Projecting Births in a California School District[*][**]

by

Shelley Lapkoff
Lapkoff & Gobalet Demographic Research, Inc.
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Abstract

School district administrators need 10 or even 20-year enrollment forecasts for facilities planning. One of the most important variables in producing long-range forecasts is the birth trend in the community. This paper discusses demographic analyses used to forecast births in the Palo Alto, California, school district for the year 2000 and analyses to indicate the trend in births from 2000 to 2010. Women in the childbearing ages are estimated indirectly by projecting the population over age 40. On the basis of remarkably stable "survival" (migration and mortality combined) rates of those over age 40, the population at older ages is anticipated to rise, leaving less housing available for households with women in the child bearing ages. Meanwhile, age-specific fertility rates in Palo Alto are extremely low, however they increased by 35 percent during the 1980s for those in their 30s. Three different birth forecasts are presented (Low, Medium, and High) that indicate births in the community are likely to decline over the next decade and are likely to continue declining after the turn of the century.

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Introduction

School district administrators are dependent on forecasts of school enrollments to make good decisions about school facilities. Currently, many California districts are experiencing increased enrollments at the elementary level, and districts are deciding whether to build new school sites or reopen closed sites. Schools typically take two to three years to construct, last between 30 and 100 years, and cost as much as 30 million dollars. Before making such sizable expenditures, school administrators look to enrollment forecasts to justify the need for new facilities throughout the life of the facility.

The California legislature has permitted school districts to collect fees from residential developers if the district can "prove" that the new housing will create the need for new school facilities. To evaluate the full impact of new development on school facilities, long-range forecasts are usually needed; enrollments are forecast until all housing anticipated for the community is built.

Along with forecasting housing growth, forecasting the number of births in a school district is one of the most important assumptions in a long range enrollment forecast. Since cohort survival models use kindergarten enrollments to forecast all future grades, errors in the trend of kindergarten enrollment will compound as the forecast period lengthens.

Background on Palo Alto Unified School District

The Palo Alto Unified School District (PAUSD) includes the city of Palo Alto (located about 30 miles south of San Francisco), Stanford University, and a small part of the city of Los Altos. The community is affluent, well educated, and possesses one of the oldest population age distributions in the county.

In 1966, over 15,000 students were enrolled in PAUSD. By 1990, only 7,000 students were enrolled -- less than half of the District's enrollments two and a half decades earlier (see Chart 1).

Chart 1
Total Enrollment in PAUSD: 1966 - 1991
(From Eleventh Day Enrollment Data)
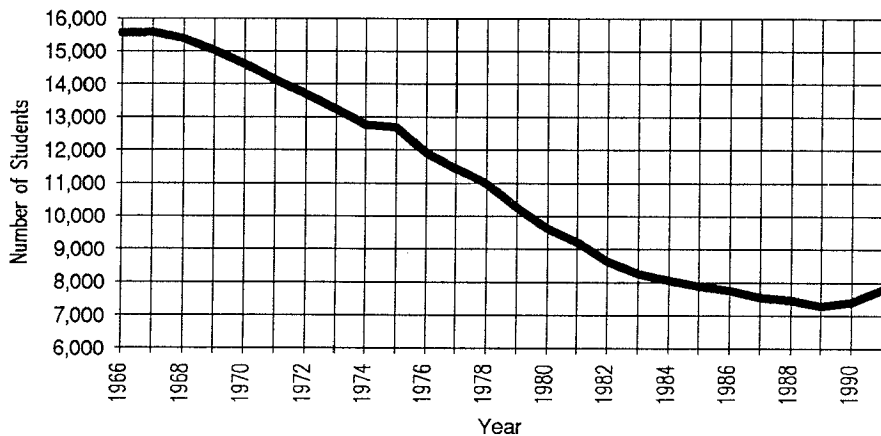
In recent years, enrollments have begun to increase, first at the elementary level, then at the middle school level, and finally at the high school level (see Chart 2). The rise in enrollments, particularly at the elementary level, provided an incentive for the district to change from a K-6 grade configuration at the elementary level to a K-5 grade configuration. While this temporarily relieved overcrowding at the elementary level, continued enrollment increase could necessitate an opening of a closed school. The District would like to avoid the expense of renovating the old school site for operational use if elementary enrollments might soon stabilize or decline. Only a sustained enrollment increase would require the opening of another school.

