PROGRAM FOR AGE, SEX
AND ETHNICITY FORECASTS
(PASEF)

San Diego

ASSOCIATION OF
GOVERNMENTS

401 B Street, Suite 800
San Diego, CA 92101
(619) 595-5300

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ABSTRACT

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Chapter 1

OVERVIEW

This document describes PASEF, the program for forecasting detailed demographic characteristics. These data represent the most recent addition to SANDAG's demographic and economic characteristic estimates and forecasts. We forecast population for 18 five-year age groups (0-4, 5-9, ..., 80-84, 85+) stratified by sex and four ethnic groups (Hispanic, non-Hispanic White, non-Hispanic Black, and non-Hispanic Asian & Other) for the region and for various geographic areas. These include census blocks and split census blocks comprising SANDAG's Master Geographic Reference Area (MGRA) system. These detailed demographic characteristic forecasts are part of the 2020 Cities/County Forecast summary data.

The detailed demographic characteristics forecast comes directly from the 2020 Regionwide Forecast, but requires aggregating the single year of age detail into the five-year age groups used in PASEF, and an adjustment for special populations. The forecasting method accounts separately for special populations, which include college and military populations. It is important to separate special and non-special populations not only because they have different characteristics, but also because special population characteristics are relatively stable over time. Therefore, while PASEF incorporates changes in the overall size of the special population, it assumes their age, sex and ethnicity profile does not change during the forecast. A bottom-up method is used to forecast special population characteristics. PASEF first forecasts special populations for census tracts and then aggregates the census tract forecasts to sub-regional areas (SRAs) and the region. The San Diego region is divided into 41 SRAs for planning and data reporting purposes. SRA boundaries have changed little since 1960.

The non-special population forecast uses a top-down method—first for the region, then for SRAs, next for census tracts, and finally for MGRAs, with the larger geographic area serving as controls. MGRAs generally follow census blocks, with some blocks split for transportation modeling purposes and to adhere to other geographic areas that do not follow census blocks (e.g., community planning areas). While the characteristics forecast for SRAs and census tracts requires new procedures, the MGRA forecast uses the same method as the PASEE model that produces annual demographic characteristics estimates.

This document contains three additional chapters. Chapter 2 describes the forecast methodology. Chapter 3 describes the derivation of the database that constitutes the input and output of PASEF. Finally, Chapter 4 is the programming reference. It provides general programming information for the PASEF code, including a description of source files, data and utilities.

Chapter 2

TECHNICAL SPECIFICATIONS

INTRODUCTION

The technical specifications for PASEF describe the input, output, and computations for developing subregional population forecasts by age/sex/ethnicity (demographic characteristics).

INPUT

1. January 1995 and January 1996 demographic characteristics estimates by whole census tract

2. July 1995 regional demographic characteristics estimates from the 2020 Regionwide Forecast

3. July 1995 total population estimates by MGRA

4. 2000, 2005, 2010, 2015, 2020 regional demographic characteristics forecasts from the 2020 Regionwide Forecast

5. 2000, 2005, 2010, 2015, 2020 total population forecasts by MGRA

6. Forecasted change, (by five year increments) between 1995 and 2020, in the shares of non-special population by sex and ethnicity within SRAs

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8. Census tract to SRA reference table

9. List of special population census tracts

OUTPUT

1. Intermediate files of population by age, sex, and ethnicity by SRA and census tract

2. 1995, 2000, 2005, 2010, 2015 and 2020 demographic characteristics by MGRA

NOMENCLATURE

The variable naming convention in this chapter is descriptive and reduces the need to include definitions after each equation. These include:

Variable	Description
POP	Base year, or prior forecast year, total population.
SPOP	Base year, or prior forecast year, special population.
NSPOP	Base year, or prior forecast year, non-special population.
FPOP	Forecast year total population.
FSPOP	Forecast year special population.
FNSPOP	Forecast year non-special population.

PASEF also uses the subscripts a, s, and e to refer to age, sex, and ethnicity, respectively. For the identification of geographic areas, PASEF uses ct, sra, mgra, ct=spec and ct=nspec, with the last two representing special and non-special population census tracts. Equations showing regional information do not contain a geographic subscript.

BASE YEAR ESTIMATES (JULY 1995)

SANDAG provides demographic characteristic estimates by MGRA for January 1 of each year, but estimates are needed for July 1995 to correspond to the population base used in the 2020 Cities/County Forecast. To provide an accurate assessment of changes in demographic characteristics over the forecast, the July estimates by MGRA also must be consistent with (sum up to) the July 1995 regional estimates that provide the population base used in the 2020 regionwide forecast.

PASEF develops July estimates for special and non-special populations. PASEF uses a bottom-up approach to estimate the special population—developing SRA and regional estimates from census tract estimates. For the July 1995 non-special population estimates, PASEF uses a top-down approach—first for the region, followed by SRAs, then by census tracts, and finally by MGRAs, with the larger geographic area serving as controls.

Special Population Estimates

Because of data limitations, PASEF treats the entire population in a census tract as either special or non-special. The census tracts considered as special include 28.01, 29.01, 38.00, 50.00, 55.00, 62.00, 63.00, 64.00, 66.00, 76.00, 77.00, 83.05, 87.01, 91.05, 92.01, 94.00, 95.01, 99.01, 99.02, 106.02, 113.00, 114.00, and 187.00. To streamline programming, PASEF computes the initial July demographic characteristics estimates for every census tract in this part of the program. These initial estimates are the average of the 1/1/95 and 1/1/96

estimates, which are controlled using our Pachinko method, to the July total population estimate from the MGRABASE:

$$POP_{a,s,e,ct} = (POP95_{a,s,e,ct} + POP96_{a,s,e,ct}) / 2;$$
$$POP_{a,s,e,ct} = Pachinko\ (POP_{a,s,e,ct}),\ therefore$$
$$MGRABASEPOP_{ct} = \Sigma POP_{a,s,e,ct,}$$

where MGRABASEPOP is the total population in the July 1995 MGRABASE.

For special population census tracts, these initial estimates require no further adjustment. Additional adjustments are needed to finalize the estimates in non-special census tracts. These adjustments are described later.

