

RESULTS OF THE 1988 DRESS REHEARSAL POST ENUMERATION SURVEY

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1.0 Introduction

The Dress Rehearsal Post Enumeration Survey (PES) served two purposes. It was both a dress rehearsal of the 1990 PES and an evaluation of the Dress Rehearsal Census. The 1988 Dress Rehearsal Census was conducted in St. Louis City, counties in East Central Missouri, and counties in Eastern Washington State. The 1988 PES consisted of two samples. The first was a population or P-sample, which consisted of all people living in the PES sample blocks at the time of the PES interview. The other sample was the enumeration or E-sample, which consisted of all enumerations assigned to the PES sample blocks by the census process.

The PES was designed to be a block sample with an overlapping P-sample and E-sample. The P-sample measures undercoverage and the E-sample measures overcoverage. The addresses for the housing units in the sample blocks were listed and large blocks were subsampled. The PES interviewer collected names, characteristics, and census day addresses for all residents in sample households at the time of the PES interview. Also, names and characteristics were obtained for persons moving from the sample address between census day and the date of the PES interview.

The Dress Rehearsal PES and census data were computer matched. Following the computer matching, the matching clerks performed within block matching, duplicate searching, and matching in the surrounding blocks. Reported alternate addresses for the movers were coded to census geography (i.e., geocoded) and persons were searched in the census at their reported census day address.

Selected cases were sent to the field for a follow-up interview and the results were recorded on the match forms. When new census day addresses were obtained for PES persons during the follow-up interview, these persons were searched at the new census day address. The final result was to classify each P-sample person as counted or missed in the census counts. Each E-sample person, in turn, was classified as correctly or erroneously enumerated in the census.

The PES methodology is described in detail in the paper by Childers and Hogan (1990). The remainder of this paper will present the final results and assess the impact of errors in the PES process on those results.

2.0 Dual System Estimates

The Dual System Estimator has been described extensively by Marks, et. al. (1974), Wolter (1986), etc. The estimated percent undercount from the dual system estimates and the estimated standard error of the estimate are in Tables 1, 2, and 3 for the three district offices in the dress rehearsal. The estimated percent undercount is 100 times 1 minus the ratio of

the census total to the dual system estimate of the population. The post-stratification variables in Table 1 are the race/ethnic origin groups (white non-Hispanic and all other race/ethnic origin groups) and tenure (owner and non-owner). In Table 2 the post-stratification variables are type of enumeration area (TAR and non-TAR, which is prelist and update/leave) and the two race/ethnic origin groups. In Table 3 the post-stratification variables are type of enumeration area (list/enumerate and non-list/enumerate, which is TAR and prelist).

Persons in the white, non-Hispanic post-strata have been shown to have a lower percent undercount than the black and other races in previous census evaluations. This is confirmed in St. Louis. Past experience has also shown a larger percent undercount in the dual system estimates for non-owners than for owners. In St. Louis this assertion is confirmed in the post-strata for owners and non-owners within the two racial groupings in Table 1.

The estimate for the white, non-Hispanic persons in TAR areas in East Central Missouri was unexpectedly high with an undercount estimate of 8.5 percent. This may be due to a large number of college students in Columbia, Missouri.

The estimated percent undercount from the dual system estimates by age and sex for the three test sites are in Tables 4, 5, and 6.

The estimated percent undercount by race, (i.e., white, non-Hispanic and other races) and the estimated standard error of the estimate for St. Louis and Columbia are in Table 7. This table shows the differential undercount estimated by the PES.

3.0 Smoothed Estimates

In order to reduce the sampling variability, the direct post-strata estimates were smoothed. The first step was computing the direct estimates together with a full variance-covariance matrix. A regression model was fit to these data. The response variable was the adjustment factor, (i.e., the estimated true population divided by the census count for the post-strata). The explanatory variables were selected from a set of indicator variables for the post-strata, the census substitution rate for the post-strata and various interaction terms. The fitted model included a constant plus indicator variables for tenure, age 0 to 29, sex, and white non-Hispanic. (See Isaki, *et al.*, 1990).

