GEORGE R. ARIYOSHI
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November 28, 1977

MEMORANDUM

TO: Umeo Hashiro
Planner
Master Plan Office
Department of Social Services & Housing

FROM: W. R. Arbeit
Administrator
Research & Statistical Analysis Section
Office of Correctional Information & Statistics

SUBJECT: WHY INMATE POPULATION PROJECTIONS CHANGE A#78-14

The purpose of this memorandum is to clear up confusion about why our inmate population projections have changed occasionally and why we use different statistical models to project the inmate population. Specifically, it is intended to answer questions raised about why our projections of the adult felon population, excluding felons who are incarcerated in Community Correctional facilities, have recently changed from those in the past.

I. GENERAL BACKGROUND

Projecting inmate populations, as in any attempt at predicting the future, is imprecise and risky. Innumerable factors -- or, to use a statistical term, variables -- affect the outcome of what the future will be at any given time. The best we can do is make an educated guess about what is going to happen. In statistics, there are mathematical methods of making educated guesses, and these educated guesses are called projections.

Projections are based on one to any number of factors, or variables, that can affect the future. In real life, the number of variables are endless. All the statistician can do is select the variables he feels are most important in affecting the future, then use one of the many mathematical methods available to "predict" what will happen.

In any on-going operation of making projections, such as ours, the statistician can use only the information he has available to him and choose the mathematical method that works best.

At the OCIS, we have reasonably accurate information on two variables -- time and the past inmate population. Our projections are based on the daily head count of inmates going back to July 1, 1975. We do not have as accurate information on a number of unpredictable variables that affect the inmate population. These variables can include corrections administrative or policy decisions, the state of the economy, the unemployment rate, the school dropout rate, etc. For example, the number of inmates can depend on the makeup of the judiciary and parole board, whether those agencies are "strict" or "lenient" in placing people in prison or in paroling them.

Given our limited base of information, we can only detect trends in the inmate population, based on the past inmate population, and select from a number of statistical methods to try to predict how these trends will behave in the future.

II. STATISTICAL MODELS

To project inmate populations, we use seven basic statistical models. Each is based on the two variables of time and past number of inmates.

Using these models, we can tell you, for example, that the number of male felons is increasing or decreasing and at what rate, and we can project how much the population likely will increase or decrease at any given date in the future. But we cannot tell you why the felon population is rising or falling (without further study), nor can we tell you, for example, what the effect of a new parole board chairman or a change in judiciary policies will have on the population trend.

In short, the statistical methods we use detect trends in the past inmate population and, based on these trends, project them into the future. So far, these methods have proved to be accurate in making relatively short-range projections -- that is, six months to a year into the future.

The following is a list of the statistical formulas we use. The variables are X (time) and $\hat{Y}$ (number of inmates). The other letters of the alphabet, A and B, are fixed numbers which are determined by the variables of time and past number of inmates.

Here are the formulas:

1. $\hat{Y} = \bar{X}$ ($\bar{X}$ = mean of X)
2. $\hat{Y} = A + BX$
3. $\hat{Y} = A + B/X$
4. $1/\hat{Y} = A + B/X$
5. $\hat{Y} = A + B\sqrt{X}$
6. $\hat{Y} = Ae^{(BX)}$ (e = base of natural logarithm)
7. $\hat{Y} = AX^{B}$
8. $\hat{Y} = A + B\ln X$ (lnX = natural logarithm of X)

What all these statistical formulas do is take the same data and project the current inmate population trends into the future. What we do in deciding which is the best model to use in our projections is select the one that fits best -- that is, works best. In other words, we use the one that most accurately projects the inmate population within reasonable limits. For example, some models may predict a minus population one, two or three years hence. In this case, we know the inmate population may decline, but we also know that it will not decline to zero and that it cannot possibly drop to, say, minus 23. So we would reject projections that show negative inmate populations.

There are also mathematical formulas to give you the model of best fit, but to describe them would take a long memorandum in itself. Suffice it to say that we choose the model that works best.

In practice, we almost always use Formula 1 ($\hat{Y} = \bar{X}$) or Formula 2 ($\hat{Y} = A + BX$), called linear regression, for two reasons: They are the simplest and they usually give the best fit. Generally, it is best to avoid unnecessarily complex formulas in making projections so long as the simpler ones work.

The projection methods we use differ considerably from those used in the Hawaii Correctional Master Plan. Ours are less complex, but more important, ours have proved to be much more accurate in projecting future inmate populations.