PASEF sums the estimates for the special population census tracts to create special population estimates for the region. It also derives a total special population estimate for each SRA. These regional and SRA special population estimates are used in the calculation of the non-special population estimates.

$$SPOP_{a,s,e} = \Sigma POP_{a,s,e,ct=spec,}\ where\ \Sigma\ is\ the\ sum\ of\ the\ special\ population\ census\ tracts;$$
and
$$SPOP_{sra} = \Sigma MGRABASEPOP_{ct=spec,}\ where\ \Sigma\ is\ the\ sum\ of\ the\ special\ population$$
census tracts within an SRA.

Non-Special Population Estimates

Region

PASEF derives the non-special demographic characteristics population estimates for the region by subtracting the special population estimates, determined above, from the July 1995 population estimates that provide the population base used in the 2020 Regionwide Forecast (DEFMPOP), aggregated into 5-year age groups. For purposes of controlling, PASEF also creates a regional non-special population estimate by sex and ethnic group:

$$NSPOP_{a,s,e} = DEFMPOP_{a,s,e} - SPOP_{a,s,e};\ and$$
$$NSPOP_{s,e} = \Sigma NSPOP_{a,s,e,}\ where\ \Sigma\ is\ the\ sum\ across\ age\ groups.$$

SRAs

The initial non-special population estimate for an SRA is the sum of the estimates for the non-special population census tracts within the SRA. PASEF then, for the first stage of controlling, creates an estimate of the non-special population by sex and ethnicity:

$$NSPOP_{a,s,e,sra} = \Sigma POP_{a,s,e,ct=nspec};\ and$$
$$NSPOP_{s,e,sra} = \Sigma NSPOP_{a,s,e,sra,}\ where\ \Sigma\ is\ the\ sum\ across\ age\ groups.$$

A two-way iterative proportionate method and a ± 1 iterative rounding routine are used to control the non-special population demographic characteristics estimates for SRAs to the region and to the MGRABASE population estimate in the SRA. This controlling is done in 2 stages. The first stage controls the initial sex and ethnic estimate ($NSPOP_{s,e,sra}$) to the non-special total population estimate in the SRA ($NSCNTRL_{sra}$) and to the non-special population estimate by sex and ethnicity in the region ($NSPOP_{s,e}$). PASEF derives the SRA control by subtracting the total special population estimate, determined above, from the total population estimate from the MGRABASE:

$$NSCTRL_{sra} = MGRABASEPOP_{sra} - SPOP_{sra}$$

The first stage of controlling insures that the following conditions are simultaneously satisfied with no rounding error:

$NSCNTRL_{sra} = \Sigma NSPOP_{s,e,sra}$, where Σ is the sum across sex and ethnic groups; and
$NSPOP_{s,e} = \Sigma NSPOP_{s,e,sra}$, where Σ is the sum across the SRAs.

The normalized sex and ethnic estimates provide the SRA controls for the second controlling stage, which normalizes the initial non-special population age estimates. This stage, using the same method as stage 1, is done separately for each sex and ethnic group. PASEF controls the age estimates within each sex and ethnic group to the $NSPOP_{s,e,sra}$ and to the regional non-special demographic characteristics estimates ($NSPOP_{a,s,e}$). The second stage of controlling insures that the following conditions are simultaneously satisfied with no rounding error:

$NSPOP_{s,e,sra} = \Sigma NSPOP_{s,e,a,sra}$, where Σ is the sum across age groups; and
$NSPOP_{s,e,a,} = \Sigma NSPOP_{s,e,a,sra}$, where Σ is the sum across the SRAs.

Census Tracts

For census tracts classified as non-special, PASEF starts with the initial demographic characteristics estimates previously developed and, for purposes of controlling, creates a non-special population estimate by sex and ethnic group:

$$POP_{s,e,ct=nspec} = POP_{a,s,e,\ ct=nspec},\ \text{where } \Sigma \text{ is the sum over the age groups.}$$

PASEF uses the same 2-stage controlling process described for the SRAs, using the non-special estimates for the SRAs and the total population from the MGRABASE as controls.

The first controlling stage controls the initial sex and ethnic estimates ($POP_{s,e,ct=nspec}$) to the total population estimate in the census tract ($MGRABASEPOP_{ct=nspec}$) and to the non-special population estimate by sex and ethnicity for the parent SRA ($NSPOP_{s,e,sra}$). The first stage of controlling insures that the following conditions are simultaneously satisfied with no rounding error:

$MGRABASEPOP_{ct=nspec} = \Sigma POP_{s,e,ct=nspec}$, where Σ is the sum across sex and ethnic groups; and

$NSPOP_{s,e,sra} = \Sigma POP_{s,e,ct=nspec}$, where Σ is the sum across the census tracts.

The normalized sex and ethnic estimates provide the census tract controls for the second controlling stage, which computes the initial age estimates. PASEF controls the age estimates within each sex and ethnic group to the $POP_{s,e,ct=nspec}$ and to the non-special demographic characteristics estimates for the SRA ($NSPOP_{a,s,e,sra}$). The second stage of controlling insures that the following conditions are simultaneously satisfied with no rounding error:

$POP_{s,e,ct=nspec} = \Sigma POP_{s,e,a,ct=nspec}$, where Σ is the sum across age groups; and

$NSPOP_{s,e,a,sra} = \Sigma POP_{s,e,a,ct=nspec}$, where Σ is the sum across the census tracts.

MGRA Estimates

The final computation distributes the demographic characteristics estimates for census tracts to the MGRAs. This method assumes that each MGRA follows its parent census tract's demographic characteristics distribution, while adhering to the total population estimate from the MGRABASE. PASEF uses our Pachinko routine and, within each census tract, allocates to MGRAs in their ascending order according to population size. After an MGRA is processed, PASEF lowers the census tract control total (i.e., the demographic characteristics population estimates) to account for the activity allocated. PASEF recomputes the probability distribution used in Pachinko and continues the allocation process. The MGRA with the largest population (the last MGRA in sorted order) receives the unallocated remainder of the census tract's demographic characteristics population distribution, which also adds to the total population in that MGRA. As such, the sequential application of this method across MGRAs is self-controlling.

FORECASTING METHOD

PASEF develops a separate forecast for special populations, whose 1995 demographic characteristic distributions are held constant over the forecast horizon. This special population forecast uses a bottom-up approach—developing SRA and regional forecasts from the census tract forecasts. The demographic characteristics in special population census tracts are forecast by factoring the 1995 demographic characteristics to the total population forecast from the 2020 Cities/County Forecast.