Grade K-5 Enrollments, 1966 to 1991
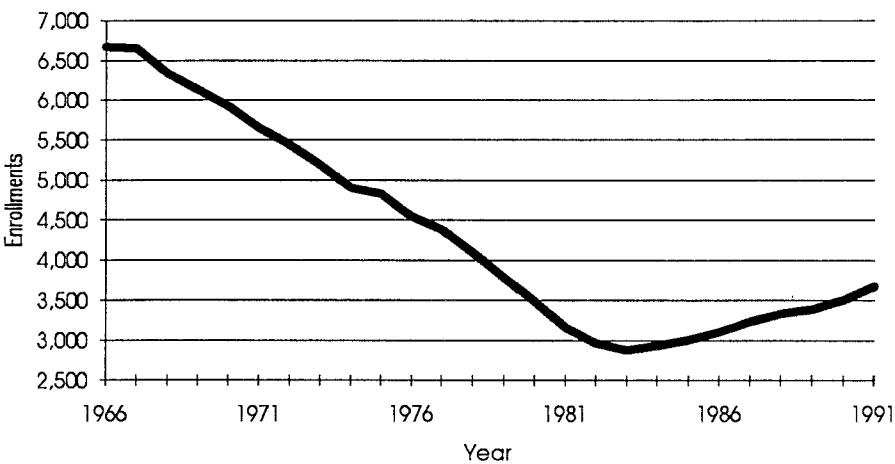
Grade 6-8 Enrollments, 1966 to 1991
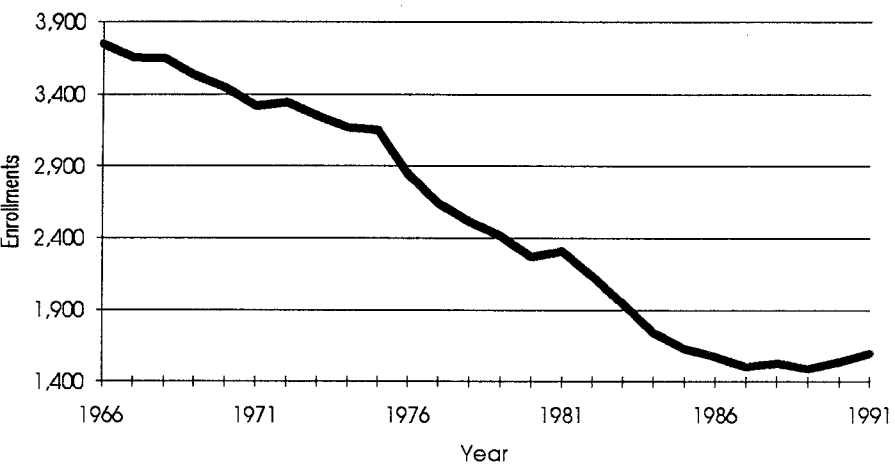
Grade 9-12 Enrollments, 1966 to 1991
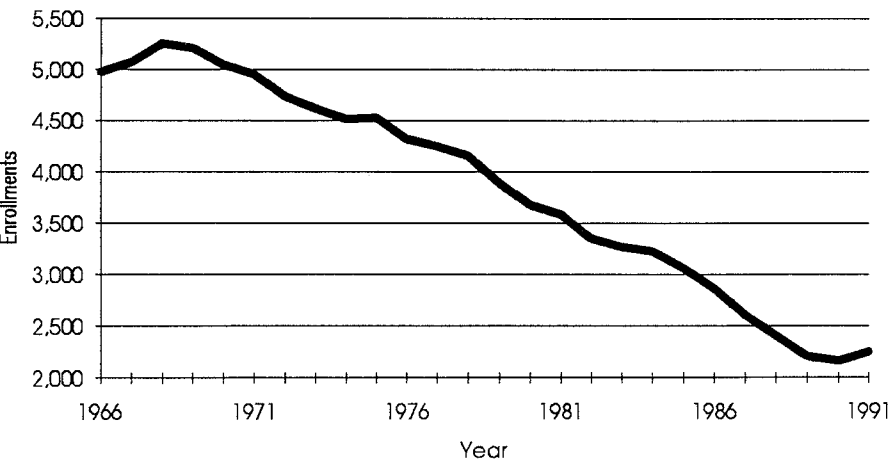
To underscore how important births are in the overall enrollment trend, Chart 3 shows the number of births in the city of Palo Alto between 1970 and 1990. The decline in enrollments corresponds to declining numbers of births in the city. As births began to increase, elementary enrollment increases followed five years later.

Chart 3

Births in the City of Palo Alto, 1970 to 1990
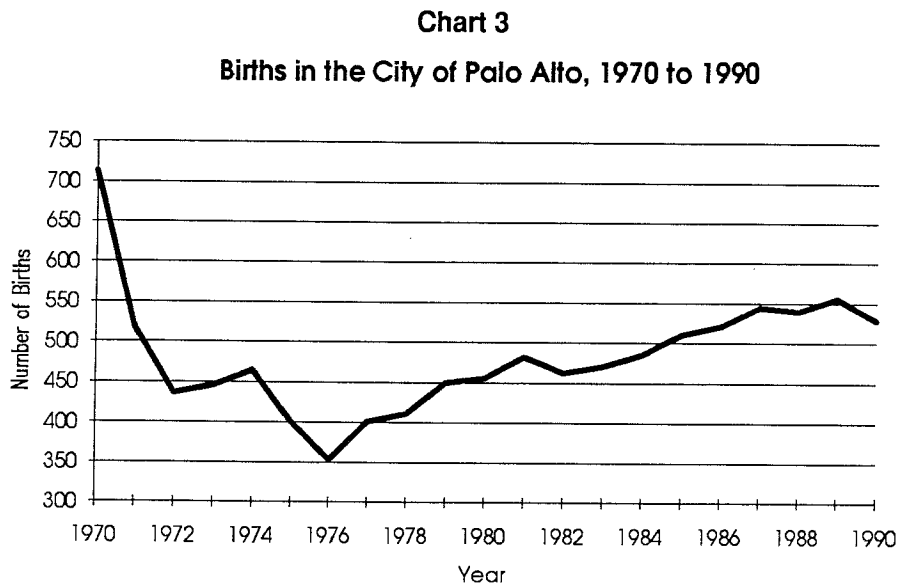
There are two components to forecasting births: the number of women of child bearing age in the community, and age-specific fertility rates. Each component is discussed below.