There are as many projection methods as there are statisticians, and no method is perfect. But as Hideto Kono, Director of the Department of Planning and Economic Development pointed out in a memorandum last year (see Appendix A), you must use the methods that work best under the circumstances.

III. MALE FELON POPULATION

In our quarterly reports in inmate population projections (see Appendix B), we have mostly used Formula 2. We use it because it works. So far we have been accurate in using the formula, as our monitoring of our projections shows. The linear regression model, Formula 2, so far has accurately determined trends in the inmate population and projected them with a high degree of accuracy into the future. But it must be remembered that as population trends change over time, so do the projections. That's because they are based on past trends.

The population trend for male felons has changed considerably from what it had been in the past. During the previous calendar year, the population of convicted male felons in all facilities except the CCC's had been declining steadily. But starting last January, the population trend reversed itself and started climbing again. It has been rising ever since. Why this reversal in the population trend? We don't know. That information must come from a separate study. What our data clearly does show is that since the first of the year, there has been a continuing increase in the male felon inmate population.

Because Formula 2 (in fact, all the formulas we use) projects the future inmate population based on the past population, it did not accurately reflect the most recent trend. The reason for this was that it projected the future population from the entire base -- that is, from the daily head count population going back to July 1, 1975 -- giving equal weight to all the data, whether old or recent.

What we decided to do, then, was project the population using only the <u>most recent trend</u>. So we discarded

past population figures going back beyond January of this year, the month in which the male felon population started to rise. We called this method Model B (see Appendix B).

Both Model A (which uses the entire base) and Model B use the same mathematical formula in making inmate projections. They differ only in their use of data bases: Model A uses the daily head count population going back to July 1, 1975; Model B, the daily head count population going back only to January 1, 1977.

Because of the change in the trend of the population, Model A was consistently underestimating the projected male felon population. For this reason, we decided to use Model B, and we found it to be more accurate than Model A in projecting the male felon population.

In our quarterly projection report, we showed projection figures for both Model A and Model B, allowing you to choose which projection model to use in making your decisions. Because the Model B projection proved to be more accurate, however, we recommended that you use it.

We are continuing to monitor and test our projections, and if the admission pattern for male felons starts to decline and Model B to prove faulty, we will let you know immediately. Indeed, if any of our statistical models start to fail, we will discard them for ones that work better.

It should be pointed out, however, that we receive more information -- that is, as the data base expands with the addition of new information -- the projection figures will change.

APPENDIX A:

Memo On Uniformity And Consistency

In Population Projections

GEORGE R. ARIYOSHI
Governor

HIDETO KONO
Director

FRANK SKRIVANEK
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DEPARTMENT OF PLANNING
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MEMORANDUM

May 5, 1976

TO: All Federal, State, County and Private Agencies
Using Hawaii Population Projections

FROM: Hideto Kono, Director, DPED

SUBJECT: Uniformity and Consistency in Population Projections

A recurring difficulty in Federal, State, County and Private planning work in Hawaii has been the need for uniformity and consistency, as well as validity, in the preparation and use of Hawaii population projections. Such projections are critical to sound planning.

Chapter 225-2 (b)(14), Hawaii Revised Statutes, relating to powers and duties of the Director of the DPED, states that the Director "shall cooperate with all public agencies to ensure an ongoing, uniform and valid base of data and projections" to fulfill the responsibility for the development and coordination of a State Plan.

As one response to that legislative mandate, our Department has prepared a major report, The Population of Hawaii, 1958-2025: Recent Trends and Projections. It follows earlier, similar reports. It summarizes more than 20 separate studies--public and private--of the future population of the State or the City and County of Honolulu, (or both), and offers nine new series of projections to the year 2025.

The nine series are based on three fertility assumptions, three migration assumptions, and one mortality assumption. The resulting series were compared with findings of the DPED Economic Model. This comparison indicates that the projections titled Series E-2 have been the most consistent with our economic analysis, and are probably the most satisfactory for planning purposes.

Everyone engaged in this field of work recognizes that there can be no perfection in projections. It is also recognized that a lack of uniformity in the use of projections for planning by various agencies causes considerable difficulty and confusion.

Given our legislative mandate to encourage uniformity and validity in data and projections, I request that all agencies involved in population projections use the Series E-2 to promote that uniformity.

