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REPORT ON A COMPARISON OF SEVERAL SMALL AREA COVERAGE SURVEY ESTIMATORS USING SIMULATION

by

Cary T. Isaki, Linda K. Schultz and Elizabeth T. Huang
Statistical Research Division
Bureau of the Census
Room 3132, F.O.B. #4
Washington, D.C. 20233 U.S.A.

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I. Introduction

I.A. Background

The Coverage Evaluation Survey (CES) of the 1990 Decennial Census will provide estimates of the total population for a variety of geographic areas and characteristics. This report provides information on the performance of some small area estimation procedures for total population based on a simulation of the undercount. The report consists of two parts. The first part considers the state of New Jersey and considers coverage estimates for counties, places, enumeration districts (EDs) and census blocks in the state. A single state was used chiefly because of cost. New Jersey was selected because it was of moderate size, had a reasonable number of large cities, a reasonable amount of rural population, and a moderate sized minority population (Black and Hispanic). The second part of this report documents the results of measures of performance for five additional states.

A number of coverage estimation results, using various measures of coverage, termed measures of performance, were computed. The coverage estimation methods are based on synthetic estimation. In synthetic estimation, unbiased CES estimates of coverage ratios (true total population divided by census enumerated) provided at broad levels are applied to census enumerated levels within the broad levels. For example, if we wish to estimate total Black males in Philadelphia, the CES may not provide a direct estimate. It may, however, provide an estimated coverage ratio for Black males in all cities like Philadelphia in the Middle

Atlantic Division of the U.S. A synthetic estimator of Black Males in Philadelphia may be constructed by using this coverage ratio. The model assumption is that the coverage ratio previously described holds as well for Philadelphia. To the extent that it does not, we have a potential for bias in the synthetic estimator. The census has a potential for bias as well so the issue is which is closer to the true total population and at what geographic levels.

No one knows the actual coverage ratios in practice. In fact, the number and definition of the categories for which coverage ratios are to be computed is somewhat subjective. Moreover, coverage ratios require estimation. In this report, we considered the effects of sample based estimation of the coverage ratios under a simple sample design. Results in this case are referred to as "replicate" or "replicate factor". When the coverage ratios are assumed known without error, such results are referred to as "known factor". The terminology is a carryover from previous research on issues of census adjustment. In that context, the term "adjustment factor" was used in place of coverage ratio. We persist in using the term "factor" in the interest of maintaining continuity in reporting research results. Apart from the implementation of adjustment itself, the main differences in the CES effort versus census adjustment for 1990 are timing and sample size. The latter directly affects our research results because with a CES, less accurate "factors" will be available for synthetic estimation use.

I.B. References

The references needed as background for this report are those papers, reports and presentations provided by members of the Small Area Research Group of the Statistical Research Division (SRD), Bureau of the

Census. We list the reports below with a brief description of their contents. We consider only simulation work using artificial populations. The artificial populations were used as a standard for comparison with adjustment results and the census at various levels of geography and characteristics.

a. Isaki, Diffendal and Schultz(1986). "Statistical Synthetic Estimates of Undercount for Small Areas", Proceedings of the Bureau of the Census Second Annual Research Conference, pg 557-569, Reston, Virginia. - Describes the basic small area adjustment problem and the construction of the artificial population. Synthetic estimators are proposed and evaluated using several measures of performance for state and county levels and for race groups but assuming known factors.

b. Schultz, Huang, Diffendal and Isaki (1986). "Some Effects of Statistical Synthetic Estimation on Census Undercount of Small Areas", 1986 Proceedings of the Section on Survey Research Methods of the American Statistical Association. - Introduces sampling error into the adjustment factor and examines the effects on synthetic estimation of counts down to the county level.

c. Isaki and Schultz (1987). "Report on the Effects of the Violations of Assumptions on Regression Estimation of Census Coverage Error", Statistical Research Division Report Series, CENSUS/SRD/RR-87/04. - Looks at regression assumptions such as failure to include an explanatory variable, bias in the direct estimates of undercount and the synthetic regression assumption. Comparisons were made at the state and county total population level.

d. Isaki, Diffendal and Schultz (1987). "Report on Statistical Synthetic Estimation for Small Areas", Statistical Research Division Report Series, CENSUS/SRD/RR-87-02. - Describes several synthetic estimators in detail and compares them at the state and county level when adjustment factors are known and estimated.

