

U.S. Census Coverage Measurement Survey Results

Vincent Thomas Mule, Jr.
U.S. Census Bureau

Abstract: This paper shows the results of evaluating the coverage of the 2010 U.S. Census based on the Census Coverage Measurement (CCM) survey. The U.S. Census Bureau estimated the net error of undercount or overcount based on the dual system estimation methodology. The program also estimated the components of census coverage that included erroneous enumerations and omissions. This paper shows the estimated results of this evaluation of the 2010 Census. Results are shown for the population and housing unit coverage. The results shown focus on demographic, tenure and housing unit characteristics; governmental entities and census operations.

1. Introduction

The 2010 Census Coverage Measurement (CCM) program was the survey-based program to evaluate the coverage of the 2010 Census in order to improve future censuses, including 2020 and beyond. The CCM was designed to measure the coverage of housing units and the household population excluding group quarters and persons residing in group quarters. The CCM provided estimates of the net coverage error and the components of census coverage by using a post-enumeration survey. Since the CCM was an evaluation, its results did not affect the 2010 Census counts. The other principal method to measure coverage is Demographic Analysis.

The 2010 CCM sample design was a large complex survey of 170,000 housing units in the United States (excluding remote Alaska) and 7,500 housing units in Puerto Rico. In the CCM survey, we conducted an independent enumeration of housing units and persons in housing units. The results were matched to census enumerations to identify coverage results. The CCM consisted of five sampling activities, five data collection activities, and three matching activities prior to the estimation of census coverage. A high-level overview that shows the relationship and timing of the major CCM activities can be found in Whitford (2008). The CCM program produced estimates for the United States and Puerto Rico. This paper focuses on some of the United States results. Additional results can be found on the 2010 CCM Results website.

2. Net Coverage Estimation

Like the 1990 Post-Enumeration Survey (PES) and the 2000 A.C.E., the 2010 CCM evaluated net coverage by using dual system estimation to generate population estimates of housing units and persons in housing units. For the CCM, we used logistic regression modeling instead of post-stratification to produce synthetic estimates of net coverage. The parameters in the model were based on a national sample and then applied to each individual census case. Information collected at the individual level was then used in conjunction with information collected at an aggregate level to provide estimates. The logistic regression modeling allowed us to reduce the correlation bias in the total population estimates without having to include unnecessary higher-order interactions as when forming

This report is released to inform interested parties of ongoing research and to encourage discussion of work in progress. Any views expressed on statistical, methodological, technical or operational issues are those of the authors and not necessarily those of the U.S. Census Bureau

post-stratification cells. This allowed us to include additional variables in the model that can potentially help reduce synthetic error for national, state, county, and place estimates.

As part of this estimation, we implemented operations to account for missing data and to reduce the sampling and nonsampling errors in the estimates. This included imputation of missing characteristics, handling and imputation of unresolved statuses and an adjustment for the person estimates to minimize correlation bias using results derived from Demographic Analysis estimates.

When doing either the person or housing unit estimation, we used the same independent variables (main effects) and interactions in each logistic regression model. See Olson (2012) for more details on the logistic regression models. The main effects used in the person and housing unit models are listed in Table 1.

Table 1: Main Effect Variables in Person and Housing Unit Logistic Regression Models

Person Models	Housing Unit Models
<ul style="list-style-type: none"> • Race/Hispanic Origin domains • Tenure • Age/Sex groups • Region of the country • Metropolitan Statistical Area Size by Type of Enumeration Area • Presence of Spouse in Household • Relationship to Householder • Tract-level Census Participation Rates • Bilingual and Replacement Questionnaire Mailing Areas 	<ul style="list-style-type: none"> • Structure type and size of the dwelling • Occupancy and tenure • Region of the country • Metropolitan Statistical Area size by Type of Enumeration Area (TEA) • Measures of the number of address list changes in the neighborhood near to Census Day • Bilingual and Replacement Questionnaire Mailing Areas

Estimates of net undercount are the difference of the dual system estimate and the census count. A positive estimate indicates a net undercount and a negative estimate indicates a net overcount.

$$Net\ Undercount = DSE - Census$$

where DSE is the dual system estimate

We also report the estimate of percent net undercount. The percent net undercount is the net undercount estimate calculated above divided by the DSE expressed as a percentage.

$$Percent\ Net\ Undercount = \left(\frac{DSE - Census}{DSE} \right) \times 100$$

3. Components of Census Coverage

This section summarizes how the CCM program produced estimates of the components of census coverage. Table 2 identifies the components of census coverage for the 2010 CCM for both people in housing units and housing units. For both universes, we estimated the number of correct enumerations, erroneous enumerations, and omissions. Sections 3.1 to 3.4 provide more information on the components of census coverage.