The final adjustment factor was a combination of the direct estimate and the regression estimate. As was expected, the results were to bring in the more extreme adjustment factors. For example, the direct estimate of the adjustment factor for black (non-white non-Hispanic) males 20 to 29 years of age in St. Louis was 1.29. The smoothed factor was 1.18. The factor for white non-Hispanic females 20 to 29 years of age in Columbia was 1.14. This was reduced to 1.07, still a significant adjustment, but the percent undercount from the smoothed estimate was only half of the percent undercount from the direct estimate.

The results of the smoothing are given in Tables 8 and 9. The smoothing was not done for the Washington State test site. These smoothed factors for St. Louis and Columbia would have been used in any adjustment of the data. Research continues for the smoothed estimates of the undercount.

4.0 The E-sample

Since the dual system estimator requires estimating the number of distinct matchable persons captured in the census, a correction is made for the erroneous enumerations and enumerations with insufficient information for matching in the estimates of total population. Enumerations are classified as unresolved when an enumeration status of correct or erroneous enumeration could not be determined using the results of a follow-up interview for an E-sample nonmatch. The enumeration status is imputed for the unresolved cases.

The data in Section 4 include all of the unweighted E-sample enumerations in the dress rehearsal in housing units and in the non-institutional, non-military group quarters. Table 10 contains the number and percent of correct enumerations, erroneous enumerations, insufficient information for matching, and unresolved in the three test sites.

4.1 Erroneous Enumerations

The erroneous enumerations from the E-sample are grouped into four classes: those caused by geocoding errors, duplicate enumerations, fictitious enumerations, and enumerations of people who should not have been counted in inside the search area on census day according to census residence rules. The distribution of erroneous enumerations by test site is presented in Table 11. The percentages in parentheses are the percent of total E-sample persons. The total unweighted percent erroneous enumeration are 4.4 percent in St. Louis, 3.3 percent in Columbia, and 3.0 percent in Washington.

4.1.1 Geocoding Error

Enumerations are classified as erroneous when the housing unit enumerated within the sample block was actually located outside the search area. The rate of erroneous enumeration due to geocoding error in the dress rehearsal census was low (less than 0.3 percent) with minimal contribution to the overall erroneous enumerations.

Errors in coding to census geography falling within the search area are not classified as erroneous enumerations for the estimate of the undercount using the PES, because the P-sample matches in the surrounding blocks are classified as enumerated in the census. The PES is designed for the P-sample and the E-sample search area to balance.

4.1.2 Fictitious Persons

Census enumerations are classified as fictitious from the follow-up interview when no one in the search area has any knowledge of the person's existence. Fictitious census persons are examined by type of enumeration and by type of household. The types of enumeration are mail return, enumerator-filled, and group quarters. Mail returns are completed

by the household member and returned to the Census Bureau through the mail. The enumerator-filled census questionnaires are completed by personal interview by census enumerators. The persons enumerated in group quarters are enumerated by a special procedure for institutional and noninstitutional persons and are not included in the tabulations by mail return and enumerator filled census questionnaires.

An inspection of the percentage of fictitious persons enumerated on mail returned questionnaires can help evaluate the quality of the E-sample data. Census enumerators are more likely to fabricate persons than household members who return their completed census questionnaires through the mail. A relatively large percentage of fictitious persons enumerated on mail return questionnaires as compared to enumerator filled questionnaires is an indication of the presence of misclassification of fictitious persons.

Whole households are more likely to be fabricated than partial households. There have been instances of widowed, elderly women reporting a dead husband when an enumerator may appear threatening or an enumerator getting the name of one person from the mail box and creating a family. There may also be family pets enumerated on a mail return census questionnaire and uncooperative respondents fabricating persons in their household. However, the majority of the fabrications are whole households and many fabrications are single person households.

Table 12 contains fictitious persons by type of enumeration for the three test sites. The percentages in parentheses are the percent of total persons in the E-sample. As expected, almost all of the fictitious persons in the dress rehearsal were generated from enumerator-filled census questionnaires. Mail return questionnaires completed by the household respondent rarely contain fictitious persons. There were no fictitious census persons uncovered in the Washington district office.