e. Diffendal, Schultz, Huang and Isaki (1987). "Comparison of Adjustment Methods for Census Undercount in Small Areas", 1987 Proceedings of the Social Statistics Section of the American Statistical Association. - Includes regression based adjustment results and compares them, at the county level. Also looks at synthetic estimators at the place and enumeration district level for several states.

f. Isaki, Schultz, Diffendal and Huang (1988). "On Estimating Census Undercount in Small Areas", Journal of Official Statistics, Vol 4, No. 2. - Comprehensive review of the adjustment factors and comparison of adjustment methods. A good definition of the artificial populations is provided.

The last reference in the above is a summary of our work to date based on the artificial populations. The reader should be familiar with its contents. It is assumed that the reader is familiar with the artificial populations, sampling simulation, notation and measures of performance used in the reference.

I.C. Contents

The main purpose of this report is to document adjustment (now coverage evaluation) results not reported elsewhere. Principally, this implies that block results for New Jersey as well as place and enumeration district results for a handful of additional states will be provided. In section II, the results for New Jersey are provided. The areas range from counties to blocks. In section III, county, place and enumeration district results for New York, California, Missouri, North Dakota and Mississippi are presented. The results are provided for several coverage evaluation methods for two artificial populations and for both known and replicate factors.

II. New Jersey Coverage Estimates

The various geographic levels for New Jersey - counties, places, enumeration districts and blocks are examined with respect to coverage evaluation to provide the reader with a sense of the magnitude of "error" as one turns from one geographic level to another. Block coverage evaluation estimates are available for New Jersey only, because of costs. In the following, aside from block results, restricting discussion to replicate factor results will suffice. The same conclusions would be drawn using the known factor results. Tables of measures of performance for the known factor cases are provided in Tables 1a-5a.

II.A.Counties (21)

In the case of replicate factors and in addition to the two synthetic estimators Syn 2 and Syn DA for counties, we also have two regression estimates, Smoothed Factor and Smoothed State. Using Artificial Population 3 (AP3) as the standard, Syn 2 performed best according to all of the measures of performance (See Table 1). Using Artificial Population 2 (AP2) as the standard, Smoothed State performs better than the rest for almost all measures. Syn 2 performed best with respect to some absolute relative error (ARE) type measures and an absolute difference in proportion (ADP) type measure while Smoothed Factor does best in the PI measure. The reader is referred to Table 1a for the known factor situation. The census was inferior to all four adjustment methods.

II.B.Places (462)

For places the Smoothed State estimate was not implemented because the appropriate explanatory variables were not readily available. Among the remaining three estimation methods and the census, Syn 2 was judged to be the best for both AP2 and AP3. Syn DA performed best for a few measures but Syn 2 was better overall. For places, the census was nearly inferior over all measures except for the "count" measures and MARE. Stratifying the 462 places by size classes (< 10,000; 10,000-50,000; 50,000+) and repeating the measures also reveals that for 50,000+ places, Syn 2 is best (both AP2 and AP3). For the other two size classes (both AP2 and AP3), Syn DA does perform best for some measures (See Tables 3 and 4).

One measure of interest is the MARE. For counties using the Syn 2 method, the MARE is approximately .0070. This is the figure for places

as well. The MARE for places 50,000+ is double that for counties. The magnitude is of interest because (jumping ahead) it is of the same level of MARE for ED's with MAREs for blocks at about the same level for the replicate case. Census MARE results are lower for blocks than for EDs. Another is the maximum ARE which is over 13% for the census in some place 50,000+.

II.C.Enumeration Districts (7657)

The pattern of superiority among Syn 2, Syn DA and the census is the same for both AP2 and AP3. Syn 2 is superior in all measures except SADP and the count of ED's with respect to ARE. In the former, Syn DA is best while in the latter the census is best. The census has smaller MARE than Syn DA. The max ARE is of the order of .65. The results are presented in Table 5. An additional 12 ED's have no census count.

