

## COVERAGE AND COMPLETENESS IN THE CENSUS 2000 SUPPLEMENTARY SURVEY

Michael Starsinic & Keith Albright

Demographic Statistical Methods Division, U.S. Census Bureau, Washington, DC 20233

**Keywords:** Census 2000 Supplementary Survey, American Community Survey, coverage, sample completeness

### 1. INTRODUCTION<sup>1</sup>

Any survey's usefulness lies in part on what its answer is to the question "Are you actually getting information from everyone you want to?" Missing people who should be in your survey can cause serious biases in the results, if you disproportionately miss persons that differ on variables of interest from those you did measure. Both nonresponse and undercoverage can be significant contributors to this "missingness" problem, and since their effects of biasing the survey are similar, we would like to measure their combined impact. Undercoverage is often measured separately, as with a standard coverage ratio. In this paper, we propose a new measure called "sample completeness" which will examine the effect of undercoverage and nonresponse together on the 2000 American Community Survey (ACS) national test (the Census 2000 Supplementary Survey (C2SS)), and we will compare its sample completeness to that of the 1990 census long form. The ACS is a monthly survey which will provide data comparable to that from the decennial census's sample (or long form) questionnaire and will replace the long form for the 2010 census.

We will briefly discuss the sampling methodology for the C2SS and the 1990 long form and our reasons for using data from the 1990 census instead of Census 2000, how to calculate the sample completeness ratio, some important differences between the long form and C2SS data, and a comparison of the sample completeness ratios for various demographic groups.

### 2. SURVEY OVERVIEWS

#### 2.1 CENSUS 2000 SUPPLEMENTARY SURVEY DESIGN

For the C2SS, the primary sampling unit (PSU) was a county or collection of counties. Of the 1,925 PSUs, 536 were identified as self-representing (mostly based on a size threshold of 250,000), and from those remaining, two were selected from each stratum (defined on various demographic data). For housing units, the sampling rate was based on a desired national sample size of 890,000, which produced a sampling interval in most states of 186.

Units that had not responded to the C2SS either through the mail or through a telephone interview were sampled at a 1-in-3 rate for a personal interview. Units whose address was deemed unmailable were sampled at a 2-in-3 rate. This rate was included in our "base weight" for the C2SS. Other weighting adjustments were made, including a noninterview adjustment and controlling to the total number of housing units, before a final adjustment to the individuals' weights using demographically-defined population controls. For more information on the C2SS, see U.S. Census Bureau (2001).

#### 2.2 USING 1990 LONG FORM DATA INSTEAD OF 2000 LONG FORM DATA

When this analysis was first initiated, the Census 2000 long form data had not been released and would not be released for some time. Even though the primary goal was to compare the C2SS to the 2000 long form data, it was decided to compare the C2SS to the 1990 data first, both as a "trial run" for the future 2000 long form analysis, and as a possible early indicator of any major data quality issues with the C2SS. There were several substantial differences in what data was collected and how it was processed between the 1990 long form data and the C2SS data. Those issues will be described in section 4 below.

#### 2.3 1990 CENSUS LONG FORM DESIGN

The primary sampling unit for the 1990 long form was the housing unit. Units were selected at one of three rates:

- 1-in-2 for governmental units with an estimated population less than 2,500

---

<sup>1</sup> This paper reports the results of research and analysis undertaken by Census Bureau staff. It has undergone a more limited review than official Census Bureau publications. This report is released to inform interested parties of research and to encourage discussion.

- 1-in-8 for portions of tracts with an estimated population of 2,000 or more which did not fall in the 1-in-2 category
- 1-in-6 for all other locations

Within geographically defined weighting areas, individuals' weights were adjusted using iterative proportional fitting (raking) to census counts, with the marginal totals defined by housing unit and person demographics. Note that there was no specific weighting adjustment for noninterviews. For more information on the long form, see U.S. Census Bureau (1992).

### 3. MAJOR DIFFERENCES BETWEEN THE 1990 LONG FORM AND THE C2SS

Because we compared the C2SS to the 1990 long form instead of the 2000 long form, there were several comparability issues we needed to address.