Forecasting the Number of Women of Child Bearing Age

Palo Alto is an older community in which most of the housing is occupied by households containing women beyond the childbearing ages. About half of the single family unit housing has been held by the same owner since at least 1976 (the earliest year for which we have data), and it is likely that most of these houses are occupied by "empty nesters." The elementary enrollment increases experienced by PAUSD during the 1980s has raised the question whether housing turnover in older neighborhoods is responsible. Are houses that have been held by elderly persons changing ownership to families with young children? If so, will this trend continue in future years, further increasing the number of relatively young adult women in the population?

We forecast the number of women in the child bearing years indirectly. For reasons that will become evident, our strategy is to estimate the number of women *beyond* the child bearing ages, and assume each of these older women represents a household. If the number of older women in the community is expected to decline over the next decade, then we presume that more housing units will be "freed up" during the decade and available for young families. If the number of older women in the community is expected to rise, then we would expect fewer housing units available to newcomers. Note that we are essentially using women as a proxy for households. Ideally, we would like to estimate the number of *housing units* that will be available in the future to young families in Palo Alto.[1] Because women generally live longer than men, a household is most likely to dissolve when a woman dies. In addition, it is more convenient to use women than men in evaluating child bearing because women are more restricted than men in the age at which they have children.

The decennial censuses were used to evaluate the potential of forecasting women beyond the child bearing ages. Age-specific transition rates are calculated for each five-year age group between 1970 and 1980 and between 1980 and 1990.[2] The transition rates in Palo Alto have remained remarkably constant between 1970 and 1990. Table 1 shows the net transition rates for each decade. (A transition rate of 1.0 would mean the age group neither grew nor declined as it aged ten years. A rate above 1.0 would suggest in-migration and a rate lower than 1.0 would suggest out-migration or high mortality.)

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[1]An analysis of housing turnover in Palo Alto, which is not discussed here, showed that housing turnover had been relatively stable over the last two decades, and that housing turnover was not anticipated to increase in future years.
[2]For example, the population aged 40-44 in 1970 is compared with the population 50-54 in 1980. The ratio of the population aged 50-54 in 1980 to the population aged 40-44 in 1970 is the 40-44 transition rate for 1970-1980.

Table 1
Transition Rates

Age in Earlier Census	1970>1980	1980>1990
25-29	1.07	0.97
30-34	0.83	1.02
35-39	0.83	0.94
40-44	0.84	0.88
45-49	0.85	0.80
50-54	0.66	0.79
55-59	0.87	0.81
60-64	0.73	0.79
65-69	0.85	0.78
70-74	0.66	0.73
75+	0.35	0.31

For those aged 40 and over, the transition rates are very similar in the two decades. This similarity is encouraging, suggesting that historical transition rates may be a good predictor of future rates between 1990 and 2000 and between 2000 and 2010.

One test of the stability of the transition rates is to see how well we can predict the 1990 population using only the 1970 and 1980 decennial population figures. Chart 4 shows the actual 1990 population and a 1990 population projected from the 1980 census. The projected 1990 population closely matches the actual 1990 population. The projection slightly underestimates the population between ages 35 and 50. (No projection was made for the population under age 35.)

Chart 4
1990 Female Population:
Actual and Projected from 1980 Census Data
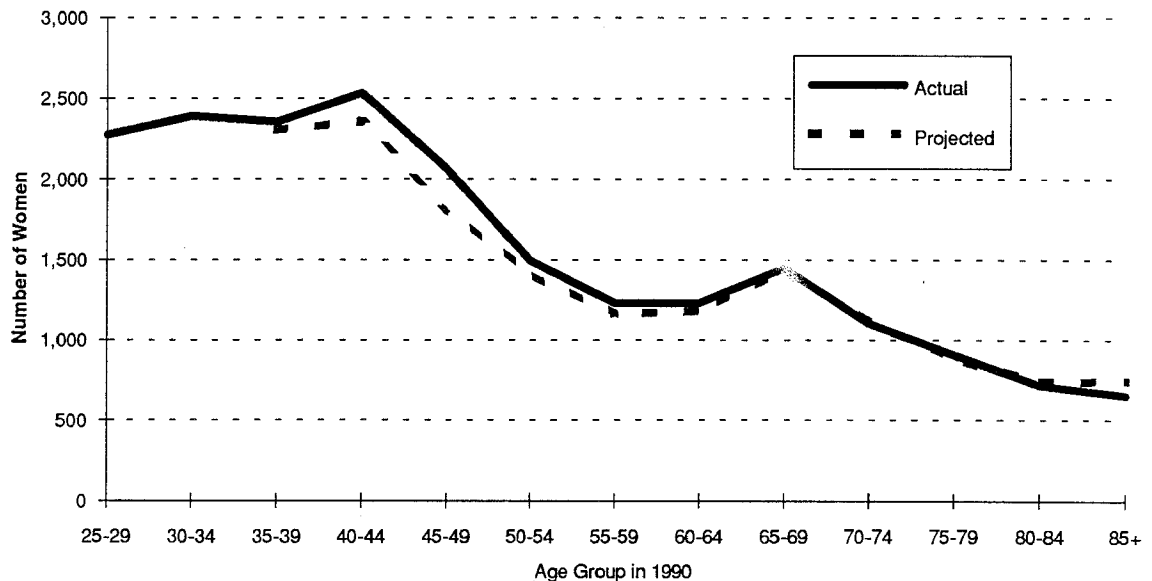
To forecast the female population to the year 2000, the population in 1990 is aged 10 years and adjusted for migration and mortality. In Table 2 the 1980 to 1990 transition rates are applied to the female population in 1990.