Table 2: Components of Census Coverage

People in Housing Units	Housing Units
1. Correct enumerations 2. Erroneous enumerations 3. Whole-person census imputations 4. Omissions	1. Correct enumerations 2. Erroneous enumerations 3. Omissions

3.1 Correct Enumerations for Components

An enumeration was considered to be correctly enumerated if the record corresponds to a person or housing unit that should have been included in the correct geographic area. Since we produced national, state, county, and place estimates, the definition of the correct geographic area for the person estimates changed depending on the area being evaluated.

For person national-level estimates, an enumeration was considered to be correctly enumerated if the record corresponded to a person or housing unit that should have been included anywhere in the U.S. in the coverage universe. This criterion applied to the estimates of the total population and other domains like demographic characteristics and census operational areas. For state, county, and place estimates, the definition changed to require that the person should have been enumerated in that area. When duplication or multiple inclusion of a person occurs, one of the enumerations was determined to be where the person should have been counted on Census Day according to the CCM processing rules. This enumeration was classified as correct and the other enumeration(s) were classified as the erroneous enumeration(s).

For housing units, we limit the matching to the sample block cluster search area. The CCM only searched for duplicates within that area. Any estimates of erroneous enumerations due to duplication will be based on searching for duplicate housing unit addresses in the census in that limited geographic area. The limitation on field work around the sample block cluster search area does not allow us to classify any geocoding errors as being erroneous enumerations in housing unit estimates for states, counties, or places. This will have implications on the estimate of erroneous enumerations for housing units as well.

3.2 Erroneous Enumerations for Components

For component estimation, the CCM program reported the number of erroneous enumerations. When examining the reasons that a case can be erroneous, we will report the results based on three groupings: The three groupings are:

- Persons or units that should not have been enumerated at all
- Duplicate person or housing unit enumerations
- Enumerations included in wrong location for person estimates of state, counties and places.

3.3 Whole-Person Census Imputation

For people in housing units, we tallied the number of whole-person census imputations. Whole-person census imputations were when all of the characteristics were imputed for these census person records. The CCM program was not in a position to assess whether an individual whole-person census imputation was correct or erroneous because, in large part, there was no practical way to follow up on records for which all information was imputed. Therefore, this report provides the count of whole-person imputations. For housing units, there were none. Table 3 shows the 5 categories of whole-Person Census Imputations.

Table 3. Whole-Person Census Imputation Categories

Count Imputation	
1.	Status Imputation - No information about the housing unit; housing unit imputed as occupied, vacant, or non-existent. Those imputed as non-existent were removed from the census files.
2.	Occupancy Imputation - Existence of housing unit confirmed, but no information as to occupancy status; imputed as occupied or vacant.
3.	Household Size Imputation - Occupied status confirmed, but no information as to household count; the household population count was imputed.
Population Count Already Known for the Housing Unit	
4.	Whole Household - Population count known; all characteristics imputed for the entire household.
5.	Partial Household - Population count known; all characteristics imputed for some, but not all, persons in the household.

Note: Any housing unit imputed as occupied during count imputation also had its household population count imputed, which resulted in whole-person census imputations.

3.4 Omissions

We estimated the total number of omissions in the census as well. A direct estimation method for the number of omissions is not available. In the past, different definitions and estimators of omissions were used. The CCM omission estimator subtracts the estimate of correct enumerations from the population estimate.

4. Summary of Coverage for the Total Household Population

This section summarizes the net coverage and the components of census coverage for the total household population. This includes comparisons of net coverage to past surveys and the national components of census coverage results.

4.1 Net Coverage

The national estimate of the net overcount for the 2010 Census was 36,000 persons or 0.01%. The 2010 Census did not have a significant net undercount or overcount. That is, the CCM population estimate was not significantly different from the census count. Table 4 shows the results for the past three census coverage measurement surveys. The 1990 survey measured a net undercount, and the 2000 survey measured a net overcount.

Table 4. National Estimates of Net Undercount by Year

Year	Census Count (Thousands)	Net Undercount		Percent Net Undercount	
		Estimate (Thousands)	Standard Error (Thousands)	Estimate (%)	Standard Error (%)
2010	300,703	-36	429	-0.01	0.14
2000	273,587	-1,332*	542	-0.49*	0.20
1990	248,710	3,994*	488	1.61*	0.20

The 2010 Census count excludes persons in group quarters and persons in Remote Alaska.

A negative net undercount or percent net undercount estimate indicates an overcount.

An asterisk (*) denotes a (percent) net undercount that is significantly different from zero.

The 2000 and 1990 estimates are from Kostanich (2003).