#### 3.1 MULTIPLE RACE RESPONDENTS

In 2000, for the first time in a decennial census, respondents could give more than one response to the race question. The C2SS also allowed persons to respond with more than one race, which makes direct comparisons of race data to 1990 with its one-race-only question impossible.

A variable used in the editing of (but not the tabulation for) both the Census 2000 and the C2SS data recoded multiple race respondents into one of the 6 major race categories. It wasn't a perfect solution, but was the best available to us.

#### 3.2 ASIANS, NATIVE HAWAIIANS, AND OTHER PACIFIC ISLANDERS

In 1990, these persons comprised one major race group. However, for Census 2000, Native Hawaiians and Other Pacific Islanders had been separated into their own, sixth major race group. We used the detailed race codes available in the 1990 long form to separate the combined group into two, and performed our analysis using the six race groups.

#### 3.3 HOUSEHOLDS WITH MINIMAL DATA

Also, C2SS and the 1990 long form used different definitions of what the minimum amount of data was required for persons in a housing unit so that the housing unit would be declared a valid interview. Applying the C2SS rules to the long form data showed

that a few units classified as interviews under the long form rules would be reclassified as noninterviews. The opposite process, applying the long form rule to the C2SS data also revealed a small number would switch classification. However, the effects of this difference are negligible, and we did not account for it in our analysis.

### 4. SAMPLE COMPLETENESS COMPUTATION

A traditional measure of survey quality is the coverage ratio (CR), which measures how well the initial sample, adjusted for nonresponse, captures the true (or final estimated) population. It is computed as

$$CR = \frac{\sum \text{weights after nonresponse adjustment}}{\text{total}}$$

The coverage ratio utilizes weights that include adjustment for nonresponse but not for final measures of coverage. However, the long form weighting methodology adjusts for nonresponse and coverage in the same step, so a traditional coverage ratio can't be calculated for the long form data.

We propose a measure called the sample completeness (SC) ratio which attempts to capture the error due to both coverage and nonresponse.

$$SC = \frac{\sum \text{weights before nonresponse adjustment}}{\text{total}}$$

It uses the sum of the base (or unbiased sampling) weights, before any adjustments for nonresponse.

For the 1990 long form data, we use the inverse of the a priori sampling rate (1-in-2, 1-in-6, or 1-in-8) as the base weight. For the mail and telephone respondents to the C2SS, the base weight is the inverse of the sampling rate. For personal interview respondents, it is the inverse of the sampling rate multiplied by the inverse of the subsampling rate (1-in-3 or 2-in-3) described in section 2.1 above.

The denominator for the ratio will be the census counts from 1990 and 2000, excluding the group quarters population (e.g. college dorms, prisons, military barracks, etc.). The C2SS was a survey of the household population only and did not collect information on group quarters.

We would certainly like to compare the sample completeness ratios between the two surveys for specific groups. To draw conclusions about statistical significance, we need to be able to calculate standard errors for both estimates.

Standard errors for the 1990 long form data were computed using published design factors. Standard errors for the C2SS were computed using the successive differences replication methodology, which is the methodology used for calculating all direct C2SS variance estimates.

It is important to note that the standard errors for the C2SS estimates are much higher than the standard errors for the 1990 long form, thus hindering our ability to find significant differences between the sample completeness ratios. This is due in part to the large disparity in sample size. The 1990 long form had approximately 38.6 million persons, while the C2SS had approximately 1.3 million.

The significance of comparisons was based on the standard t-test for independent samples with different variances.

5. COMPARISON OF SAMPLE COMPLETENESS RATIOS

Because of the potentially large standard errors on the C2SS estimates and the generally small differences between the sample completeness ratios, most of our analysis is restricted to the national level. Few comparisons are significant at lower levels of geography.

Highlighted lines in these tables are significantly different at the 90% confidence level.

**Table 1** - Sample Completeness Comparison: Total Population, Hispanic Origin and Race

	1990 Long Form	C2SS	Significantly Different at 90% Level?
Total Population	89.73%	90.19%	Yes
Hispanic	84.45%	88.14%	Yes
Not Hispanic	90.25%	90.49%	No
White	91.23%	93.45%	Yes
Black	80.67%	85.11%	Yes
AI/AN	91.35%	88.05%	No
Asian	89.37%	89.24%	No
N. Hawaiian/OPI	87.22%	88.22%	No
Some Other Race	86.33%	60.66%	Yes

“AI/AN” is an abbreviation for American Indian & Alaska Native. “N. Hawaiian/OPI” is an abbreviation for Native Hawaiian and Other Pacific Islander.