For the non-special population forecast, PASEF uses a top-down approach—regional, followed by SRAs, then by census tracts, and finally by MGRAs, with the larger geographic areas serving as controls. PASEF derives the regional non-special population forecast from the 2020 Regionwide Forecast of demographic characteristics, aggregated into 5-year age groups. The crux of the subregional forecasting method for non-special populations focuses on SRAs, where PASEF uses the historical trend in demographic characteristic distributions. Forecasts for non-special population census tracts essentially assume that the demographic characteristics in each census tract change in the same direction and magnitude of their parent SRA's non-special population demographic characteristics. Finally, PASEF does the MGRA forecast with the same method it uses for the July 1995 estimates.

Special Population Forecast

For each special population census tract, the initial forecast consists of the base, or prior forecast year, demographic characteristics set. The initial forecast is controlled, using a ± 1 Pachinko method, to the total population forecast from the 2020 Cities/County Forecast MGRABASE (FMGRABASEPOP):

$$FPOP_{a,s,e,ct=spec} = POP_{a,s,e,ct=spec}$$
$$FPOP_{a,s,e,ct=spec} = Pachinko(FPOP_{a,s,e,ct=spec}), \text{ therefore}$$
$$FMGRABASEPOP_{ct=spec} = \Sigma FPOP_{a,s,e,ct=spec}.$$

PASEF sums the forecasts for the special population census tracts to create special population forecasts for SRAs and for the region. It also derives the total special population forecast in each SRA to be used in controlling.

$FSPOP_{a,s,e} = \Sigma FPOP_{a,s,e,ct=spec}$, where Σ is the sum of all special population census tracts; $FSPOP_{a,s,e,sra} = \Sigma FPOP_{a,s,e,ct=spec}$, where Σ is the sum of the special population census tracts within an SRA; and
$FSPOP_{sra} = \Sigma FSPOP_{a,s,e,sra}$, where Σ is the sum across all demographic characteristics levels.

Non-Special Population Forecast

Region

PASEF derives the non-special demographic characteristics population forecast for the region by subtracting the forecast, determined above, from the population forecast based on the 2020 Regionwide Forecast, aggregated into 5-year age groups (FDEMFPOP). For controlling, PASEF aggregates the regional forecast to sex and ethnic groups:

$FNSPOP_{a,s,e} = FDEFMPOP_{a,s,e} - FSPOP_{a,s,e}$; and
$FNSPOP_{s,e} = \Sigma FNSPOP_{a,s,e}$, where Σ is the sum across age groups.

A two step method provides the non-special population forecasts for SRAs. The first step computes the sex and ethnic composition, and the second step, the age composition within each sex and ethnic group.

The sex and ethnic composition forecast is based on the change in the sex and ethnic group shares for each SRA, which is an input (CHGSHR$_{s,e,sra}$). (The determination of these changes, which are based on historical trends, is described in chapter 3.) These 8 shares represent the forecast change, for each five year increment between 1995-2020, in the proportion of the non-special population in each sex and ethnic group. As such, they sum to zero for each SRA.

PASEF assumes that the share changes linearly over the 25-year forecast horizon and, therefore, applies the same change for each 5-year forecast interval. The forecast share, for each sex and ethnic group, is computed by adding the change in share to the base or prior forecast year share. The forecast of non-special population by sex and ethnic group is computed by applying the forecast shares to the SRA non-special total population forecast. The total non-special population is determined by subtracting the total special population, computed earlier, from the total population from the 2020 Cities/County Forecast MGRABASE:

$$SHRNSPOP_{s,e,sra} = NSPOP_{s,e,sra} / NSPOP_{sra} \text{ (base or prior forecast year shares);}$$
$$FSHRNSPOP_{s,e,sra} = SHRNSPOP_{s,e,sra} + (CHGSHR_{s,e,sra}) \text{ (forecast shares); and}$$
$$FNSPOP_{s,e,sra} = FNSCTRL_{sra} * FSHRNSPOP_{s,e,sra}; \text{ (initial forecast) where,}$$
$$FNSCTRL_{s,e,sra} = FMGRABASEPOP_{sra} - FSPOP_{sra} \text{ (non-special total population forecast).}$$

Using the controlling method described earlier, the initial sex and ethnic forecast (FNSPOP$_{s,e,sra}$) is simultaneously adjusted to the non-special total population forecast in the SRA (FNSCNTRL$_{sra}$) and to the non-special population forecast by sex and ethnicity in the region (FNSPOP$_{s,e}$). The first stage of controlling insures that the following conditions are simultaneously satisfied with no rounding error:

$$FNSCNTRL_{sra,} = \Sigma FNSPOP_{s,e,sra,} \text{ where } \Sigma \text{ is the sum across sex and ethnic groups; and}$$
$$FNSPOP_{s,e} = \Sigma FNSPOP_{s,e,sra,} \text{ where } \Sigma \text{ is the sum across the SRAs.}$$

PASEF next derives the non-special population by age within each sex and ethnic group. The initial forecast for the SRA represents the base, or prior forecast year, age composition within each sex and ethnic group; that is:

$$FNSPOP_{a,s,e,sra} = NSPOP_{a,s,e,sra}.$$

The normalized sex and ethnic forecasts are the SRA controls for the second stage, which controls the initial non-special population age forecasts. PASEF controls the age forecast within each sex and ethnic group to the FNSPOP$_{s,e,sra}$ and to the regional non-special

forecast (FNSPOP$_{a,s,e}$). The controlling is done separately for each sex and ethnic group and assumes the age composition for the non-special population in each SRA changes at the same rate and direction as the regional age composition. The second stage of controlling ensures that the following conditions are simultaneously satisfied with no rounding error:

FNSPOP$_{s,e,sra}$ = ΣFNSPOP$_{s,e,a,sra}$, where Σ is the sum across age groups; and
FNSPOP$_{s,e,a}$ = ΣFNSPOP$_{s,e,a,sra}$, where Σ is the sum across the SRAs.

Census Tracts

A two step method provides the forecasts for non-special population census tracts. The first step computes the sex and ethnic composition, and the second step, the age composition within each sex and ethnic group.