Table 2

Projection of Female Palo Alto Population in 2000

Age	1990 Population	Transition Rate	2000 Projection
30-34	2,390	1.02	
35-39	2,354	0.94	
40-44	2,530	0.88	2,442
45-49	2,061	0.80	2,218
50-54	1,494	0.79	2,230
55-59	1,230	0.81	1,649
60-64	1,228	0.79	1,176
65-69	1,446	0.78	992
70-74	1,101	0.73	975
75-79	907	0.31	1,121
80-84	716	0.31	806
85+	652	0.31	705
45+	10,835		11,873
50+	8,774		9,654

In 1990, there were 10,835 women over age 45; it is projected that 11,873 women will be over age 45 in 2000, implying that there will be less housing in Palo Alto available to new families.

The projection indicates that households available to women of childbearing age will have declined by 10.5 percent by the year 2000.

Another important consideration is the size of the post World War II baby boom generation. By the year 2000, most of the boomers will be between the ages of 40 and 50. Thus, we might expect that more of the migrants to Palo Alto will be in these ages, already beyond the child bearing ages than the transition rates from 1980 to 1990 would suggest. If this expectation is accurate, the number of women in the childbearing ages will drop by even more than 10 percent in the mid to late 1990s.

The population in 2010 can be projected from the simulated 2000 population. Naturally, the farther into the future the projection goes, the less reliable it will be. Nonetheless, the forecast may suggest whether major changes are likely to occur in Palo Alto's population. Table 3 shows the simulated 2000 population, the 1980-90 transition rates, and the projected 2010 population. The projection indicates that the population over age 50 in 2010 is expected to be even larger in the year 2010. *The simulation indicates a continuing decline in the available housing units to women under age 50.*

Table 3

Forecast of Female Palo Alto Population in 2010

Age	2000 Projection	Transition Rate	2010 Projection
30-34			
35-39			
40-44	2,442	0.88	
45-49	2,218	0.80	
50-54	2,230	0.79	2,153
55-59	1,649	0.81	1,775
60-64	1,176	0.79	1,755
65-69	992	0.78	1,330
70-74	975	0.73	934
75-79	1,121	0.31	769
80-84	806	0.31	714
85+	705	0.31	816
50+	9,654		10,246

Failed Attempt

An alternative for forecasting the older population in Palo Alto would be to piggy back on forecasts for the U.S. With the larger population of the U.S. and little immigration effects, a forecast of the U.S. population over age 40 should be fairly reliable. This possibility was explored but rejected because an historical analysis revealed that trends in Palo Alto's population age distribution did not follow county or national trends. An example of this lack of correspondence is illustrated below.

Chart 5
Percentage of the Female Population Over Age 50
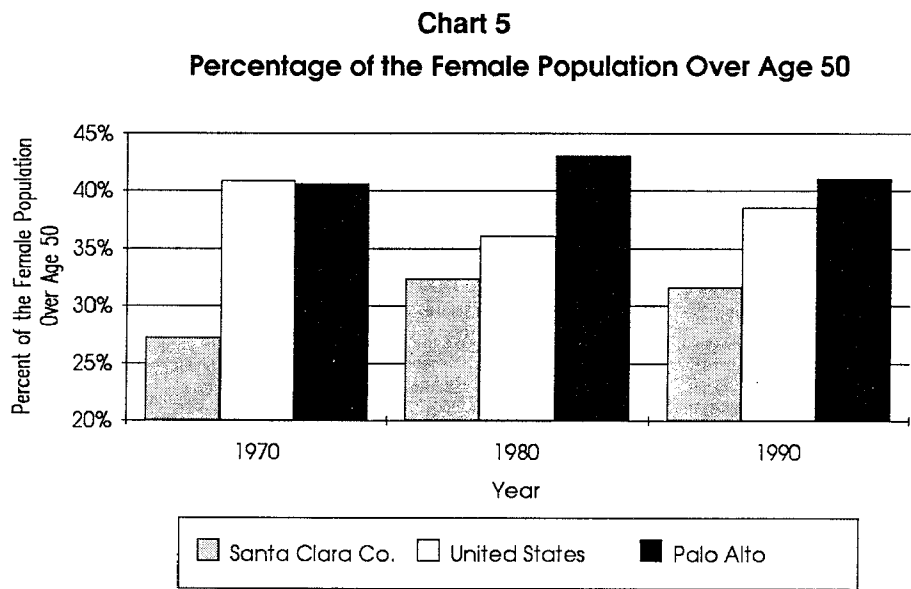
The percentage of the population over age 50 was relatively stable in Palo Alto over the three decades. By contrast, the county showed significant increases in the percentage over age 50 between 1970 and 1980 and a modest decline between 1980 and 1990. Meanwhile, in the U.S., the percentage of the population over age 50 declined between 1970 and 1980 but increased between 1980 and 1990. *This analysis underscored the need for a local area population projection.*