The Sample completeness ratios for the total population, Hispanic, White, and Black all were significantly higher for the C2SS than the 1990 long form. Overall, the values are fairly similar for all the groups, except for Some Other Race.

The very low C2SS sample completeness ratio for Some Other Race is due to a systematic difference between Census 2000 and the C2SS in the way Hispanic respondents in personal interviews answered the race question. Personal interview respondents who said they were Hispanic respondents were much more likely to give their race as Some Other Race in Census 2000 than C2SS, where many more gave their race as White. That relative lack of sample cases causes the weighted estimate to significantly underestimate the census count; in other words, a low sample completeness ratio. This also may be contributing to the relatively high sample completeness ratio for White respondents in C2SS (more individuals marking White in the sample than expected from the census).

**Table 2** - Sample Completeness Comparison: Multiple Race Respondents

	C2SS SC Ratio	
	With MRs Assigned	Single Race Only
White	93.45%	93.59%
Black	85.11%	84.98%
AI/AN	88.05%	79.44%
Asian	89.24%	90.43%
N. Hawaiian/OPI	88.22%	98.63%
Some Other Race	60.66%	62.47%
Multirace		76.48%

Table 2 compares the C2SS sample completeness rates with and without the multiple race respondents recoded to one race. The first column repeats the values from Table 1, where multiple race respondents have been recoded to one of the races they marked. The second column shows only the persons who responded with only one race, with all multiple race respondents in a separate group. There were minimal changes for White, Black, Asian, and Some Other Race, but large changes for AI/AN and NH/OPI. Both AI/AN and NH/OPI had high percentages of persons reporting more than one race among those who reported that race.

The next three tables look at the sample completeness by five-year age groups, sex by broad age group, and metropolitan status.

**Table 3 - Sample Completeness Comparison: Age**

	1990	C2SS
Under 5	90.17%	87.22%
5-9	90.48%	88.43%
10-14	90.70%	91.24%
15-19	89.51%	89.94%
20-24	85.21%	85.86%
25-29	86.59%	85.64%
30-34	88.31%	88.74%
35-39	89.35%	89.16%
40-44	90.13%	90.83%
45-49	90.49%	92.15%
50-54	90.70%	93.21%
55-59	91.57%	92.27%
60-64	91.98%	93.04%
65 and up	92.31%	94.03%

As with race and Hispanic origin, the sample completeness rates for age are comparable between 1990 and C2SS. The C2SS is significantly different from the long form in half of the 14 age categories. There is a sizable drop off in the sample completeness rate for the 20-29 age group in both 1990 and the C2SS. Overall, the C2SS trend is similar to that of the 1990 Census.

**Table 4 - Sample Completeness Comparison: Sex/Age**

	1990	C2SS
Males	89.23%	89.44%
Males 20-34	85.93%	85.13%
Males 65+	92.19%	94.68%
Females	90.20%	90.91%
Females 20-34	87.67%	88.48%
Females 65+	92.40%	93.55%

Not surprisingly, female rates are slightly higher than corresponding male rates. With the exception of Males 20-34, C2SS rates are slightly higher than corresponding 1990 long form rates.

**Table 5 - Sample Completeness Comparison: Metropolitan Area**

	In MSA		Not in MA	
	1990	C2SS	1990	C2SS
Total Population	89.21%	90.59%	91.53%	88.54%
Hispanic	84.12%	89.02%	87.65%	78.84%
Not Hispanic	89.81%	90.86%	91.69%	89.11%
White	91.02%	94.45%	91.90%	89.92%
Black	79.12%	85.07%	88.84%	85.34%
AI/AN	93.60%	86.59%	89.01%	90.44%
Asian	89.19%	89.79%	92.56%	77.01%
N. Hawaiian/OPI	86.59%	90.01%	90.11%	78.62%
Some Other Race	86.17%	61.14%	87.93%	55.24%

Metropolitan Area (MA) definitions were used as they were in each census. No attempt at a “standardization” of the area definitions was made.