For census tracts classified as non-special, the initial forecast is the base year demographic characteristics set. For purposes of controlling, PASEF creates an initial non-special population by sex and ethnic group:

FPOP$_{a,s,e,ct=nspec}$ = POP$_{a,s,e,ct=nspec}$; and
FPOP$_{s,e,ct=nspec}$ = ΣFPOP$_{a,s,e,ct=nspec}$, where Σ is the sum across age groups.

The first stage controls the initial sex and ethnic forecast (FPOP$_{s,e,ct=nspec}$) to the population forecast in the census tract from the 2020 Cities/County Forecast MGRABASE (FMGRABASEPOP$_{ct=nspec}$) and to the non-special population forecast by sex and ethnicity for the parent SRA (FNSPOP$_{s,e,sra}$).

The first stage of controlling insures that the following conditions are simultaneously satisfied with no rounding error:

FMGRABASEPOP$_{ct=nspec}$, = ΣFPOP$_{s,e,ct=nspec}$, where Σ is the sum across sex and ethnic groups; and
FNSPOP$_{s,e,sra}$ = ΣFPOP$_{s,e,ct=nspec}$, where Σ is the sum across the census tracts.

The sex and ethnic calculations provide the census tract controls for the second stage, which controls the initial age forecast. PASEF controls the age forecast within each sex and ethnic group to the FPOP$_{s,e,ct=nspec}$ and to the non-special demographic characteristics forecast for the SRA (FNSPOP$_{a,s,e,sra}$). The second stage of controlling insures that the following conditions are simultaneously satisfied with no rounding error:

FPOP$_{s,e,ct=nspec}$ = ΣFPOP$_{s,e,a,ct=nspec}$, where Σ is the sum across age groups; and
FNSPOP$_{s,e,a,sra}$ = ΣFPOP$_{s,e,a,ct=nspec}$, where Σ is the sum across the census tracts.

MGRA Forecast

PASEF then distributes the demographic characteristics forecasts for census tracts to the MGRAs. This method assumes each MGRA follows its parent census tract's demographic characteristics distribution, while adhering to the total population forecast in the MGRA from 2020 Cities/County Forecast MGRABASE. This method uses our Pachinko routine and, within each census tract, allocates to MGRAs in their ascending order according to population size. After an MGRA is processed, PASEF lowers the census tract control total (i.e., the demographic characteristics population forecast) to account for the activity allocated. It recomputes the probability distribution used in our Pachinko routine and continues the allocation process. The MGRA with the largest population (the last MGRA in sorted order) receives the unallocated remainder of the census tract's demographic characteristics distribution, which also adds to the total population in that MGRA. As such, the sequential application of this method across MGRAs is self-normalizing.

VERIFICATION

The outline below specifies the checks used to verify that PASEF was working properly.

I. All inputs read and outputs written correctly

II. 1995 special pop estimates (census tract (CT), SRA, Region)

    A. Special pop CTs properly identified
    B. Initial CT estimates >=Jan 95 total pop and =<Jan96 total pop
    C. Initial CT estimates >= 0
    D. Sum of final CT estimates = total pop (from July 95 MGRABASE)
    E. IOD of initial CT and final CT estimates close to zero
    F. SRA and region estimates = sum of the final CT estimates
    G. SRA total special pop computed correctly

III. 1995 Non-Special Pop estimates (CT, SRA, region)

    A. Region
        1. DEFM estimates collapsed into appropriate age categories
        2. Non-special pop = DEFM - special pop (from II.F)
        3. Non-special pop by sex and ethnicity computed correctly

    B. SRA
        1. Initial estimates >=Jan 95 total pop and =<Jan96 estimates
        2. Non-special pop = initial estimates – special pop (from II.F)
        3. Non-special pop >= 0, report on any negatives set to zero
        4. Non-special pop by sex and ethnicity computed correctly
        5. Sex and ethnic estimates controlling
            a) SRA control = total pop (from July 95 MGRABASE) – special total pop (from II.G)

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b) Sum of sex and ethnic estimates for each SRA = SRA control (from III.B.5.a)

c) Sum of sex and ethnic estimates across SRAs = regional controls (from III.A.3)

d) Check reasonableness of controlled sex and ethnic estimates

6. Age estimates controlling

a) Sum of age estimates for each SRA = SRA controls for each sex and ethnic group (from III.B.5)

b) Sum of age estimates across SRAs = regional controls by age for each sex and ethnic group (from III.A.2)

c) Check reasonableness of age, sex, ethnic estimates

7. Sum of special + non-special estimates by age, sex, and ethnicity across SRAs = DEFM estimates (from III.A.1)

8. Check 1995 intermediate output file of SRA non-special population estimates

C. Census Tract

1. Non-special pop tract properly identified
2. Initial estimates >=Jan 95 total pop and =<Jan96 estimates
3. Pop by sex and ethnicity computed correctly
4. Sex and ethnic estimates controlling

a) Tract control = total pop (from July 95 MGRABASE)

b) Sum of sex and ethnic estimates for each CT = CT control (from III.C.4.a)

c) Sum of sex and ethnic estimates across CTs = SRA controls (from III.B.5)

d) Check reasonableness of controlled sex and ethnic estimates

5. Age estimates controlling

a) Sum of age estimates for each CT = CT controls for each sex and ethnic group (from III.C.4)

b) Sum of age estimates across CTs = SRA controls by age for each sex and ethnic group (from III.B.6)

c) Check reasonableness of age, sex, ethnic estimates

6. Sum of age, sex, ethnic estimates across CTs = DEFM estimates (from III.A.1)

IV. 1995 MGRA ESTIMATES

A. Estimates >=0
B. Sum of age, sex, ethnic estimates for each MGRA = total pop (from July 95 MGRABASE)
C. Sum of age estimates across MGRAs = CT controls by age for each sex and ethnic group (from II.A-E and III.C.5)

V. Special Population Forecast (CT, SRA, Region)

    A. Special pop CTs properly identified
    B. Initial CT forecasts = base year pop by age, sex and ethnicity (from MGRABASE)
    C. Sum of final CT forecasts = total pop (from MGRABASE)
    D. IOD of initial CT and final CT forecasts close to zero
    E. SRA and region forecasts = sum of the final CT forecasts
    F. SRA total special pop forecasts computed correctly

VI. Non-Special Pop Forecast (CT, SRA, region)

    A. Regional
        1. DEFM forecast collapsed into appropriate age categories
        2. Non-special pop = DEFM - special pop (from V.F)
        3. Non-special pop by sex and ethnicity computed correctly