The fictitious census persons were in 7 sample households in Columbia and 70 sample households in St. Louis. Table 13 contains these households by whole household fictitious and partial household fictitious. The two partial households in Columbia contain matched and fictitious persons. One household is a mail return and one is enumerator filled. The three partial households in St. Louis contain correct enumerations and fictitious persons. One household is from a mail return and two are from enumerator filled census questionnaires.

4.1.3 Census Duplicates

A census duplicate is defined as an E-sample census enumeration that is also enumerated within the search area. These census duplicates are separated into an E-sample person duplicated with another E-sample person, with a non E-sample person in the sample block, and with a census enumeration in the surrounding blocks. The E-sample census persons duplicated within the sample block are examined by age, sex, and race. Age, sex, and race do not seem to have an effect on duplication in the census, except when the data are missing. Missing characteristics

from an enumeration indicate a less than complete interview in the census. One census enumeration had complete data and the duplicate had a name, but incomplete characteristics from a less than complete interview.

The total census duplication within the search area is in Table 14. The duplication within the sample block in the E-sample is 1.6, 1.3, and 0.9 percent in St. Louis, Columbia, and Washington, respectively. The duplication between the E-sample persons and the non E-sample persons in the search area increased the percent census duplication by 0.2 percent, 0.5 percent, and 0.2 percent in St. Louis, Columbia, and Washington. Three triplicates identified in the Columbia district office are included in the duplication results in Table 14.

4.1.4 Census Residence Rules

The erroneous enumerations caused by a misapplication of the census residence rules are census persons who were enumerated in the sample block, but actually should have been counted outside the search area according to census residence rules or not counted at all, because they were born since census day or died before census day. This includes persons who moved to the address after census day. The term "other erroneous" denotes these erroneous enumerations in Table 11.

5.0 The P-sample

The P-sample is composed of all persons living in the sample blocks during the time of the PES interview. The PES interview collected information to classify each P-sample person as a nonmover or a mover. These P-sample nonmovers and movers measure undercoverage in the census. Each person is classified as matched to the census, not matched to the census, unresolved, and insufficient information for matching. The unresolved and insufficient information for matching cases are imputed with a match status. This data includes unweighted persons in housing units and persons in noninstitutional, nonmilitary group quarters.

5.1 P-sample Nonmatches For Nonmovers and Movers

Table 15 contains the percent nonmatch of total P-sample persons in St. Louis, Columbia, and Washington for movers and for nonmovers. The percent nonmatch in this table is the number of nonmatches divided by the sum of the resolved matches and nonmatches. The unresolved match statuses are assumed in this calculation to be missed at the same rate as the resolved persons. The movers who lived outside the test site on census day were deleted from these tabulations. This simple estimator allows us to study omissions in some detail. It differs from the final imputations used in the dual system estimate given earlier.

The movers are not matched at a higher rate than nonmovers. This has been previously reported in all census evaluations. More mobile persons are more likely to be missed in the census than are more stable segments of the population. They are also harder to correctly match. The movers add less than one

percent in all three test sites to the total percent not matched for all persons.

The percent of movers within the test site and total movers are in Table 16. We could only match movers within the test site for dress rehearsal, because we did not have a census outside the test sites. In 1990 we will search the mover's census day addresses given in the PES interview anywhere in the country.

The percentage of movers for Columbia and Washington are the same. The lower percent movers in St. Louis may be due to the type of area. The difference could also be in the quality of reporting the census day address in the PES interview.

5.2 P-sample Nonmovers by Type of Nonmatch

The nonmatches for nonmovers were coded by type. The code "N1" indicated a partial household nonmatch. There were other persons in the household who were matched or possibly matched to the census. The code "N2" indicated a whole household nonmatch, where the address is matched to the census. There existed a census questionnaire for the address, but other persons were enumerated at the address or the housing unit was vacant. The code "N3" indicated a whole household nonmatch where the basic address was enumerated in the census, but the PES apartment or unit was not enumerated in the census. These occur in multi-unit buildings or trailer parks. No census questionnaire was enumerated in the census for this unit. The code "N4" indicated a whole household nonmatch where the PES address was not found in the census. This was a housing unit nonmatch with all persons not matched in the census.