4.2 Overall Summary

Table 5 shows the estimates of the components of census coverage for the household population. The first part of the table shows how the census household population count of 300.703 million was distributed among correct enumerations, erroneous enumerations, and whole-person census imputations. We estimated that 284.7 million (94.7%) were correct enumerations, 10.0 million (3.3%) were erroneous enumerations, and 6.0 million (2.0%) were whole-person census imputations. Of the 10 million erroneous enumerations, 8.5 million (2.8%) were erroneous enumerations due to duplication and 1.5 million (0.5%) were erroneous enumerations for other reasons. The CCM estimated that 16.0 million people were omitted from the census. Omissions are people who should have been enumerated in the United States, but were not. Many of these people may have been accounted for by the 6.0 million whole-person census imputations.

Table 5. Components of Census Coverage for the United States Household Population (in Thousands)

Component of Census Coverage	Estimate	Standard Error	Percent	Standard Error
Census Count	300,703	0	100.0	
Correct enumerations ¹	284,668	199	94.7	0.07
Enumerated in the same block cluster ²	280,852	220	93.4	0.07
Enumerated in the same county, though in a different block cluster	2,039	55	0.7	0.02
Enumerated in the same state, though in a different county	830	34	0.3	0.01
Enumerated in a different state	948	31	0.3	0.01
Erroneous enumerations	10,042	199	3.3	0.07
Due to duplication	8,521	194	2.8	0.06
For other reasons ³	1,520	45	0.5	0.01
Whole-Person Census Imputations ⁴	5,993	0	2.0	0
Estimate of Population from the Census Coverage Measurement ⁵	300,667	429	100.0	
Correct enumerations ¹	284,668	199	94.7	0.1
Omissions ⁶	15,999	440	5.3	0.1
Net Undercount	-36	429	-0.01	0.14

1. For the national table, someone who should have been counted is considered a correct enumeration if he or she was enumerated anywhere in the United States.

2. More precisely, enumerated in the *search area* for the correct block cluster. For definitions of block cluster and search area, see accompanying text.

3. Other reasons include fictitious people, those born after April 1, 2010, those who died before April 1, 2010, etc.

4. These imputations represent people from whom we did not collect sufficient information. Their records are included in the census count.

5. This number is the CCM estimate of people who should have been counted in the CCM household universe. It does not include people in group quarters or people living in the Remote Alaska type of enumeration area.

6. Omissions are people who *should have been* enumerated in the United States, but were not. Many of these people may have been accounted for in the whole-person census imputations above.

5. Person Census Coverage for Census Operational Outcomes

This section summarizes the components of census coverage for person records based on the result of the census operations. This includes Mail Return Status and results from the Nonresponse Followup (NRFU) field operations. The components of census coverage discussed are correct enumerations, erroneous enumerations, and whole-person census imputations. Because operational outcomes are characteristics of the census records that we cannot measure in the P sample, we cannot generate dual system estimates for census operational outcomes. Therefore, this section does not show estimates of net coverage or omissions.

5.1. Mail Return Status

The CCM estimated census coverage by mail return status of the housing unit where the person was enumerated. While most people in a housing unit for which we have a valid mail return were included on the mail return for that unit, some of the people in that housing unit were enumerated in a subsequent census operation. This analysis does not differentiate between these cases.

For housing units that were part of the mail return universe and did return a questionnaire, Table 6 shows that the components of census coverage were about the same across the various dates of return. The percentage of whole-person census imputations was very small when a form was returned.

There were 61 million person records in housing units that were mail-return eligible but did not have a valid return. Further, these housing units were in mailback areas, had pre-identified adequate address information for mailout, and were not undeliverable as addressed (UAA). For these cases without a valid return, we estimated that 3.7% were erroneous enumerations due to duplication and 6.9% required whole-person census imputations. For more information on the mailback operation, official counts, and an assessment of the mail return and mail response rates, see Letourneau (2012).

The last row of the table shows the component structure of the 18 million person records who were not in the mail return universe. These include the enumerations in housing units a) in Update/Enumerate or Remote Update/Enumerate TEAs, b) in mailback areas with pre-identified, inadequate address information for mailing, or c) determined to be UAA. For these 18 million census records, 11.0% were erroneous enumerations due to duplication, and 7.1% were whole-person census imputations.