    B. SRA
        1. Base year shares by sex and ethnicity computed correctly from intermediate file and sum to 1.0 for each SRA
        2. Forecasted shares by sex and ethnicity computed properly and are >=0 and sum to 1.0 for each SRA
        3. SRA control = total pop (from MGRABASE) – special total pop (from V.G)
        4. Initial forecasts by sex and ethnicity computed properly
        5. Sex and ethnic forecast controlling
            a) Sum of sex and ethnic forecasts for each SRA = SRA control (from VI.B.3)
            b) Sum of sex and ethnic forecasts across SRAs = regional controls (from VI.A.3)
            c) Check reasonableness of controlled sex and ethnic forecasts

        6. Age forecast controlling
            a) Initial forecasts = age, sex, ethnic population from intermediate file
            b) Sum of age forecast for each SRA = SRA controls for each sex and ethnic group (from VI.B.5)
            c) Sum of age forecasts across SRAs = regional controls by age for each sex and ethnic group (from VI.A.2)
            d) Check reasonableness of age, sex, ethnic forecasts

        7. Sum of special + non-special forecasts by age, sex, and ethnicity across SRAs = DEFM estimates (from VI.A.1)
        8. Check intermediate output file of SRA non-special forecasts

    C. Census Tract

        1. Non-special pop tract properly identified
        2. Initial forecasts = base year forecasts or 1995 estimates (from MGRABASE)

3. Pop by sex and ethnicity computed correctly
4. Sex and ethnic forecast controlling
   a) Tract control = total pop (from MGRABASE)
   b) Sum of sex and ethnic forecast for each CT = CT control (from V1.C.4.a)
   c) Sum of sex and ethnic forecasts across CTs = SRA controls (from VI.B.5)
   d) Check reasonableness of controlled sex and ethnic forecasts

5. Age forecast controlling
   a) Sum of age forecast for each CT = CT controls for each sex and ethnic group (from VI.C.4)
   b) Sum of age forecasts across CTs = SRA controls by age for each sex and ethnic group (from VI.B.6)
   c) Check reasonableness of age, sex, ethnic forecasts

6. Sum of age, sex, ethnic forecasts across CTs = DEFM forecasts (from VI.A.1)

VII. MGRA FORECASTS

A. Forecasts >=0
B. Sum of age, sex, ethnic forecast for each MGRA= total pop (from MGRABASE)
C. Sum of age forecasts across MGRAs = CT controls by age for each sex and ethnic group (from V.A-E and VI.C.5)

Chapter 3

DATABASE DESCRIPTION

This chapter provides a detailed description of the database used in PASEF. PASEF, a component of the Demographic Characteristics Program, is maintained on SANDAG's UNIX network. The main directory is */box4/udm/mod/db/aset/forecasts*. All files that are identified in this document as "Ingres tables" reside in the *sr9* Ingres database (consult the SANDAG Configuration Management Plan or the Ingres documentation for a description of databases). Microsoft Excel workbooks used to calculate some of the input parameters and to create reports reside on SANDAG's Novell network in the common directory *m:\res\pasef*.

The description of the database generally follows the chronology used in the development and execution of the forecasting program. Not all of the tables in sr9 that are a part of PASEF are described in the narrative, but descriptions of each table and definitions of all variables are included in the Ingres Tables paragraph.

DATABASE DESCRIPTION

January and July Population Estimates

The development of the July 1 MGRA estimates by age, sex, and ethnicity involved several sets of estimates. MGRA and census tract total population estimates are produced annually for January 1 and come from the POPEST system. They are based on the housing unit method. For the region, the regionwide forecasting model (Demographic and Economic Forecasting Model - DEFM) contains a cohort-component model that produces annual July 1 estimates by single year of age, sex, and ethnicity. Finally, the preparation of the 2020 Cities/County Forecast required total population estimates by MGRA for July 1995 that were also developed from January MGRA estimates.

Population Forecast

The 2020 Regionwide Forecast provides the regional population control totals by age, sex, and ethnic group. This forecast is based on the DEFM model that incorporates future expectations of birth and death rates and ties domestic migration to future changes in the region's economy. The forecast of international migrants is a mostly a function of U.S.

immigration policy and historical trends of international migration into the San Diego region.

The total population controls for all subregional levels of geography come from the 2020 Cities/County Forecast. This forecast is based on spatial interaction land use models that rely heavily on local land use policies and their interrelationships with the region's transportation network.

Forecast of the Change in the Shares of the Non-Special Population by Sex and Ethnicity for SRAs

The forecast of non-special population for SRAs relies on an external projection of the change in the shares or population by sex and ethnic group. These shares represent the proportion of the population change in each sex and ethnic group and, therefore, sum to zero for each SRA.

These share changes were developed in two steps—step 1 produces changes by ethnic group; and step 2 produces changes by sex within each ethnic group. The computations for this forecast are in a spreadsheet *sra_share_change.xls* located on *m:\res\pasef*.

For step 1, PASEF assumes that the share change for each ethnic group between 1995 and 2020 is the same as it was between 1980 and 1998. The historical change in share is based on information from the 1980 census and SANDAG's latest detailed demographic characteristic estimates. In both years, the population in special population census tracts within each SRA was removed to create the non-special population information.

An initial 2020 forecast of the non-special population share by ethnic group was prepared by adding the 1995-2020 change in share to the 1996 share. Adjustments were made to these shares in 3 SRAs where the forecast seemed unreasonable. The non-Hispanic white share was negative in SRA 4. It was set to a threshold minimum of 5 percent and the shares in the other three ethnic groups were adjusted down proportionately. SRA 5 showed an extreme increase in the minority share of 23 percentage points, which was capped at 20 percentage points and raised the non-Hispanic White share to compensate. The ethnic shares in SRA 20 were held constant at 1995 levels. The historical data for this SRA showed a significant drop in the share of non-Hispanic Whites, which was not likely to continue given the large developments planned for eastern Chula Vista and Otay Ranch.

To create share changes that would be consistent with the 2020 Regional Growth Forecast, an initial 2020 non-special population forecast by ethnic group was developed for each SRA. The adjusted shares for 2020 were multiplied by the non-special total population from the 2020 Cities/County Forecast. This SRA non-special population forecast by ethnicity, however, did not match the 2020 regional forecast. So, iterative proportionate adjustment methods were used to control the non-special population forecast to both the SRA total non-special population forecast and the regional forecast by ethnicity.