The code "L" indicates the nonmover was matched to a person on a census questionnaire that was rejected during census processing. This situation usually occurs when there were two census questionnaires data captured with the same census identification number. One was enumerator filled and one was a late mail return. Only one of these census questionnaires could have been accepted as the census enumeration for the household. On some occasions the PES persons matched the persons on the census questionnaire that was not accepted. Even though the PES and census persons were matched, they were considered not matched, since the census person was not considered enumerated in the census.

Persons can also be coded "L" within a household from an accepted census questionnaire. This occurs when the matched person was deleted from the census questionnaire by filling the cancellation circles. All PES persons coded "L" were considered not matched to the census.

The percent not matched by type is in Table 17 for the three sites. The percent of the nonmatches for nonmovers who were recorded on a census questionnaire, but later removed from the census counts in St. Louis, Columbia, and Washington were 3.9, 4.5, and 1.4 percent, respectively. The gross percent nonmatch could be reduced by these percents for each site, if these rejected persons had actually been enumerated. The rules for accepting questionnaires have been changed for 1990. The mail

return questionnaires have been proven to be more reliable than the enumerator filled questionnaires.

In Columbia 46.8 percent and in Washington 43.9 percent of the nonmatches were whole household nonmatches where the address was not found in the census. In St. Louis, 9.4 percent of the nonmatches were also address nonmatches. In St. Louis 40.1 percent of the nonmatches were whole household nonmatches where the address was in the census, but the persons were not enumerated. This may indicate better housing unit coverage in St. Louis than in Washington and Columbia. It may also mean that the quality of the address matching for rural areas was lacking.

The census mailing lists in St. Louis were purchased from vendors. In Columbia and Washington the address lists were purchased for the TAR areas and compiled by the Census Bureau for the remainder of the areas. The urban areas with house number and street name areas are easier to match than the more rural addresses composed of route and box numbers and some with only location descriptions.

The percentage of whole household census nonmatches where the address is not in the census (i.e., the persons coded N4) by type of enumeration area and by test site are in Table 18. This does not include the whole household nonmatches where the address is a missed unit within an enumerated multi-unit structure (i.e., the persons coded N3). For prelist and update/leave areas in Columbia, the percentage of whole household census nonmatches was high compared with the TAR areas. If the address matching portion of the person matching was done correctly, this represents a high rate of housing unit misses in the census causing the persons to be missed in the census.

This was not true for the Washington test site. There was a high rate of housing unit misses in TAR areas. This percent was unexpected in a TAR area because of the method of compiling census mailing lists in TAR areas.

5.3 P-Sample Unresolved for Nonmovers and Movers

The percent unresolved for the movers and nonmovers in each test site are in Table 19. Persons with insufficient information for matching were tabulated as unresolved.

The percent unresolved was 1.8 percent in St. Louis, 2.8 percent in Columbia, and 1.8 percent in Washington. The nonmover percent unresolved was less than one percent in all three sites. The percent unresolved for movers was 22.1 percent in St. Louis, 33.9 percent in Columbia, and 19.4 percent in Washington. These unresolved cases for movers were composed of problems in geocoding the mover addresses received within the test site and of cases geocoded, but other information such as names of the neighbors and cross streets was not confirmed during the matching.

This high unresolved rate reflects a conscious design decision. We felt it was better to leave cases unresolved than to attempt matching with poor data. Some cases might have matched. However, we could not be confident that the rest were truly not

enumerated. The persons not matched represent cases for which we are confident that the movers did not get counted at their unique census address according to census residence rules. This does not mean that a person was missed in the census. It means the movers were not enumerated where they should have been counted according to census residence rules.

6.0 Conclusion

The Dress Rehearsal PES had two goals. One was to evaluate the 1988 Dress Rehearsal Census. The other was to test the PES for 1990. Our conclusion is that it succeeded in both goals. Through its analysis, not only of the overall level of census coverage error, but also of the sources and correlates of census error, the Dress Rehearsal PES alerted census designers of potential problems for the 1990 Census. Some of these problems are correctable such as the 'L' cases or the error rate in the vacant/delete process. We must await the results of the 1990 Census to see the extent to which the problems were corrected. Other problems may be harder to correct. The PES demonstrated clearly that the problem of differential undercount, especially of adult black males, has yet to be solved.