For persons in MAs, total population, Hispanic, White, and Black are significantly higher in C2SS than 1990. The ratios in non-MA areas are generally lower, but the differences are usually not significant.

The next table looks at American Indians and Alaska Natives on and off reservations, and the metropolitan area status of those off.

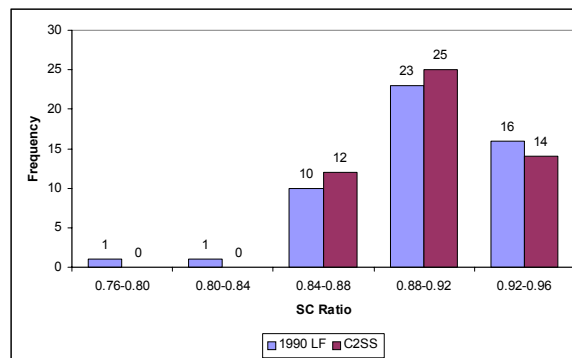
**Table 6 - American Indians and Alaska Natives**

	1990	C2SS
On AIR	84.78%	88.05%
Not on AIR	95.45%	88.05%
In MA	94.72%	84.68%
Not in MA	97.26%	99.98%

The C2SS estimates are generally lower, in part because the C2SS sample was not as representative of the American Indian and Alaska Native population as it could have been. The stratification of the PSUs in the initial sample did not account for reservations.

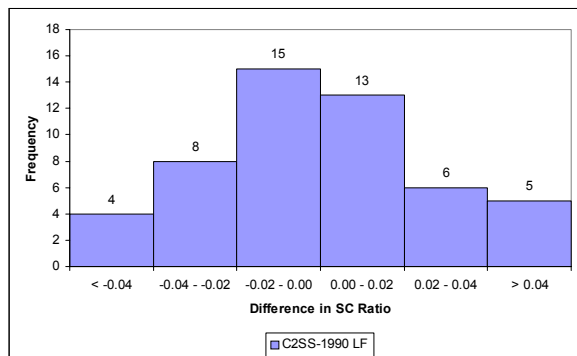
So far, we have only looked at sample completeness ratios at the national level. We will now look at two distributions of sample completeness ratios for the total population at the state level (including the District of Columbia, but not Puerto Rico).

**Figure 1 - Distribution of State Sample Completeness Ratios**



In this histogram we can see that the distribution of the sample completeness ratios for C2SS and the long form are very similar. There are two low-valued ratios in the long form which are not present in C2SS, but otherwise the distributions are quite close.

**Figure 2** - Distribution of Difference of State Sample Completeness Ratios



This is a histogram of the difference between the C2SS and 1990 long form sample completeness ratios for each state. Only a handful of these differences are significant, at the extremes of the distribution. The largest positive differences (C2SS > long form) are mostly states with a large population, like New York. The largest negative differences (long form > C2SS) are mostly states with small populations.

6. CONCLUSIONS AND FUTURE RESEARCH

Overall, most estimates of sample completeness for C2SS were comparable to equivalent estimates from the 1990 long form. Additionally, some C2SS estimates showed a significant improvement over 1990 estimates, and most estimates of sample completeness were fairly high (85%-90%).

The sample completeness ratio attempts to quantify the level of completeness in the original sample *relative to the census*. Thus, whatever biases and nonsampling errors are present in the census data could affect the interpretation of the sample completeness ratios. Here, we are comparing ratios from two different censuses, potentially compounding our problems. However, the fact that the ratios are fairly similar for both could be seen as an indication that the problem may not be that large.

Obviously, the next step in this project is to compare the sample completeness of the C2SS to the 2000 long form data. That should prove much more informative about the quality of the C2SS as compared to the 2000 long form. But based on the results of this analysis, we expect the C2SS to compare favorably in most cases.

7. REFERENCES

U.S. Census Bureau, "1990 Summary Tape File 3 Technical Documentation on CD-ROM", <http://factfinder.census.gov/metadoc/1990stf3td.pdf>, 1992.

U.S. Census Bureau, "Accuracy of the Data (2000)", <http://www.census.gov/acs/www/Downloads/C2SS/Accuracy.pdf>, 2001.