A new set of shares for each ethnic group in 2020 was computed from this controlled forecast. Step 2 splits these new shares into males and females assuming that the 1996 population distribution between the sexes, for each ethnic group, does not change. Subtracting the 1995 shares from the 2020 shares yields changes for the 25 year period, which are divided by five to create changes for each five year increment, the inputs to PASEF by sex and ethnicity.

INGRES TABLES

Note: All tables reside in the *sr9* Ingres database. "Type" refers to database storage type according to the following:

Type	Description
integer1	1 - Byte Integer
smallint	2 - Byte Integer
integer	4 - Byte Integer
float4	4 - Byte Floating Point (Decimal)
float8	8 - Byte Floating Point (Double precision)
char(N)	Fixed-Length Character String (N Bytes)
varchar(N)	Variable-Length Character String (Maximum N Bytes)

TABLE:	*dfcst_sra_chgshr*	
DESCRIPTION:	Input table. Change in the non-special population share, for each five-year increment between 1995-2020, of each ethnic and sex group by SRA.	
SOURCE:	Derived.	
NOTES:		

Column	Type	Values
sra	integer1	SRA id
hispm	float4	Hispanic Male Share
hispf	float4	Hispanic Female Share
nhwm	float4	Non-Hispanic White Male Share
nhwf	float4	Non-Hispanic White Female Share
nhbm	float4	Non-Hispanic Black Male Share
nhbf	float4	Non-Hispanic Black Female Share
nham	float4	Non-Hispanic Asian and Other Male Share
nhaf	float4	Non-Hispanic Asian and Other Female Share

TABLE: *dfcst_XX*

DESCRIPTION: Census Tract population by ethnicity, sex and age; year XX.

SOURCE: Output from PASEF

NOTES: Special population and non-special population are mutually
                    exclusive.

Column	Type	Values
ct_90	smallint	Census Tract Number
sra	integer1	Sub-regional Area Number
ethnicity	integer1	1: Hispanic; 2: Non Hispanic White; 3: Non Hispanic Black; 4: Non Hispanic Asian & Other
sex	integer1	1: Male; 2: Female
age	integer1	0: 0 to 4; 1: 5 to 9; 2: 10 to 14; 3: 15 to 19; 4: 20 to 24; 5: 25 to 29; 6: 30 to 34; 7: 35 to 39; 8: 40 to 44; 9: 45 to 49; 10: 50 to 54; 11: 55 to 59; 12: 60 to 64; 13: 65 to 69; 14: 70 to 74; 15: 75 to 79; 16: 80 to 84; 17: 85+
pop	integer	Population
spop	integer	Special Population
nspop	integer	Non-special Population

TABLE:	*dfcst_XX_sra*	
DESCRIPTION:	SRA population by ethnicity, sex and age; year XX.	
SOURCE:	Output from PASEF	
NOTES:		

Column	Type	Values
sra	integer1	Sub-regional Area Number
ethnicity	integer1	1: Hispanic; 2: Non Hispanic White; 3: Non Hispanic Black; 4: Non Hispanic Asian & Other
sex	integer1	1: Male; 2: Female
age	integer1	0: 0 to 4; 1: 5 to 9; 2: 10 to 14; 3: 15 to 19; 4: 20 to 24; 5: 25 to 29; 6: 30 to 34; 7: 35 to 39; 8: 40 to 44; 9: 45 to 49; 10: 50 to 54; 11: 55 to 59; 12: 60 to 64; 13: 65 to 69; 14: 70 to 74; 15: 75 to 79; 16: 80 to 84; 17: 85+
pop	integer	Population
spop	integer	Special Population
nspop	integer	Non-special Population

TABLE: *dfcst_XX_mgra*

DESCRIPTION: MGRA population data by ethnicity, sex and age (Normalized); year
                  XX

SOURCE: PASEF output

NOTES:

Column	Type	Values
mgra	smallint	MGRA Number
ethnicity	integer1	1: Hispanic; 2: Non Hispanic White; 3: Non Hispanic Black; 4: Non Hispanic Asian & Other
sex	integer1	1: Male; 2: Female
age	integer1	0: 0 to 4; 1: 5 to 9; 2: 10 to 14; 3: 15 to 19; 4: 20 to 24; 5: 25 to 29; 6: 30 to 34; 7: 35 to 39; 8: 40 to 44; 9: 45 to 49; 10: 50 to 54; 11: 55 to 59; 12: 60 to 64; 13: 65 to 69; 14: 70 to 74; 15: 75 to 79; 16: 80 to 84; 17: 85+
pop	integer	Population

TABLE:	*dfcst_XX_tab*	
DESCRIPTION:	MGRA population data by ethnicity, sex and age (Tabular); year XX	
SOURCE:	Output from PASEF	
NOTES:		

Column	Type	Values
mgra	integer1	MGRA number
ethnicity	integer1	1: Hispanic; 2: Non Hispanic White; 3: Non Hispanic Black; 4: Non Hispanic Asian & Other
sex	integer1	1: Male; 2: Female
a0	integer	Population in Age Group 0 - 4
a1	integer	Population in Age Group 5 - 9
a2	integer	Population in Age Group 10 - 14
a3	integer	Population in Age Group 15 - 19
a4	integer	Population in Age Group 20 - 24
a5	integer	Population in Age Group 25 - 29
a6	integer	Population in Age Group 30 - 34
a7	integer	Population in Age Group 35 - 39
a8	integer	Population in Age Group 40 - 44
a9	integer	Population in Age Group 45 - 49
a10	integer	Population in Age Group 50 - 54
a11	integer	Population in Age Group 55 - 59
a12	integer	Population in Age Group 60 - 64
a13	integer	Population in Age Group 65 - 69
a14	integer	Population in Age Group 70 - 74
a15	integer	Population in Age Group 75 - 79
a16	integer	Population in Age Group 80 - 84
a17	integer	Population in Age Group 85+
tot	integer	Total Population