Table 6. Components of Census Coverage by Mail Return Date

Mail Return Date	Census Count (Thousands)	Correct Enumerations (%)	Erroneous Enumerations		Whole-Person Census Imputations (%)
			Duplication (%)	Other Reasons (%)	
U.S. Total	300,703 (0)	94.7 (<0.1)	2.8 (<0.1)	0.5 (<0.1)	2.0 (0)
Valid Returns					
2/25-3/17	8,065 (0)	97.4 (0.3)	2.1 (0.3)	0.3 (<0.1)	0.2 (0)
3/18-3/24	83,659 (0)	98.1 (<0.1)	1.4 (<0.1)	0.3 (<0.1)	0.2 (0)
3/25-3/31	65,740 (0)	97.5 (<0.1)	1.9 (<0.1)	0.4 (<0.1)	0.2 (0)
4/1 - 4/7	31,060 (0)	96.9 (0.2)	2.4 (0.1)	0.5 (<0.1)	0.3 (0)
4/8 - 4/15	14,990 (0)	96.5 (0.2)	2.7 (0.2)	0.5 (<0.1)	0.3 (0)
4/16 - 4/30	13,267 (0)	96.1 (0.3)	3.0 (0.3)	0.5 (<0.1)	0.4 (0)
5/1 - 9/7	4,174 (0)	96.5 (0.4)	2.4 (0.3)	0.6 (0.1)	0.5 (0)
No Valid Return	61,307 (0)	88.6 (0.1)	3.7 (0.1)	0.9 (<0.1)	6.9 (0)
Not in Mail Return Universe	18,442 (0)	81.2 (0.8)	11.0 (0.8)	0.8 (<0.1)	7.1 (0)

Standard errors are in parentheses below the estimate.

The 2010 Census count excludes persons in group quarters and persons in Remote Alaska.

5.2. Nonresponse Followup Operations

The 2010 NRFU Operation included four 2010 Census field operations:

- NRFU
- NRFU Reinterview
- NRFU Vacant Delete Check, and
- NRFU Residual

The NRFU field operation primarily involved census enumerators interviewing and verifying the status of housing units in areas that received a mailback 2010 Census questionnaire but did not respond by mail. The NRFU Reinterview operation was a quality control check on the NRFU enumerator's work. The NRFU Vacant Delete Check (VDC) operation verified housing units determined to be vacant or nonexistent during NRFU. Additionally, the VDC operation included a first-time enumeration of housing units.

The NRFU Residual operation came about because monitoring of the NRFU field operation detected a potentially large number of occupied housing units lacking information about the number of people living in the housing unit. The NRFU Residual operation was the last attempt to complete a full interview for this type of unit. Its workload also included housing units from the NRFU field operation for which a questionnaire was completed, but no data were captured for the case in the data capture system. Jackson et al. (2012) assesses the 2010 NRFU operation and provides official workload totals and more detailed

information about the operation. Differences in counts between the census assessment and the CCM occur because we evaluated only the persons included in the final census while the NRFU assessment covers persons and housing units deleted during census processing. Keller and Fox (2012) have additional breakdowns of the components of census coverage for cases in the NRFU operation not shown here.

Table 7 shows the components of census person coverage focusing on whether the housing unit was included in the NRFU or the VDC field operations. Most persons in housing units that were part of the NRFU field operation but not in VDC were in housing units that were worked in May and June. The table shows that 84.6% of the June cases were correct enumerations, compared to 90.2% of the cases in May. We can see that the percentage of whole-person census imputations increases as the enumeration occurred further from Census Day.

For people in housing units in the VDC operation, results are shown by whether the housing unit was included in the NRFU operation. The percentages of erroneous enumerations due to duplication and whole-person census imputations were about the same for cases that had been previously worked (15.3% and 17.0% in both VDC and NRFU) versus those being worked for the first time (16.1% and 14.1% in VDC but not NRFU).

Table 7: Components of Census Coverage for Persons by
Nonresponse Followup Field Operation Status

NRFU Field Operation	Census Count (Thousands)	Correct Enumerations (%)	Erroneous Enumerations		Whole-Person Census Imputations (%)
			Duplication (%)	Other Reasons (%)	
U.S. Total	300,703 (0)	94.7 (<0.1)	2.8 (<0.1)	0.5 (<0.1)	2.0 (0)
In NRFU but not VDC					
April	1,717 (0)	93.1 (1.0)	3.7 (0.9)	0.6 (0.2)	2.6 (0)
May	59,057 (0)	90.2 (0.2)	4.0 (0.2)	0.8 (<0.1)	5.0 (0)
June	14,766 (0)	84.6 (0.5)	4.8 (0.5)	0.9 (<0.1)	9.6 (0)
July and August	211 (0)	74.8 (4.1)	6.8 (4.3)	1.2 (0.8)	17.3 (0)
Unknown Month	175 (0)	66.1 (1.3)	2.3 (1.2)	0.5 (0.2)	31.2 (0)
In VDC and in NRFU	2,393 (0)	65.7 (1.2)	15.3 (1.2)	2.0 (0.3)	17.0 (0)
In VDC but not NRFU	2,828 (0)	69.0 (2.4)	16.1 (2.4)	0.8 (0.2)	14.1 (0)
Not in NRFU or VDC but in NRFU Reinterview or Residual	349 (0)	76.6 (2.4)	8.1 (2.4)	0.3 (<0.1)	14.9 (0)
Not in any NRFU Universe	219,207 (0)	97.3 (<0.1)	2.1 (<0.1)	0.4 (<0.1)	0.3 (0)

Standard errors are in parentheses below the estimate.

