. It should be considered that where the volume of migration seems unlikely to be great enough to have much influence on the size of the future population, it may nevertheless have a disproportionately large effect on the numbers in certain sex-age groups, owing to the peculiar sex-age composition of the migrant population.

329. As a rule, the future course of migration is more difficult to predict with any assurance than that of either fertility or mortality. Migration is very sensitive to changing economic conditions, not only within the country for which projections are to be made, but also in other countries from which it may draw immigrants or to which it may send emigrants. Changing legal and administrative regulations and changing public sentiments may also have a great effect. Furthermore, in very many countries it is not even possible to get a satisfactory measure of the past trends of immigration and emigra-

tion. The statistics on this subject are often very faulty, and their coverage and definitions are often not adequate for the purpose of measuring those inward and outward movements which have a lasting influence on the population of the country.<sup>48</sup> For these reasons, calculations relating to the possible effects of migration are commonly carried out separately from those relating to births and deaths, and the results are presented separately so that different estimates can readily be derived on various assumptions as to future amounts of immigration and emigration. It is in this manner that the factor of migration was treated in the population projections prepared by the United Nations staff.

#### A. THE MODEL OF RECENT OVERSEAS MOVEMENTS OF EUROPEAN ORIGIN

330. The United Nations projections for Latin American countries were accompanied by a model which could be used to estimate the effects of any given annual amounts of immigration and emigration upon the population figures for various sex-age groups, computed without regard to migration, for various countries in the region.<sup>49</sup> This model is reproduced in tables 47 to 50, inclusive. It is based on the statistics of postwar immigration and emigration for Argentina, and is relevant to recent migration from Europe to countries overseas and to the return movements of previous migrants,

<sup>48</sup> United Nations, *Problems of Migration Statistics*, Population Studies, ST/SOA/Ser. A., No. 5.

<sup>49</sup> *The population of South America, 1950-1980*, Annex C.