TABLE: *pop_defm*

DESCRIPTION: Regional Control Population

SOURCE: DEFM

NOTES: DEFM Single-Year-of-Age Population Aggregated to 5-Year Groups

Column	Type	Values
year	integer1	Year Id in the Form 95, 00, 05 and so on
age	integer1	0: 0 to 4; 1: 5 to 9; 2: 10 to 14; 3: 15 to 19;
		4: 20 to 24; 5: 25 to 29; 6: 30 to 34; 7: 35 to 39;
		8: 40 to 44; 9: 45 to 49; 10: 50 to 54;
		11: 55 to 59; 12: 60 to 64; 13: 65 to 69;
		14: 70 to 74; 15: 75 to 79; 16: 80 to 84; 17: 85+
hispm	integer	Hispanic Male Population
hispf	integer	Hispanic Female Population
nhwm	integer	Non-Hispanic White Male Population
nhwf	integer	Non-Hispanic White Female Population
nhbm	integer	Non-Hispanic Black Male Population
nhbf	integer	Non-Hispanic Black Female Population
nham	integer	Non-Hispanic Asian and Other Male Population
nhaf	integer	Non-Hispanic Asian and Other Female Population

TABLE: *pop_95_average*

DESCRIPTION: Average of detailed 1995 and 1996 population by characteristic.

SOURCE: Derived from research.pop_95_base and research.pop_96_base data.

NOTES: Derived from tables in research database and replicated in sr9.

Column	Type	Values
sra	integer1	SRA Number
ct_90	smallint	Census Tract Number
ethnicity	integer1	1: Hispanic; 2: Non Hispanic White; 3: Non Hispanic Black; 4: Non Hispanic Asian & Other
sex	integer1	1: Male; 2: Female
age	integer1	0: 0 to 4; 1: 5 to 9; 2: 10 to 14; 3: 15 to 19; 4: 20 to 24; 5: 25 to 29; 6: 30 to 34; 7: 35 to 39; 8: 40 to 44; 9: 45 to 49; 10: 50 to 54; 11: 55 to 59; 12: 60 to 64; 13: 65 to 69; 14: 70 to 74; 15: 75 to 79; 16: 80 to 84; 17: 85+
pop	integer	Population

TABLE:	*xref_mgra_sr9*
DESCRIPTION:	Master Series 9 Cross-Reference
SOURCE:	SANDAG
NOTES:	See 2020 Cities/County Forecast, Database Description, Volume 3 for a description of this table.

TABLE:	*mgrabase_XX_7*
DESCRIPTION:	MGRABASE for Year XX; CT and MGRA population controls.
SOURCE:	UDM Output
NOTES:	See 2020 Cities/County Forecast, Database Description, Volume 3 for a description of this table.

Chapter 4

PROGRAMMER'S REFERENCE

INTRODUCTION

This chapter provides general programming information for the PASEF demographic characteristics forecasting program including a description of source files, data, and utilities. The discussion covers the current program organization and operation, and provides general detail to assist in making changes to source code to prepare an executable program. Additional technical information describing the various relationships and equations is available in Chapter 2 of this document. Detailed program documentation is provided in each source file as described below. Furthermore, much of what is discussed here may be described in more detail in Chapter 3, Database Description, which contains the detailed database formats and organization for the input and output data discussed in each section.

NOMENCLATURE

In general, a file or table name is descriptive and its extension, if applicable, identifies its purpose. The UNIX environment, including Ingres, is case sensitive. Most program or file (also table) names are in lower case, may be up to 32 characters, and may use the underscore character ("_") or the dot character (".") in the name or extension. Generally, the "." character is used to separate a file name and extension. Ingres tables have no extension, but may make use of the underscore character. Ingres table names cannot contain the dot character. The following nomenclature is used to help identify the assorted programs, tables, files and scripts used in PASEF (the <> symbols represent a name or parameter and are not typed:

- *<file_name>.sc* : identifies C source files that may contain embedded SQL calls. These are processed by the Ingres C preprocessor into C source files.
- *<file_name>.c* : identifies C source files, either as edited or as output from the Ingres C preprocessor.
- *<file_name>.o* : object files created by the C compiler.
- *< file_name>* : executable programs, output files and other data.
- *< file_name>*.build, *<file_name>*.load : SQL scripts
- *<table_name>_xx*, *<file_name>_xx* : xx identifies a year in the form (90,95, and so on).
- *<argument_name>* or *<flag_name>* : identifies a runtime argument, parameter or flag.

In the paragraphs that follow, the appropriate directory path is identified. Unless stated otherwise, files are assumed to reside in the listed directory. Where more than one directory is discussed, the symbol "~" signifies the parent directory path for the UNIX components of the system: */box4/udm/mod/db/aset/forecasts*. Path and file names are listed in *italics*. Any PC-based utilities or applications are identified with the complete path. Any files, utilities, or programs that don't conform to the general naming conventions will be identified as necessary.

ENVIRONMENT

PASEF is maintained on SANDAG's UNIX network. The main directory is */box4/udm/mod/db/aset/forecasts*. All of the PASEF data are maintained in the Ingres relational database management system. The database for PASEF is *sr9*. Table 4-1 summarizes the organization of the PASEF development and operational software and data.

Table 4-1
PASEF Software and Data Organization

| Label	System (location)	Description
/box4/udm/mod/db/aset/ forecasts	UNIX Network	Primary PASEF working directory
/box4/udm/mod/db/aset/ forecasts/code	UNIX Network	PASEF program development directory
/box4/udm/mod/db/aset/ forecasts/data	UNIX Network	PASEF data directory
/box4/udm/mod/db/aset/ forecasts/scripts	UNIX Network	PASEF SQL table maintenance scripts
sr9	UNIX Network - Ingres RDBMS	Principal PASEF Ingres database

INPUT AND OUTPUT

PASEF is the main program. Its flow of information is illustrated in Figure 4-1. PASEF is run from, and all ASCII output is directed to */box4/udm/mod/dbaset/forecasts/ops*. All input for and output from PASEF are Ingres tables as identified in Table 4-2. Each table is described in Chapter 3, Database Description.

Table 4-2
PASEF Input and Output

| Table	Description
pop_95_average	Input - July 1995 pop averaged from 1995 and 1996 tables.
pop_defm	Input - 2020 Forecast control population by age, sex and ethnicity.
dfcst_sra_chgshr	Input – changes in SRA ethnicity, sex shares
xref_mgra_sr9	Input - Master MGRA cross-reference table.
mgrabase_XX_7	Input - MGRABASE pop controls.
dfcst_XX_sra	Output table base year XX- SRA level pop data.
dfcst_XX_mgra	Output table base year XX- MGRA level pop data (normalized).
dfcst_XX_tab	Output base year XX- MGRA level pop data, tabular format.
dfcst_XX	Output - CT level pop data, year XX. Also input for base year XY.