The 2010 Census count excludes persons in group quarters and persons in Remote Alaska.

Table 8 shows the components of census coverage for the NRFU field operation cases by respondent type for the housing unit. Proxy response cases had 5.6% erroneous enumerations due to duplication and 23.1% whole-person census imputations. Household member respondent cases have 4.2% erroneous enumerations due to duplication and 1.6% whole-person census imputations.

Table 8. Components of Census Coverage by
Nonresponse Followup Field Operation Respondent Type

Nonresponse Followup Field Operation Respondent Type	Census Count (Thousands)	Correct Enumerations (%)	Erroneous Enumerations		Whole-Person Census Imputations (%)
			Duplication (%)	Other Reasons (%)	
U.S. Total	300,703 (0)	94.7 (<0.1)	2.8 (<0.1)	0.5 (<0.1)	2.0 (0)
Household Member	61,437 (0)	93.4 (0.2)	4.2 (0.2)	0.8 (<0.1)	1.6 (0)
Proxy	16,294 (0)	70.1 (0.3)	5.6 (0.3)	1.1 (<0.1)	23.1 (0)
Unknown Respondent Type	589 (0)	68.2 (1.1)	3.3 (1.1)	0.5 (0.1)	28.0 (0)
Not in NRFU Field Operation ¹	222,384 (0)	96.9 (<0.1)	2.2 (<0.1)	0.4 (<0.1)	0.5 (0)

Standard errors are in parentheses below the estimate.

The 2010 Census count excludes persons in group quarters and persons in Remote Alaska.

1. Includes persons in another NRFU operation and persons not in any NRFU universe. For more information, see Keller and Fox (2012).

6. Census Coverage for States and Other Governmental Entities

The CCM evaluated the census coverage of the fifty states, the District of Columbia, and counties and places with over 100,000 total population. For state estimates of net coverage, we produced estimates of the root mean squared error that added an estimate of synthetic bias to the sampling variance of the synthetic estimates. For governmental entities below the state level, the CCM estimated net coverage for counties and places with a total census population, including persons residing in a group quarters, over 100,000. See Davis and Mulligan (2012) for the net coverage estimates for those areas. The CCM also estimated the components of census coverage for counties and places with a total population over 500,000.

Based on the root mean squared error estimates, the estimated percent net undercount for persons for each state and the District of Columbia was not statistically different from zero. Also for the counties and places over 100,000 total population, the percent net undercount was not statistically different than zero. Table 9 summarizes the components of census coverage for the states and the District of Columbia.