Forecasts of the Age Mix of Women Within the Child Bearing Ages

The cohort survival method we used to forecast the population beyond the child bearing ages is not adequate for estimating women within the child bearing ages. The cohort survival method does not work well for the younger aged women because most of these women will be migrating into Palo Alto and are not aging from women in the community 10 years prior.

The population aged 20 to 40 in the year 2000 is more likely to reflect the age distribution of the general population than the localized aging process in Palo Alto. The change in the age mix of women within the child bearing ages in Palo Alto was similar to the change in the U.S. generally between 1980 and 1990, as shown below.

Table 4
Age Distribution of Women in the Prime Child Bearing Ages

| | United States | | Palo Alto | |
	1980	1990	1980	1990
Age Group				
20-24	29%	23%	22%	16%
25-29	27%	26%	26%	27%
30-34	24%	27%	27%	29%
35-39	19%	25%	24%	28%
20-39	100%	100%	100%	100%

Although the precise age distribution differs between the U.S. and Palo Alto, the change over time is quite similar. In both Palo Alto and the U.S., women age 20-24 as a percentage of women aged 20-39 declined during the 1980s. The share of women age 30-34 increased modestly during the period in both cases. And the share of women aged 35-39 grew significantly over time in both Palo Alto and the U.S. These data suggest that trends of the U.S. age mix of women in the child bearing ages can guide estimates of the age mix in Palo Alto.

The age distribution of the U.S. for the year 2000 is forecast by the Census Bureau.[3] Since the forecast is based on existing population (that is, the population aged 10 to 29 in 1990), the forecast should be reasonably accurate. While a cohort survival technique will not be reliable for Palo Alto, it ought to be reliable for the entire U.S. In the year 2000, the Census Bureau forecasts that the share of women of prime child bearing age will be concentrated in ages 35-39. Women aged 25-34 will have a lower share than in 1990, while women age 20-24 will have the same share in 1990 than in 2000. This forecast suggests that Palo Alto women of child bearing ages will be more highly concentrated in the late 30s by the end of the decade. Assuming the same percentage change in Palo Alto as in the U.S. concerning the age mix of women of prime childbearing age, Table 5 shows the age mix of women projected for Palo Alto in the year 2000.

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[3]Gregory Spencer, "Projections of the Population of the United States, by Age, Sex, and Race: 1988 to 2080," Population Estimates and Projections, Series P-25, No. 1018, 1989.

Table 5

Projected Age Mix of Women in the Year 2000

| | *United States* | | | *Palo Alto* | |
| | 1990 | 2000 | Percent | 1990 | 2000 |
Age Group			Change		
20-24	22%	23%	2%	16%	16%
25-29	26%	23%	-11%	27%	24%
30-34	27%	25%	-6%	29%	27%
35-39	25%	29%	16%	28%	33%
20-39	100%	100%		100%	100%

Table 6 shows the projected women of childbearing age for Palo Alto, assuming a 10.5 percent drop in the number of women under age 40 and the age mix presented in Table 5.

Table 6

Projected Women of Child Bearing Age in Palo Alto in the Year 2000

Age Group	Actual 1990	Projected 2000
20-24	1,355	1,221
25-29	2,271	1,807
30-34	2,390	2,040
35-39	2,354	2,439
Total	8,370	7,506

Fertility Rate Changes

The other key component to estimating future birth is age specific fertility rates. We compare Palo Alto age specific fertility rates to trends in the nation and state. If Palo Alto follows either the state or nation, forecasts of fertility rates for these areas could guide our assumption for Palo Alto.

Fertility rates in the U.S. and California[4]

Birth trends in California have differed from national trends. Some might say that California "leads" the nation, as illustrated in Chart 6. During the 1960s and early 1970s, both California and the U.S. had declining fertility rates, but California's rates declined more sharply and slightly earlier than the nation's. Since the mid-1970s, California's fertility rates have risen, but until recently, U.S. rates showed little change.