APPENDIX B:

Hawaii Corrections Population Projections

First Quarter, Fiscal Year 1977-78

HAWAII CORRECTIONS POPULATION PROJECTIONS

FIRST QUARTER, FISCAL YEAR 1977-78

Research & Statistical Analysis Section
Office of Correctional Information & Statistics
Intake Service Center

November 14, 1977

A#-78-13

In response to the on-going need for the up-to-date estimates of future incarcerated offender population, we present here a series of quarterly reports on this topic. These latest projections are based on data through September 30,1977.

As is appropriate for examining facility capacity and related issues, these projections are based on the "head" counts (i.e. persons physically incarcerated in Hawaii correctional facilities) rather than "assigned" counts. Were assigned counts used, all the figures would have been higher, especially male felons (a significant number of whom are not physically held in our local institutions). The use of standard head counts carries other implications of which the reader should be aware. First, felons incarcerated on the mainland (a rapidly increasing group) are not considered. This exclusion causes a significant decrease in the projection figures for this group. Second, the recent implementation of the furlough programs at Hawaii State Prison again reduces the projected population. This occurs because the actual "head" count is reduced while these persons are not physically incarcerated. Third, while Kauai CCC is included for the first time in this report; the projections should be considered quite tentative because

the data base for this group is presently inadequate. Throughout this report the reader should keep in mind these factors and their implications.

The methodology used to develop these projections is essentially the same as has been used by the Office of Correctional Information and Statistics in the past. The total population (in this case, the Corrections Division adult head count) is segmented into meaningful groups, and projections are independently determined for each segment by using regression analysis. The data base used was daily population counts from July 1, 1975, to September 30, 1977 (except for Kauai, which began June 20, 1977).

Preparing valid projections of the correctional population requires understanding not only of statistics, but also of Hawaii's criminal justice system. In determining the appropriate methodology to use, the analyst must use his professional judgment, drawing on his knowledge of both statistics and the criminal justice system. In the past we have represented the Hawaii incarcerated male felon population [1] as a nongrowth population segment. This

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[1] For purposes of this report, male felons incarcerated in the Hawaii, Maui and Kauai Community Correctional Facilities are not included in this category.

conservative assessment produced low estimates of future population size. Since then, we have re-examined our interpretations and offer the following as a speculative and tentative alternative.

Recent trends both in sentencing and in the setting of minimum terms appear to differ from those in the past. The impact of such changes, if real, would have delayed effect on the felon population. And assuming that such changes represent practices that will continue in the future, the use of a data base that includes the effects of older practices is not fully warranted. In other words, instead of determining projections from as large a data base as feasible, one should use only recent data to make projections. The danger of such an approach, however, is that an apparent trend extending over a few months may not represent a "true" long-term trend.

For this reason, two projections are reported here for the non-CCC male felons. Model A uses the same methodology as all the other projections in this report, and Model B utilizes only the daily population counts for 1977. At this point, it is difficult if not impossible to choose between Models A and B; while both have merit, the truth probably lies somewhere between the two.

Two numbers are generated on each projection. One indicates the expected average population about that date. The other serves a dual purpose of estimating the probable bed capacity need and the upper limit of the expected average population.

PROJECTIONS - DECEMBER 31, 1977

	Expected Average	Expected High
Oahu - misdemeanant males	25	39
Oahu - not sentenced males	120	131
Oahu - all females	23	27
Maui CCC - all residents	13	18
Hawaii CCC - all residents	21	29
Kauai CCC - all residents	10	14
Male felons (excluding CCC's) Model A	312	326
Male felons (excluding CCC's) Model B	331	338

PROJECTIONS - JUNE 30, 1978

	Expected Average	Expected High
Oahu - misdemeanant males	25	39
Oahu - not sentenced males	130	140
Oahu - all females	25	29
Maui CCC - all residents	13	18
Hawaii CCC - all residents	22	31
Kauai CCC - all residents	15	20
Male felons (excluding CCC's) Model A	312	326
Male felons (excluding CCC's) Model B	349	356

PROJECTIONS - DECEMBER 31, 1978

	Expected Average	Expected High
Oahu - misdemeanant males	25	39
Oahu - not sentenced males	139	150
Oahu - all females	28	32
Maui CCC - all residents	13	18
Hawaii CCC - all residents	24	32
Kauai CCC - all residents	NA	NA
Male felons (excluding CCC's) Model A	312	326
Male felons (excluding CCC's) Model B	366	374