The PES design that we tested fared well. In evaluating the accuracy of the results of the PES, we have discovered errors. The coding of "born after census" was not done correctly in the initial PES data keying, resulting in a lowered erroneous enumeration rate. One interviewer listed and interviewed the wrong block, resulting in a high nonmatch rate. The evaluation of the matching indicated that it was largely consistent and reproducible, if less than perfect. A few fictitious PES cases slipped through quality control. Ensuring accurate reporting of census day address continued to be an issue.

Still, the Census Bureau is generally pleased with the PES results and is not planning to scrap or redo major components, but to do things better. Some of the problem areas include the data entry program for the PES questionnaires, which was time consuming and troublesome. In addition, there will be some reworking of the questionnaire to include more respondent-friendly questions about alternate addresses. Shortages of microfilm readers and PES matching technicians were uncovered and were corrected for the 1990 processing. The percent of mover cases with unresolved status was high. We are re-evaluating which cases to send to follow-up. Much was learned in the smoothing process, as this was our first attempt using a full variance-covariance matrix. But, none of these are basic changes in the process.

In summary, the PES worked well as an evaluation of the Dress Rehearsal Census. In spite of errors of its own, it was able to measure and document the census coverage errors. The PES design can and will be improved, but the Bureau's choice of the PES as its basic evaluation tool seems justified.

* This paper reports the general results of research undertaken by Census Bureau Staff. The views expressed are attributable to the authors and do not necessarily reflect those of the Census Bureau. A complete version of the paper can be obtained by writing to Dr. Danny R. Childers, Statistical Support Division, Room 3209, Bldg. 4, Bureau of the Census, Washington, DC 20233.

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Table 1: Estimated Percent Undercount for St. Louis

<u>Post-Strata</u>	<u>Percent Undercount</u>	<u>Standard Error</u>
White, Non-owner, Non-Hispanic	5.9	1.9
White, Owner, Non-Hispanic	-1.2	0.9
All other Non-owner	11.4	2.4
All other Owner	8.4	1.7
Total persons	6.2	1.1

Table 2: Estimated Percent Undercount for East Central Missouri

<u>Post-Strata</u>	<u>Percent Undercount</u>	<u>Standard Error</u>
TAR, White, Non-Hispanic	8.5	4.0
Non-TAR, White Non-Hispanic	4.3	1.9
All other	10.8	4.4
Total persons	5.4	1.7

Table 3: Estimated Percent Undercount for Eastern Washington State

<u>Post-Strata</u>	<u>Percent</u>	<u>Standard Error</u>
L/E	7.3	3.2
Non-L/E	6.4	2.0
Total persons	6.8	2.0

Table 4: Estimated Percent Undercount by Age and Sex for St. Louis

<u>Age</u>	<u>Male</u>	<u>Female</u>
0-9	8.1	12.1
10-19	9.4	7.6
20-29	11.3	7.6
30-44	10.8	3.4
45-64	3.9	-1.0
65+	0.3	0.3

Table 5: Estimated Percent Undercount by Age and Sex for East Central Missouri

<u>Age</u>	<u>Male</u>	<u>Female</u>
0-9	8.2	5.4
10-19	4.5	5.7
20-29	9.6	9.2
30-44	7.6	5.1
45-64	4.4	1.9
65+	-1.9	-1.1

Table 6: Estimated Percent Undercount by Age and Sex for Eastern Washington

<u>Age</u>	<u>Male</u>	<u>Female</u>
0-9	1.4	11.6
10-19	2.9	1.1
20-29	19.2	10.7
30-44	7.6	5.7
45-64	9.1	5.6
65+	-2.6	0.6

Table 7: Estimated Percent Undercount by Race

<u>Race</u>	<u>St. Louis</u>	<u>Standard Error</u>	<u>Columbia</u>	<u>Standard Error</u>
White, NonHispanic	1.5	1.1	4.5	1.7
Other	10.2	1.4	10.8	4.4
Total	6.2	1.1	5.4	1.7