II.D.Blocks (82,434)

The coverage evaluation results for blocks are presented in Table 6 for both known and replicate factors. The Smoothed Factor result is based on replicate factors. Coverage evaluation results at this level of geography depend on whether factors are known or estimated. In both cases and for either AP2 and AP3, the census has the smallest MARE at about .0105 versus about .0155 for ED's. This was surprising. In a closer examination of why the MARE measure was smaller for the census than for the coverage evaluation estimate the possibility of a rounding error problem was examined. Census, truth and coverage estimation totals were summed for both blocks and counties, the sums differed by less than 1 percent. Therefore, it does not appear that rounding error is responsible for the smaller MARE in the block results. However, at the block level in 86% of the blocks, census = truth. Therefore, it is

conceivable that many zeros had an effect on the MARE. Apart from the MARE, both Syn DA and Syn 2 computed with known factors were superior to the census. Syn DA was superior to Syn 2 for the count measures, MARE and PI. Otherwise, Syn 2 performed better. The max ARE is .8889 for all methods (including the census). In the replicate factor case, Syn DA and Syn 2 each perform best for approximately half of the measures. Smoothed factor is not better than either of the other two adjustment methods. An additional 407 blocks have no census count.

The α measure was also examined for AP2 under the known factor situation for Syn 2. The blocks with zero census counts were eliminated from this analysis. The blocks where census equaled Syn 2 estimates were also eliminated, the remaining blocks were sorted based on the size of AP2 and split into 4 groups of 10430 blocks each.

group	α(cen)	α(Syn 2)	Range of truth
1	1598	1823	2-45
2	2223	2393	45-88
3	3449	3150	88-154
4	17775	12637	154-10207
	25,045	20,003	

It is clear from this example that the α is larger in the more populated blocks. It is also clear that Syn 2 performs better than the census in the more populated blocks. Therefore, the α measure overall is smaller for Syn 2 than for the census.

Overall, for New Jersey geographic levels, it appears that Syn 2 is superior to the other methods considered. The exceptions for counties where Smoothed State did better using AP2 and for blocks using both AP2 and AP3 where Syn DA was a bonafide competitor. The census is superior for both AP2 and AP3 using MARE as the performance measure.

Table 1. Measures of Performance Applied to the 21 Counties of New Jersey Using 4 Adjustment Techniques for Artificial Population 2 and 3 Based on a Single Replicate

	Syn 2	Syn DA	Smoothed Factor	Smoothed State	Census
No. of counties where $ARE(C_i) < ARE(E_i)$	4	9	5	7	
No. of counties where $ADP(C_i) < ADP(E_i)$	4	6	3	6	
MARE	.0070	.0095	.0079	.0081	.0131
Max ARE	.0399	.0420	.0501	.0311	.0716
Median ARE	.0029	.0066	.0049	.0048	.0072
α	1869	2205	2709	1617	5754
SADP	.0114	.0125	.0135	.0107	.0162
RSADP	1.418	1.296	1.194	1.511	-
PI	.799	.734	.796	.669	-
ϕ	1764	2205	2562	1617	3591
MP1 x 10^{+3}	.2401	.2973	.349	.2174	.5016

	Syn 2	Syn DA	Smoothed Factor	Smoothed State	Census
No. of counties where $ARE(C_i) < ARE(E_i)$	4	9	6	6	
No. of counties where $ADP(C_i) < ADP(E_i)$	3	4	4	4	
MARE	.0073	.0097	.0082	.0087	.0129
Max ARE	.0444	.0472	.0544	.0446	.0793
Median ARE	.0028	.0069	.0050	.0046	.0069
α	2247	2688	3129	2394	6825
SADP	.0114	.0137	.0144	.0128	.0178
RSADP	1.418	1.297	1.231	1.389	-
PI	.779	.778	.778	.778	-
ϕ	2142	2688	2961	2373	4452
MP1 x 10^{+3}	.2896	.3624	.403	.3201	.6211

Table 1a. Measures of Improvement Applied to the 21 Counties of New Jersey Using 2 Adjustment Techniques for Artificial Populations 2 and 3 Based on Known Factors

AP2/New Jersey	Syn 2	Syn DA	Census
No. of counties where $ARE(C_i) < ARE(E_i)$	4	9	-
No. of counties where $ADP(C_i) < ADP(E_i)$	4	6	-
MARE	.0070	.0095	.0131
Max ARE	.0399	.0420	.0716
	1866	2208	5752
SADP	.0114	.0125	.0161
RSADP	1.4181	1.2962	-
PI	.779	.734	-
	1770	2205	3598
MP1	.240	.297	.501