PROJECTIONS - JUNE 30, 1979

	Expected Average	Expected High
Oahu - misdemeanant males	25	39
Oahu - not sentenced males	148	159
Oahu - all females	30	34
Maui CCC - all residents	13	18
Hawaii CCC - all residents	25	34
Kauai CCC - all residents	NA	NA
Male felons (excluding CCC's) Model A	312	326
Male felons (excluding CCC's) Model B	384	392

PROJECTIONS - DECEMBER 31, 1979

	Expected Average	Expected High
Oahu - misdemeanant males	25	39
Oahu - not sentenced males	158	168
Oahu - all females	33	37
Maui CCC - all residents	13	18
Hawaii CCC - all residents	26	35
Kauai CCC - all residents	NA	NA
Male felons (excluding CCC's) Model A	312	326
Male felons (excluding CCC's) Model B	402	411

TRENDS

The growth rates derived from the data used for the projections in this report enable us to comprehend not only the long term trends but also changes in these trends. One may assume that these changes in growth rates will themselves continue in the future, in other words, there may be an underlying trend of the growth rates increasing. Where (and if) this is the case: the projections presented in this report will be underestimates

The following tables present the same growth data in two different ways. First, showing the population gain per year; and second, showing the number of days needed to increase the population by one.

POPULATION GROWTH RATES

FOR INCREASING GROUPS:

I. Average Net Number of Persons Gained Per Year:

	Data Base	
	1/1/77 - 3/31/77	1/1/77 - 9/30/77
Male felons (excluding CCC's) Model B	30	35

	Data Base	
	7/1/75 - 3/31/77	7/1/75 - 9/30/77
Oahu - not sentenced males	16	19
Oahu - all females	5	5
Hawaii CCC - all residents	3	3

POPULATION GROWTH RATES

FOR RAPIDLY INCREASING GROUPS:

II. Average Number of Days Needed to Increase the Net Population by One Person.

	Data Base 1/1/77 - 3/31/77	Data Base 1/1/77 - 9/30/77
Male felons (excluding CCC's) Model B	12	10

	Data Base 7/1/75 - 3/31/77	Data Base 7/1/75 - 9/30/77
Oahu - not senteced males	23	20
Oahu - all females	71	77
Hawaii CCC - all residents	125	125

Clearly, the male felon population (excluding the CCC's) is the most rapidly growing group. The rate of increase also accelerates when the last two quarters are considered. Note, however, that this holds only for projection Model B. While the reader is free to choose between the two models, the weight of evidence is clearly in favor of Model B.

The Oahu not sentenced males continues to be a problem and this problem is growing worse. Because the group is so heterogeneously defined -- it is a catch all term for all persons who cannot be clearly labled as felons or misdemeanants -- the provenience of the increase is extremely difficult to determine.

The Oahu female group while still growing rapidly, has evidenced some slow down, and this is a hopeful sign.

Hawaii CCC continues its slow growth rate. While the rate of increase is relatively low, the planned facilities will be incapable of handling the increase.

PROJECTION VALIDATION

In order to test the adequacy and validity of these projections, a special data base was constructed. This consisted of all the population daily counts up to March 31, 1977. Using the identical methodology as above, projections were made to September 30, 1977. In this way we could compare, on a post hoc basis, projections with actual population figures.

The following table compares our projections with the average head count for September and October, 1977.

PROJECTIONS - SEPTEMBER 30, 1977

	Projection	Actual Average of Sept & Oct	Difference
Oahu - misdemeanant males	26	20	-6
Oahu - not sentenced males	111	116	+5
Oahu - all females	22	18	-4
Maui CCC - all residents	14	13	-1
Hawaii CCC - all residents	20	19	-1
Male felons (excluding CCC's) Model A	312	326	+14
Male felons (excluding CCC's) Model B	320		+6
Total Using Model A	505	512	
Total Using Model B	513	512	

Again, as in past reports, the accuracy of the OCIS projection methods stand up to the harsh light of reality. Whether this will remain so is a question that can be answered only by continuing to monitor the actual population counts.

The issue of the most appropriate model for projecting the male felon population appears to have received at least a tentative answer. Model B predicted within acceptable limits, while the projection for Model A was "out of control". (The phrase "out of control" in the context of projections refers to a projection model which is unable to produce accurate predictions.) Normally a model producing out of control projections is dropped entirely from consideration, but we will continue to use it for comparison purposes only.

END