Chart 6
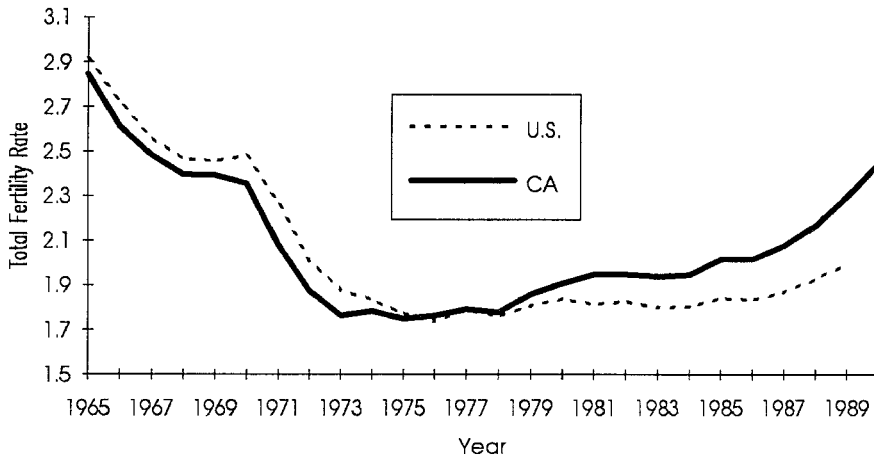### Total Fertility Rates for the U.S. and California

Chart 7 shows U.S. age-specific fertility rates in 1980 and 1989. During the 1980s fertility rates declined for women in their early twenties, but increased for women older than 25. Overall, the total fertility rate for the U.S. increased from 1.8 in 1980 to 2.0 in 1989.

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[4]Birth data for the U.S. come from U.S. Vital Statistics annual reports. Birth data for California come from the state's Department of Finance, Population Research Unit, unpublished data.

Chart 7

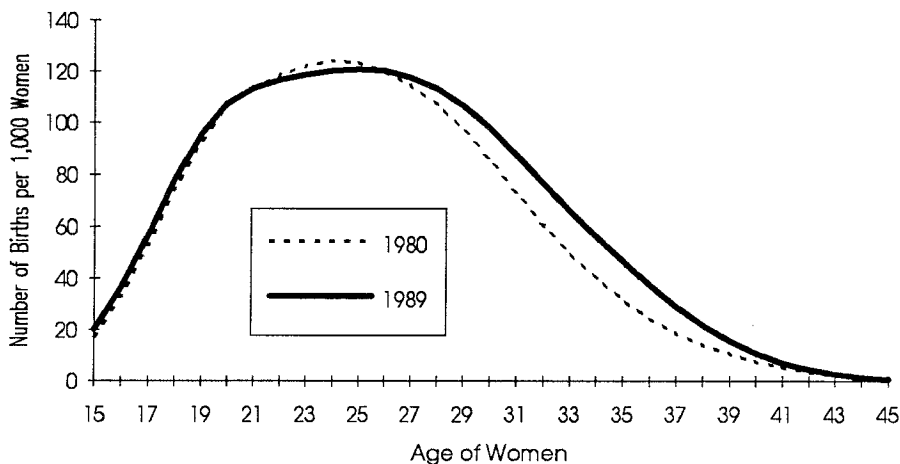**U.S. Age-specific Fertility Rates for 1980 and 1989**

Chart 8 shows California age-specific fertility rates in 1980 and 1989. In the state, fertility rates rose at all ages. During the 9-year period, the total fertility rate rose from 1.9 to 2.3.
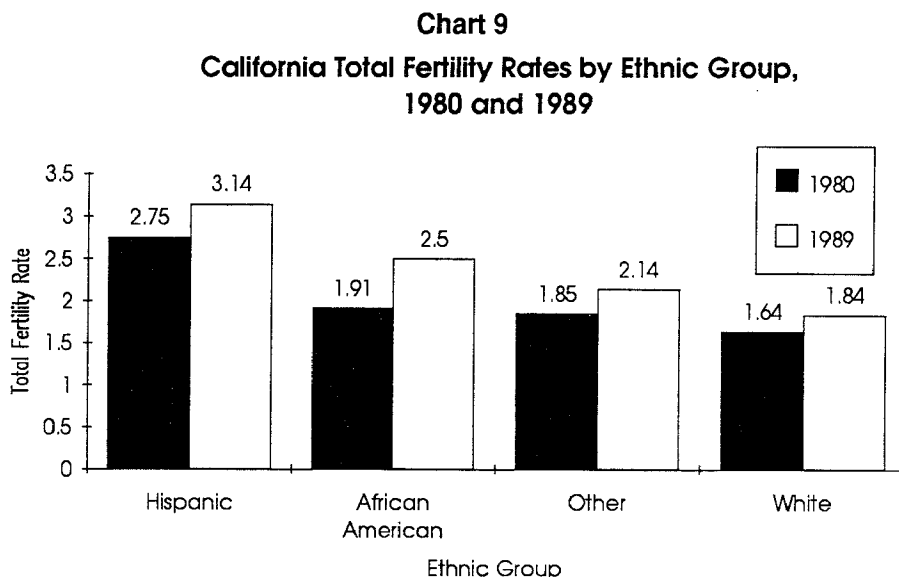
Chart 8
California Age-specific Fertility Rates for 1980 and 1989

About 20 percent of the California increase in fertility rates was due to an increase in the number and proportion of Hispanics and other minority groups who have higher fertility rates than Whites. As shown in Chart 9, the White fertility rate is about 60 percent of the Hispanic rate. As Hispanics and other minorities become more numerous and their proportions grow in California, the aggregate fertility rate will increase. Nonetheless, about 80 percent of the increase in the total

fertility rate between 1980 and 1989 was due to a greater propensity to give birth across all ethnic groups. Even White fertility rates increased 12 percent between 1980 and 1989.