AP3/New Jersey	Syn 2	Syn DA	Census
No. of counties where $ARE(C_i) < ARE(E_i)$	4	9	-
No. of counties where $ADP(C_i) < ADP(E_i)$	3	4	-
MARE	.0073	.0097	.0129
Max ARE	.0444	.0472	.0793
	2240	2696	6836
SADP	.0122	.0137	.0178
RSADP	1.459	1.297	.0178
PI	.847	.778	
	2137	2688	4452
MP1 x 10^3	.290	.362	.621

Table 2. Measures of Performance Applied to 462 Places of New Jersey Using 3 Adjustment Techniques for Artificial Populations 2 & 3 on a Single Replicate

AP2/New Jersey	Syn 2	Syn DA	Smoothed Factor	Census
No. of places where $ARE(C_i) < ARE(E_i)$	225	309	255	-
No. of places where $ADP(C_i) < ADP(E_i)$	62	82	77	-
MARE	.0071	.0098	.0077	.0081
Max ARE	.1171	.0973	.1064	.1369
	3976	4843	5553	9731
SADP	.0168	.0167	.0182	.0226
PI	.814	.801	.799	-
	3630	4839	5371	7543
MP1 x 10^{+3}	.6053	.7962	.8920	1.287
RSADP	1.3474	1.3570	1.2398	-

AP3/New Jersey	Syn 2	Syn DA	Smoothed Factor	Census
No. of places where $ARE(C_i) < ARE(E_i)$	214	312	266	-
No. of places where $ADP(C_i) < ADP(E_i)$	52	73	66	-
MARE	.0058	.0087	.0068	.0071
Max ARE	.1161	.1077	.1182	.1546
	4812	5957	6609	12068
SADP	.0177	.0179	.0192	.0251
PI	.83	.76	.81	-
	4308	5954	6396	9500
MP1 x 10^{+3}	.7195	.9779	1.0615	1.6239
RSADP	1.4229	1.4022	1.3129	-

Table 2a. Measures of Performance Applied to 462 Places in New Jersey Using 2 Adjustment Techniques for Artificial Populations 2 and 3 Based on Known Factors

AP2/New Jersey	Syn 2	Syn DA	Census
No. of places where $ARE(C_i) < ARE(E_i)$	230	300	-
No. of places where $ADP(C_i) < ADP(E_i)$	68	84	-
MARE	.0069	.0095	.0081
Max ARE	.0808	.0989	.1369
	3461	4914	9731
SADP	.0150	.0168	.0226
PI	.79	.79	-
	3360	4898	7543
MP1 x 10^{+3}	.5565	.8072	1.2874
RASDP	1.5098	1.3474	-

AP3/New Jersey	Syn 2	Syn DA	Census
No. of places where $ARE(C_i) < ARE(E_i)$	240	297	-
No. of places where $ADP(C_i) < ADP(E_i)$	53	70	-
MARE	.0061	.0083	.0071
Max ARE	.0900	.1094	.1549
	4264	5988	12068
SADP	.0159	.0180	.0251
PI	.82	.76	-
	4143	5969	9499
MP1 x 10^{+3}	.6856	.9824	1.624
RSADP	1.5777	1.3963	-

Table 3. Measures of Performance Applied to 462 Places of New Jersey, Split Into 3 Size Groupings* ($\leq$ 10,000, from 10,001 to 50,000, and Greater Than 50,000) Using 3 Adjustment Techniques for Artificial Population 2 Based on a Single Replicate

	Syn 2	Syn DA	Smoothed Factor	Census
No. of places $\leq$ 10,000	304	304	304	304
No. of places where $ARE(C_i) < ARE(E_i)$	144	192	154	-
No. of places where $ADP(C_i) < ADP(E_i)$	41	51	46	-
MARE	0.0065	0.0091	0.0071	0.0074
Max ARE	0.0573	0.0597	0.0571	0.0737
α	91	154	100	149
SADP	0.0024	0.0020	0.0022	0.0033
PI	0.90	0.86	0.88	-
ϕ	89	113	93	102
MP1 x 10^{+3}	0.0325	0.0274	0.0289	0.0564
RSADP	1.353	1.651	1.472	-