Table 9. Components of Census Coverage by State

State	Census Count (Thousands)	Correct Enumerations (%)	Erroneous Enumerations		Whole-Person Census Imputations (%)	Percent Undercount		Omissions	
			Est. (%)	SE (%)		Est. (%)	RMSE (%)	Est. (%)	RMSE (%)
U.S. Total	300,703.4	94.7	3.3	(<0.1)	2.0	-0.01	0.14	5.3	0.1
Alabama	4,663.9	92.5	4.8	0.8	2.8	0.13	1.24	7.7	1.4
Alaska	629.1	93.7	4.8	0.9	1.4	-0.85	2.22	5.5	2.3
Arizona	6,252.6	92.3	4.3	0.4	3.4	-0.42	1.19	7.3	1.2
Arkansas	2,837.0	94.2	4.2	0.6	1.6	-0.41	1.45	5.4	1.5
California	36,434.1	95.1	3.2	0.1	1.7	0.26	0.73	5.1	0.7
Colorado	4,913.3	93.8	2.9	0.4	3.3	-0.29	1.23	5.9	1.2
Connecticut	3,455.9	95.7	3.0	0.5	1.3	-0.45	1.34	3.9	1.4
Delaware	873.5	94.3	2.8	0.7	2.8	0.55	1.93	6.2	1.9
District of Columbia	561.7	93.1	4.0	0.4	2.9	2.23	2.20	9.0	2.1
Florida	18,379.6	92.9	4.5	0.4	2.7	0.45	0.86	7.5	0.9
Georgia	9,434.5	93.5	3.1	0.3	3.3	0.91	1.04	7.3	1.0
Hawaii	1,317.4	91.8	5.2	0.5	3.0	-0.44	2.08	7.8	2.0
Idaho	1,538.6	94.2	3.2	0.6	2.6	-0.03	1.70	5.8	1.7
Illinois	12,528.9	95.0	3.3	0.4	1.8	-0.48	1.02	4.6	1.1
Indiana	6,296.9	95.7	3.2	0.5	1.1	-0.67	1.14	3.6	1.2
Iowa	2,948.2	97.1	2.0	0.4	0.9	-0.28	1.41	2.6	1.4
Kansas	2,774.0	95.6	3.7	0.7	0.7	-0.67	1.44	3.7	1.5
Kentucky	4,213.5	94.4	3.7	0.5	1.8	-0.13	1.28	5.5	1.3
Louisiana	4,405.9	92.9	4.0	0.5	3.1	-0.38	1.31	6.8	1.3
Maine	1,292.8	96.4	2.5	0.6	1.1	0.65	1.99	4.2	2.0
Maryland	5,635.2	94.9	3.4	0.5	1.8	0.94	1.19	6.0	1.2
Massachusetts	6,308.7	93.8	5.1	0.8	1.1	-0.52	1.15	5.7	1.4
Michigan	9,654.6	94.9	3.5	0.4	1.6	-0.66	1.02	4.5	1.0
Minnesota	5,168.5	95.1	3.9	1.2	1.0	-0.56	1.20	4.4	1.7
Mississippi	2,875.3	91.3	6.7	1.1	1.9	0.24	1.45	8.9	1.7
Missouri	5,814.8	94.9	3.4	0.5	1.8	-0.66	1.19	4.5	1.2
Montana	960.6	93.3	3.8	0.5	2.9	-0.65	2.01	6.1	1.9
Nebraska	1,775.2	96.4	2.4	0.3	1.3	-0.54	1.61	3.1	1.6
Nevada	2,664.4	93.0	2.9	0.3	4.1	-0.04	1.46	6.9	1.4
New Hampshire	1,276.4	95.6	3.3	0.8	1.1	0.60	2.07	5.0	2.1
New Jersey	8,605.0	95.1	3.3	0.4	1.6	-0.36	1.07	4.5	1.1
New Mexico	2,016.6	92.2	4.0	0.7	3.8	-0.16	1.58	7.7	1.6
New York	18,792.4	93.1	4.8	0.3	2.1	-0.79	0.92	6.1	0.9
North Carolina	9,278.2	92.8	4.4	0.7	2.8	0.52	1.03	7.6	1.2
North Dakota	647.5	96.1	2.9	0.7	0.9	0.09	2.17	3.9	2.2
Ohio	11,230.2	95.7	2.9	0.3	1.4	-0.83	1.00	3.5	1.0
Oklahoma	3,639.3	92.6	6.0	0.8	1.4	-1.08	1.40	6.4	1.5
Oregon	3,744.4	96.0	2.4	0.5	1.6	0.02	1.32	4.0	1.4
Pennsylvania	12,276.3	95.6	3.1	0.3	1.2	0.14	0.97	4.5	1.0
Rhode Island	1,009.9	93.3	5.0	0.9	1.7	-0.81	1.91	5.9	2.0
South Carolina	4,486.2	95.2	2.7	0.6	2.1	0.41	1.25	5.2	1.3
South Dakota	780.1	95.2	2.9	0.6	1.9	0.10	2.05	4.9	2.0
Tennessee	6,192.6	94.3	3.5	0.4	2.2	0.12	1.15	5.8	1.2
Texas	24,564.4	94.0	3.5	0.3	2.6	0.97	0.85	6.9	0.8
Utah	2,717.7	94.6	4.0	1.6	1.4	-0.48	1.44	4.9	2.1
Vermont	600.4	95.9	3.7	0.7	0.5	1.29	2.43	5.4	2.4
Virginia	7,761.2	94.7	3.3	0.4	1.9	0.57	1.06	5.8	1.1
Washington	6,585.2	95.4	2.9	0.3	1.6	-0.10	1.14	4.5	1.1
West Virginia	1,803.6	91.0	7.7	2.0	1.3	-1.43	1.70	7.7	2.6
Wisconsin	5,536.8	95.7	3.1	0.4	1.2	-0.17	1.20	4.1	1.2
Wyoming	549.9	93.2	4.2	0.7	2.6	-0.51	2.31	6.4	2.3

For each state and the District of Columbia, the estimated percent net undercount is not significantly different from zero.

For percent undercount and percent omissions, we produced estimates of the root mean squared error (RMSE).

The 2010 Census count excludes persons in group quarters and persons in Remote Alaska.

7. Net Coverage of Children

Children were one of the demographic groupings that the CCM program produced coverage estimates. For children 0 to 4, the census household population count was 20,158,000. The CCM estimated a population of 20,304,000 (81,000) and an estimated net undercount of 146,000.