Table 8: Smoothed Estimates of the Percent Undercount for St. Louis

<u>Post-Strata</u>	<u>Percent</u>
White, Non-owner, Non-Hispanic	5.5
White, Owner, Non-Hispanic	- 0.7
All other Non-owner	11.7
All other Owner	5.8
Total persons	5.7

Table 9: Smoothed Estimates of the Percent Undercount for East Central Missouri

<u>Post-Strata</u>	<u>Percent</u>
TAR, White, Non-Hispanic	4.6
Non-TAR, White, Non-Hispanic	2.0
All other	9.5
Total persons	2.9

Table 10: The E-sample Enumeration Status by Test Site

<u>Enumeration Status</u>	<u>St. Louis</u>	<u>Columbia</u>	<u>Washington</u>
Correct	12,476 (91.9)	8,473 (95.5)	2,413 (94.3)
Erroneous	593 (4.4)	294 (3.3)	77 (3.0)
Insufficient Information	201 (1.5)	33 (0.4)	16 (0.6)
Unresolved	311 (2.3)	75 (0.8)	54 (2.1)
Total	13,581	8,875	2,560

Table 11: Distribution of Erroneous Enumerations

<u>Erroneous Enumeration</u>	<u>St. Louis</u>	<u>Columbia</u>	<u>Washington</u>
Misgeocoded	4 (.03)	23 (0.3)	0 (0.0)
Duplicate	221 (1.6)	114 (1.3)	22 (0.9)
Fictitious	125 (0.9)	9 (0.1)	0 (0.0)
Other	243 (1.8)	148 (1.7)	55 (2.2)
Total	593	294	77

Table 12: Fictitious Census Persons by Type of Enumeration

<u>Type of Enumeration</u>	<u>St. Louis</u>	<u>Columbia</u>	<u>Washington</u>
Mail Return	5 (0.1)	1 (.02)	0
Enumerator Filled	120 (1.9)	8 (0.3)	0
Total	125 (0.9)	9 (0.1)	0

Table 13: Fictitious Census Persons by Type of Household

<u>Type of Household</u>	<u>St. Louis</u>	<u>Columbia</u>
Whole Household	67	5
Partial Household	3	2
Total	70	7

Table 14: Total Census Duplication Within the Search Area

	<u>St. Louis</u>	<u>Columbia</u>	<u>Washington</u>
E-sample Within Sample Block	221 (1.6)	114 (1.3)	22 (0.9)
Non E-sample	44	92	12
Total	243 (1.8)	160 (1.8)	28 (1.1)

Table 15: Percent Nonmatch for Nonmovers and Movers

<u>Mover Status</u>	<u>St. Louis</u>	<u>Columbia</u>	<u>Washington</u>
Mover	33.5	13.2	16.6
Nonmover	12.5	6.2	9.5
Total	13.2	6.5	10.0

Table 16: Percent Movers Within Test Site and Total Percent Movers

<u>Mover Location</u>	<u>St. Louis</u>	<u>Columbia</u>	<u>Washington</u>
Within Test Site	4.4	7.2	7.5
Total	6.4	11.2	11.1

Table 17: Type of Nonmatch in Percent for Nonmovers

<u>Type of Nonmatch</u>	<u>St. Louis</u>	<u>Columbia</u>	<u>Washington</u>
Rejected during Processing	3.9	4.5	1.4
Partial Household	39.1	30.1	30.7
Whole Household, Address Match	40.1	11.3	13.2
Whole Household, Multi-unit not Matched	7.5	7.3	10.8
Whole Household, No Address Match	9.4	46.8	43.9

Table 18: Percent of Total Nonmovers who were Whole Household Nonmatches by Type of Enumeration Area

<u>Type of Enumeration Area</u>	<u>St. Louis</u>	<u>Columbia</u>	<u>Washington</u>
TAR	1.2	1.1	4.0
Prelist	--	3.0	1.3
Update/Leave	--	3.8	--
List/Enumerate	--	--	3.3
Total	1.2	2.9	4.2

Table 19: Percent Unresolved for Nonmovers and Movers

<u>Mover Status</u>	<u>St. Louis</u>	<u>Columbia</u>	<u>Washington</u>
Mover	22.1	33.9	19.4
Nonmover	0.9	0.3	0.4
Total	1.8	2.8	1.8