	Syn 2	Syn DA	Smoothed Factor	Census
No. of places between 10,0001 and 50,000	139	139	139	139
No. of places where $ARE(C_i) < ARE(E_i)$	78	107	94	-
No. of places where $ADP(C_i) < ADP(E_i)$	16	27	26	-
MARE	0.0072	0.0105	0.0078	0.0075
Max ARE	0.1171	0.0906	0.0955	0.1218
α	913	774	676	1139
SADP	0.0063	0.0056	0.0061	0.0077
PI	.85	.78	.78	-
ϕ	909	651	662	895
MP1 x 10^{+3}	0.1709	0.1326	0.1380	0.1993
RSADP	1.220	1.373	1.279	-

	Syn 2	Syn DA	Smoothed Factor	Census
No. of places greater than 50,000	19	19	19	19
No. of places where $ARE(C_i) < ARE(E_i)$	3	10	7	-
No. of places where $ADP(C_i) < ADP(E_i)$	5	4	5	-
MARE	0.0154	0.0159	0.0168	0.0236
Max ARE	0.0742	0.0973	0.1064	0.1369
α	2972	3915	4777	8444
SADP	0.0080	0.0090	0.0099	0.0116
PI	0.77	0.66	0.67	-
ϕ	1925	3400	3802	4941
MP1 x 10^{+3}	0.4020	0.6361	0.7250	1.0317
RSADP	1.448	1.282	1.164	-

*Based on census counts.

Table 3a. Measures of Performance Applied to 462 Places of New Jersey, Split into 3 Size Groupings* ($\leq$ 10,000, from 10,001 to 50,000, and from 50,001 and Larger) Using 2 Adjustment Techniques for Artificial Population 2 Based on Known Factors

	Syn 2	Syn DA	Census
No. of places $\leq$ 10,000	304	304	304
No. of places where $ARE(C_i) < ARE(E_i)$	143	186	-
No. of places where $ADP(C_i) < ADP(E_i)$	44	52	-
MARE	0.0066	0.0089	0.0074
Max ARE	0.0591	0.0597	0.0737
α	96	151	149
SADP	0.0018	0.0021	0.0033
PI	0.89	0.86	-
ϕ	95	114	102
MP1 x 10^{+3}	0.0213	0.0291	0.0564
RSADP	1.825	1.574	-

	Syn 2	Syn DA	Census
No. of places between 10,001 and 50,000	139	139	139
No. of places where $ARE(C_i) < ARE(E_i)$	81	104	-
No. of places where $ADP(C_i) < ADP(E_i)$	17	28	-
MARE	0.0065	0.0101	0.0075
Max ARE	0.0808	0.0911	0.1218
α	520	752	1139
SADP	0.0048	0.0057	0.0077
PI	0.86	0.76	-
ϕ	517	652	895
MP1 x 10^{+3}	0.0976	0.134	0.199
RSADP	1.6218	1.3514	-

	Syn 2	Syn DA	Census
No. of places greater than 50,000	19	19	19
No. of places where $ARE(C_i) < ARE(E_i)$	6	10	-
No. of places where $ADP(C_i) < ADP(E_i)$	7	4	-
MARE	0.0153	0.0151	0.0236
Max ARE	0.0789	0.0989	0.1369
α	2845	4011	8444
SADP	0.0084	0.0089	0.0116
PI	0.79	0.64	-
ϕ	2404	3406	4941
MP1 x 10^{+3}	0.4376	0.6441	1.0317
RSADP	1.3780	1.2917	-

*Based on census counts.

Table 4. Measures of Performance Applied to 462 Places of New Jersey Split into 3 Size Groupings* ($\leq$ 10,000, from 10,001 to 50,000, and from 50,001 and Larger) Using 3 Adjustment Techniques for Artificial Population 3 Based on a Single Replicate

	Syn 2	Syn DA	Smoothed Factor	Census
No. of places $\leq$ 10,000	304	304	304	304
No. of places where $ARE(C_i) < ARE(E_i)$	144	192	165	-
No. of places where $ADP(C_i) < ADP(E_i)$	31	40	37	-
MARE	0.0052	0.0075	0.0060	0.0059
Max ARE	0.0719	0.0671	0.0699	0.0810
	82	130	95	132
SADP	0.0024	0.0016	0.0021	0.0038
PI	0.93	0.90	0.90	-
	82	103	91	102
MP1 x 10^{+3}	0.0340	0.0229	0.0286	0.0743
RSADP	1.5651	2.3132	1.8166	-