One of the critiques of the coverage survey estimates for the 2000 census was that the coverage survey estimates underestimated the population of young children based on a comparison to Demographic Analysis estimates (Kostanich 2003). Estimating the population of young children is strength for the DA program since the major component for estimating this group is births which have shown to have very negligible errors in completeness. The Demographic Analysis program estimated a population of 21,171,000 for children 0 to 4. While the CCM program estimated a statistically significant undercount of children, the estimate was about 867,000 below the DA estimate this decade.

8. Housing Unit Coverage Results

8.1 Net Coverage

Table 10 shows the national estimates of the percent net undercount for housing units. The 2010 CCM estimated a net undercount of 0.60% for total housing units. The 2010 estimate of the percent net undercount was not significantly different from the 2000 net undercount estimate of 0.61% or the 1990 estimate of 0.96%. The results show a continued undercounting of vacant housing units, consistent with the prior two surveys.

Table 10. National Estimates of Percent Net Undercount for Housing Units by Year

Year	Occupied		Vacant		Total	
	Estimate (%)	Standard Error (%)	Estimate (%)	Standard Error (%)	Estimate (%)	Standard Error (%)
2010	0.03	0.14	4.80*	1.06	0.60*	0.20
2000	0.33*	0.13	3.37*	0.98	0.61*	0.16
1990	0.53*	0.21	4.71*	1.26	0.96*	0.24

An asterisk (*) denotes a percent net undercount that is significantly different from zero.

The 2000 and 1990 estimates are from Kilmer (2006) and Childers (1993), respectively.

For occupied units, the 2010 result is not significantly different than the 0.33% net undercount for Census 2000, but it is lower than the 1990 estimate (0.53%). For vacant housing units, the 2010 percent net undercount estimates is not significantly different than the Census 2000 or the 1990 Census estimate.

8.2. Census Coverage for Occupancy and Tenure

The CCM continued to measure differential coverage by occupancy and tenure. Table 11 shows these results. Owner-occupied housing units continued to be undercounted in 2010 but at a lower percentage than 2000 (0.20% and 0.54%, respectively). The percent net undercount for renter-occupied housing units was not statistically significant for the second consecutive decade.

For the erroneous enumerations, renter-occupied housing units had larger estimates of erroneous enumerations due to duplication (1.3% versus 0.6%) and erroneous enumerations due to other reasons (1.5% versus 0.8%) than owner-occupied units.

For vacant housing units, estimates of net undercount, omissions, and erroneous enumerations were significantly greater than for owner- or renter-occupied housing units. Most of the vacant erroneous enumerations were attributed to the “Other Reasons” category of not a housing unit.

Deciding whether an address identifies a housing unit is much more difficult when no one lives there. Information about vacant units is usually provided by a proxy respondent or based on field staff observation. The proxy respondent (or the field staff observing the unit) may not be as knowledgeable, especially about vacant boarded up units and units unfit for habitation. Confusion as to whether to include or to delete these types of vacant units from the census inventory still exists. The 2000 A.C.E. showed similar results.

Table 11. Components of Census Coverage of Housing Units by Occupancy and Tenure

Occupancy and Tenure	2010						2000
	Census Count (Thousands)	Correct Enumerations (%)	Erroneous Enumerations		Percent Undercount (%)	Omissions (%)	Percent Undercount (%)
			Duplication (%)	Other Reasons (%)			
U.S. Total	131,676 (0)	97.3 (0.1)	0.9 (<0.1)	1.8 (<0.1)	0.60* (0.20)	3.2 (0.2)	0.61* (0.16)
Occupied	116,699 (0)	98.1 (0.1)	0.8 (<0.1)	1.1 (<0.1)	0.03 (0.14)	1.9 (0.1)	0.33* (0.13)
Owner	75,975 (0)	98.6 (<0.1)	0.6 (<0.1)	0.8 (<0.1)	0.20* (0.12)	1.6 (0.1)	0.54* (0.13)
Renter	40,725 (0)	97.2 (0.3)	1.3 (0.2)	1.5 (0.2)	-0.29 (0.31)	2.5 (0.2)	-0.08 (0.21)
Vacant	14,977 (0)	91.2 (0.4)	1.4 (0.1)	7.4 (0.4)	4.80* (1.06)	13.2 (0.8)	3.37* (0.98)

Standard errors are in parentheses below the estimate.

The 2010 Census count excludes housing units in Remote Alaska.

An asterisk (*) denotes a percent net undercount that is significantly different from zero.

The 2000 estimates are from Kilmer (2006) and Viehdorfer (2012).