Chart 9
California Total Fertility Rates by Ethnic Group,
1980 and 1989

Fertility rates by Educational Attainment

Because Palo Alto residents have high levels of educational attainment, it is of interest to consider birth trends among more educated women. Chart 10 shows the difference in fertility rates between high school educated and college educated women.[5] The differences are striking: women with more education have fewer and later births.

The fertility rates of educated women changed recently. Chart 11 shows U.S. age-specific fertility rates for college educated women in 1980 and 1985. Between 1980 and 1985, highly educated women experienced declining fertility rates during their twenties, and increasing fertility rates in their thirties and forties.

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[5]National Center for Health Statistics, *Birth and Fertility Rates by Education: 1980 and 1985,* October 1990, Vital and Health Statistics, Series 21, No. 49.

Chart 10

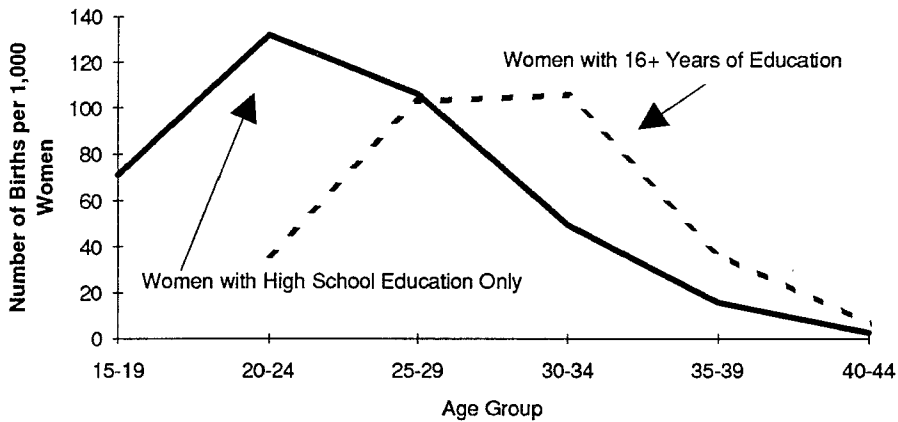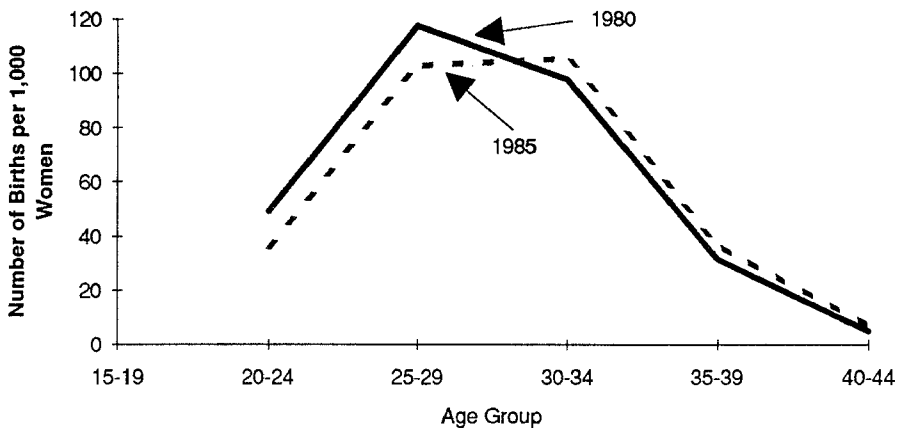**U.S. Age-specific Fertility Rates in 1985 by Education Level**

Chart 11

U.S. Age-specific Fertility Rates of Women with 16+ Years of Education

Fertility rates in Palo Alto[6]

Fertility rates in Palo Alto are much lower than for the state or nation. In 1980, the total fertility rate in Palo Alto was .99 compared to 1.91 in California and 1.75 for the nation. By 1990, fertility rates in Palo Alto were up to 1.26, compared to 2.45 in California and 1.96 in the U. S. (in 1989).

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[6]Birth data for Palo Alto were calculated from county birth data by age of mother and from 1980 and 1990 Census data.

Chart 12 shows age-specific fertility rates in the city of Palo Alto in 1980 and 1990. Fertility rates changed little for those under age 30. However, the fertility rates of those over age 30 rose dramatically.