Figure 4-1
PASEF
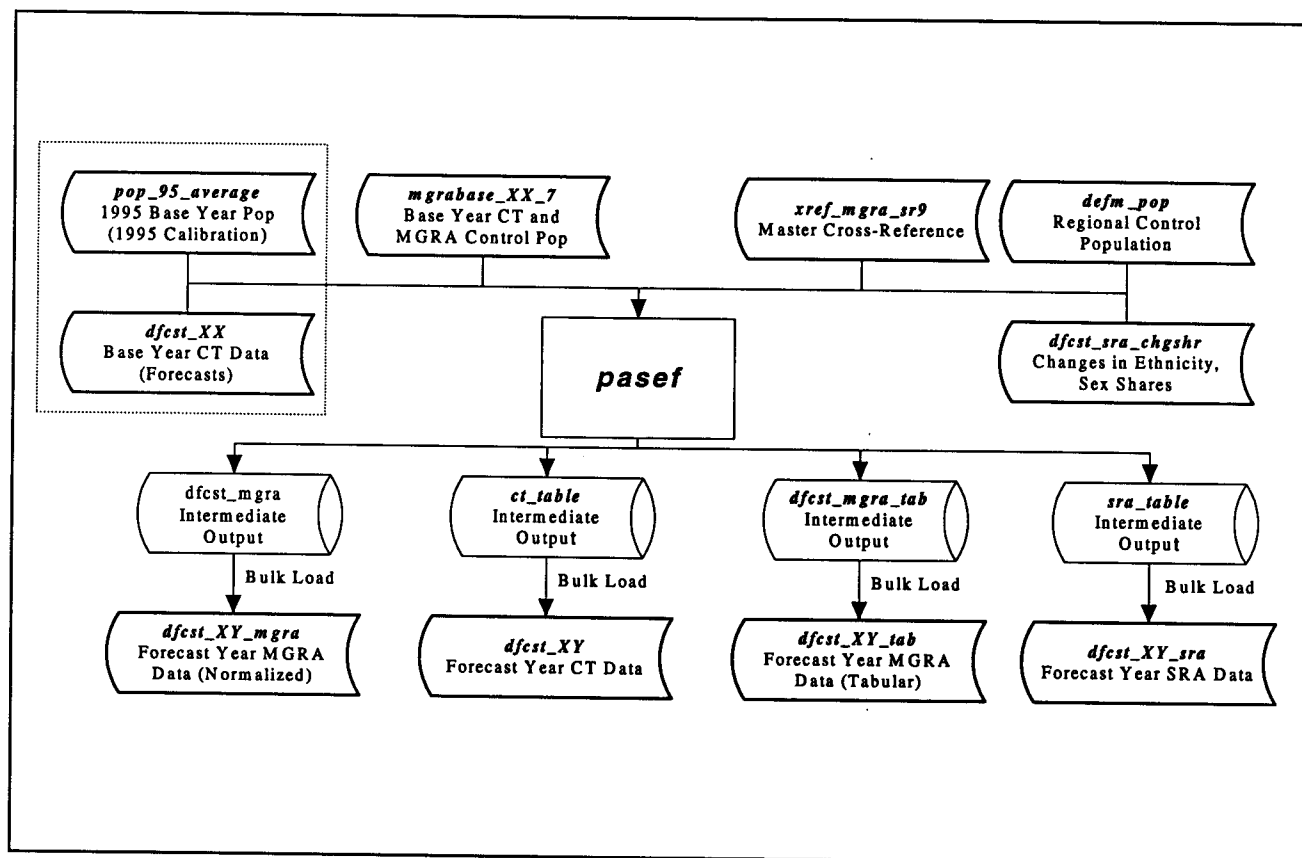
Where XX = base year (95,00,ect.); XY = forecast year (00,05,etc)

LEGEND

Directory : ~/aset/forecasts/code
Database : sr9

Ingres Table

ASCII

Process or Program
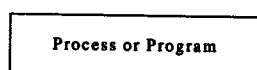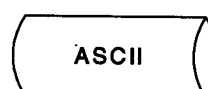
FILE : E:\active_projects\aset\dfcst\dfcst.vsd

PROGRAMMING

The forecast routines are written in UNIX C. Data originating in or being sent to Ingres tables are managed in a variety of ways. Programatically, access to Ingres tables is provided through Structured Query Language (SQL) calls that are embedded in the host language. Some utilities for constructing or analyzing data tables are written as SQL scripts that are processed by the Ingres Terminal Monitor. Output programs or report routines may be C programs, SQL scripts or Microsoft Excel spreadsheet applications.

Executable programs are constructed from a UNIX make file that usually performs three distinct steps. First, source code that contains embedded SQL calls to Ingres are examined by calls to the Ingres C preprocessor. The preprocessor produces C source files as output. C source files are compiled by the UNIX C compiler. The output from the compiler is an object file. Object files are linked, with appropriate libraries, into an executable program. Consult the UNIX Make documentation for details.

All development files are located in ~/*code*. PASEF is a C program with several source files. Table 4-3 summarizes the PASEF file organization.

Table 4-3
PASEF File Organization

File	Description
dfcst.h	Include file - contains system include files, define statements, procedure declarations, and structure type declarations.
dfcst.sc	Source file - contains main program, SQL preprocessor instructions and most of the embedded SQL procedures.
dfcst_utils.c	Source file - contains most program operations not dealing directly with SQL calls.
dfcst_ct.c	Census tract forecast routines.
dfcst_sra.c	SRA forecast routines.
dfcst_mgra.c	MGRA forecast routines.
dfcst_update.c	Source file – update controlling routines.
makefile	UNIX make file – pre-compiler, compiler and linking commands.
pasef	Executable program

EXECUTION

PASEF is run from the UNIX prompt, directory ~/*ops*, and has one runtime parameter. The command line usage is:

> *pasef <forecast_year>* <(Remember, UNIX **is case-sensitive**)
> Where forecast_year = the forecast year in the form 00,05,10,15 or 20.