9. Summary

This paper summarizes some of the 2010 survey-based coverage estimates. In addition to continuing to produce net coverage results showing undercounts or overcounts using dual system estimation, the CCM program produced the components of census coverage that include erroneous enumerations and omissions. These estimates of components of census coverage had more detail as compared to previous coverage surveys for which similar efforts were primarily research-related.

For the household population at the national level, the 2010 Census did not have a significant percent net undercount. The CCM estimated a net overcount of 0.01% (0.14% standard error) or 36,000 (429,000) persons. The CCM population estimate was not significantly different from the 2010 Census count. In previous studies, Census 2000 had a national net overcount of 0.49% (0.20%) while the 1990 Census had a net undercount of 1.61% (0.20%).

While there was no statistically significant undercount or overcount at the national level, the CCM estimated 10 million erroneous enumerations in the 2010 Census. Of the 10.0 million, 8.5 million were erroneous enumerations due to duplication while the remaining 1.5 million were erroneous enumerations due to other reasons. The 2010 Census had more erroneous enumerations due to duplication than Census

2000. The 8.5 million erroneous enumerations due to duplication in 2010 were larger than the Census 2000 estimate of 6.6 million duplicates.

One of the goals of the 2010 CCM coverage evaluation was to provide information to improve future censuses by providing measures of the coverage for key census operations. By evaluating the components of census coverage for mail returns and NRFU, we were able to see that mail returns had lower percentages of erroneous enumerations and whole-person census imputations than non-mail returns. For cases in NRFU, we were able to see where the respondent was a household member had lower percentages of erroneous enumeration and whole-person census imputations than when a proxy respondent was needed.

The CCM produced estimates for several demographic groups including young children. This paper compared the estimates of Demographic Analysis and CCM for children aged 0 to 4. The comparison showed that for the second consecutive decade that the CCM looks to be underestimating the population of this age group as compared to the Demographic Analysis program. Future work can include additional comparisons of Demographic Analysis and CCM estimates in order to help further understand the differences.

In addition to evaluating the coverage of the household population, the CCM also evaluate the coverage of housing units. For net coverage, the CCM showed similar results for 2010 as seen in 2000. Vacant units continued to be undercount with an estimated 4.8% net undercount this decade. The CCM also estimated the components of census coverage including erroneous enumerations and omission for housing units as well. Our housing unit results showed that vacant housing units had larger percentages of erroneous enumerations and omissions than occupied units.

References

Childers, D. (1993), "Coverage of Housing Units in the 1990 Decennial Census," 1990 Decennial Census Preliminary Research and Evaluation Memorandum Series No. 253.

Davis, P. and Mulligan, J. (2012), "2010 Census Coverage Measurement Estimation Report: Net Coverage for the Household Population in the United States," DSSD 2010 Census Coverage Measurement Memorandum Series #2010-G-03.

Jackson, G., Heime, S., Walker, S., and Winder, W. (2012), "2010 Census Nonresponse Followup Operations (NRO) Assessment," U.S. Census Bureau.

Keller, A. and Fox, T. (2012), "2010 Census Coverage Measurement Estimation Report: Components of Census Coverage Results for the Household Population in the United States," DSSD 2010 Census Coverage Measurement Memorandum Series #2010-G-04.

Kilmer, A. (2006), "Accuracy and Coverage Evaluation: Housing Unit Dual System Estimation Results," DSSD Census 2000 Procedures and Operations Memorandum Series #Q-91.

Kostanich, D. (2003), "Technical Assessment of A.C.E. Revision II," DSSD A.C.E. Revision II Memorandum Series #PP-61.

Letourneau, E. (2012), "Mail Response/Return Rates Assessment for the 2010 Census," U.S. Census Bureau.

Mule, T. (2012), “2010 Census Coverage Measurement Estimation Report: Summary of Estimates of Coverage for Persons in the United States,” DSSD 2010 Census Coverage Measurement Memorandum Series #2010-G-01.

Mule, T. and Konicki, S. (2012), “Census Coverage Measurement Estimation Report: Summary of Estimates of Coverage for Housing Units in the United States,” DSSD 2010 Census Coverage Measurement Memorandum Series #2010-G-02.

Olson, D. (2012), “2010 Census Coverage Measurement Estimation Report: Aspects of Modeling,” DSSD Census Coverage Measurement Memorandum Series #2010-G-10.

Viehdorfer, C. (2012), “2000 Accuracy and Coverage Evaluation: Additional Estimates of Net Coverage,” DSSD Census 2000 Procedures and Operations Memorandum Series #Q-96.

Whitford, D. (2008), “Overview of 2010 Census Coverage Measurement Program,” DSSD 2010 Census Coverage Measurement Memorandum Series #A-19, July 9, 2008.