Chart 12

Age-Specific Fertility Rates in Palo Alto in 1980 and 1990
(Excludes Stanford University)
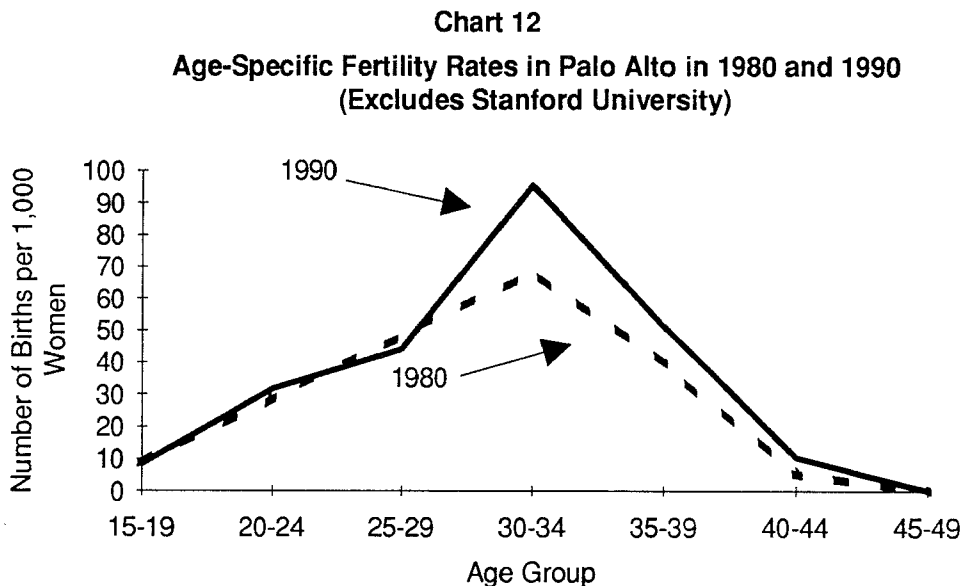
While the percentage increase in the total fertility rate in Palo Alto was almost exactly the same in California (28 percent), fertility rates in California rose for all ages while they increased only for those over age 30 in Palo Alto. Thus, the percentage increase in the over 30 fertility rates were more pronounced in Palo Alto than in California more generally.

Birth Projections

Births in Palo Alto in the year 2000 will equal the number of women in the child bearing ages multiplied by their age-specific fertility rates. The number of women in five-year age groups was estimated in a previous section (Table 6) for a subset of Palo Alto. The age-specific fertility rates are more difficult to estimate. Rates have changed significantly over the decade and it is not clear whether these trends will continue in the future. As we all know, demographers have not been very successful in forecasting fertility rates. Due to the uncertainty in the age-specific fertility rates (and the uncertainty inherent in our estimate of the number of women of child bearing age), three birth projections are provided: a High, Medium, and Low projection. The Medium projection assumes that 1990 age-specific fertility rates will continue in future years; the Low forecast assumes that rates will return to their 1980 level; and the High forecast assumes that rates will increase at the same rate over the next 10 years as they have in the last decade. All projections assume the same number of women by age, as projected in Table 6.

Table 7 shows the age specific fertility rates (ASFR) assumed in each forecast and the number of births from each age group of woman. The number of births range from 381, 473, and 608 in the Low, Medium and High forecasts. The comparable number of births for 1990 of this subset of Palo Alto is 528.

As it turns out, the Medium forecast yields a 10.5 percent decline in births, the same as the percentage decline in the overall number of women in the child bearing ages. While the age mix of women is projected to change somewhat between 1990 and 2000, the changes were offsetting (fewer women in the 30-34 age group, but more women in the 35-39 age group).

Table 7
Projected Number of Births in the Year 2000

Age Group	Projected Population	Low Forecast ASFR	Births	Medium Forecast ASFR	Births	High Forecast ASFR	Births
15-19	1,201	8.64	10	8.33	10	8.02	10
20-24	1,221	28.74	35	31.73	39	35.04	43
25-29	1,807	48.33	87	44.03	80	40.12	72
30-34	2,040	68.26	139	95.40	195	133.33	272
35-39	2,439	39.32	96	50.98	124	66.08	161
40-44	2,530	5.31	13	10.28	26	19.89	50
Total/ TFR	11,237	0.99	381	1.20	473	1.51	608

Our forecast of older women in Palo Alto for the year 2010 indicated that the community would continue to grow older. This implies that births are likely to continue declining between 2000 and 2010 unless fertility rates increase sharply.

Conclusion

The historical rise in the number of births in PAUSD -- and hence kindergarten and all subsequent grade enrollments -- was a result of two factors: a substantial rise in fertility rates among women over age 30 and a shift of more women over age 30 and fewer women in their 20s.

To forecast on a local level, the demographer needs to rely on the best data available and, when possible, to use projections at a higher level when deemed appropriate. In our case, the most reliable forecast at the local level was the number of women *outside* the child bearing ages. This was used to indirectly estimate the number of women in the child bearing ages. We attempted to use forecasts of the U.S. age distribution; we found these projections inappropriate for forecasting the older population in Palo Alto but helpful for forecasting the age mix of women in the child bearing ages. On the basis of our analysis, the population of child bearing age is likely to decline over the next 10 years, probably by at least 10 percent, and that the number of births is likely to decline by a similar percentage over the next 10 years.

A key component of any birth forecast is the underlying age-specific fertility rates. Unfortunately, we are unaware of any reliable methods for predicting trends in fertility rates. Though certain demographers have expressed opinions on this topic, no one has yet established a strong historical relationship that could be used to predict future fertility rates. To account for the inherent uncertainty in the projections due to the age-specific fertility rates, we typically produce a range of forecasts embodying different fertility rate assumptions. Our Medium forecast uses the most recent age specific fertility rates to predict future births.