	Syn 2	Syn DA	Smoothed Factor	Census
No of places between 10,001 and 50,000	139	139	139	139
No. of places where $ARE(C_i) < ARE(E_i)$	66	108	95	-
No. of places where $ADP(C_i) < ADP(E_i)$	15	26	23	-
MARE	0.0058	0.0099	0.0069	0.0071
Max ARE	0.1161	0.0893	0.0938	0.1223
	846	797	633	1156
SADP	0.0063	0.0056	0.0060	0.0086
PI	0.86	0.79	0.82	-
	833	662	618	917
MP1 x 10^{+3}	0.1626	0.1360	0.1350	0.2204
RSADP	1.3519	1.5341	1.4306	-

	Syn 2	Syn DA	Smoothed Factor	Census
No. of places greater than 50,000	19	19	19	19
No. of places where $ARE(C_i) < ARE(E_i)$	4	12	6	-
No. of places where $ADP(C_i) < ADP(E_i)$	6	7	6	-
MARE	0.0162	0.0195	0.0175	0.0262
Max ARE	0.0882	0.1077	0.1181	0.1546
α	3885	5031	5881	10779
SADP	0.0089	0.0107	0.0111	0.0128
PI	0.79	0.68	0.73	-
ϕ	2558	4547	4791	6240
MP1 x 10^{+3}	0.5230	0.8190	0.8980	1.3293
RSADP	1.4344	1.1933	1.1533	-

*Based on census counts.

Table 4a. Measures of Performance Applied to 462 Places of New Jersey, Split into 3 Size Groupings* (< 10,000, from 10,001 to 50,000, and from 50,001 and Larger) Using 2 Adjustment Techniques for Artificial Population 3 Based on Known Factors

	Syn 2	Syn DA	Census
No. of places < 10,000	304	304	304
No. of places where $ARE(C_i) < ARE(E_i)$	155	183	-
No. of places where $ADP(C_i) < ADP(E_i)$	33	37	-
MARE	0.0056	0.0072	0.0059
Max ARE	0.0732	0.0681	0.0810
α	92	123	132
SADP	0.0017	0.0017	.0038
PI	0.92	0.90	-
ϕ	92	103	102
MP1 $x10^{+3}$	0.0212	0.0240	0.0743
RSADP	2.2451	2.2086	-

	Syn 2	Syn DA	Census
No. of places between 10,001 and 50,000	139	139	139
No. of places where $ARE(C_i) < ARE(E_i)$	79	104	-
No. of places where $ADP(C_i) < ADP(E_i)$	13	26	-
MARE	0.0057	0.0092	0.0071
Max ARE	0.0793	0.0900	0.1223
α	462	751	1156
SADP	0.0047	0.0056	0.0086
PI	0.90	0.78	-
ϕ	459	649	917
MP1 x 10^{+3}	0.0900	0.1351	0.2204
RSADP	1.8387	1.5185	-

	Syn 2	Syn DA	Census
No. of places greater than 50,000	19	19	19
No. of places where $ARE(C_i) < ARE(E_i)$	6	10	-
No. of places where $ADP(C_i) < ADP(E_i)$	7	7	-
MARE	0.0166	0.0187	0.0262
Max ARE	0.0900	0.1094	0.1546
α	3710	5115	10779
SADP	0.0096	0.0106	0.0128
PI	0.84	0.67	-
ϕ	3198	4532	6239
MP1 x 10^{+3}	0.5743	0.8234	1.3292
RSADP	1.3327	1.1999	-

*Based on census counts.

Table 5. Measures of Performance of Statistical Synthetic Estimators Compared to the Census at the ED Level for New Jersey (7669 EDs)* Using AP2 and AP3 for Total Population Based on a Single Replicate

AP2/New Jersey

	Syn 2	Syn DA	Census
No. of EDs where $ARE(C_i) < ARE(E_i)$	3959	4549	
No. of EDs where $ADP(C_i) < ADP(E_i)$	1564	1605	
MARE	.0145	.0173	.0153
Max ARE	.6267	.640	.659
α	11419	12360	17809
SADP	.0187	.0186	.0232
RSADP	1.241	1.250	-
PI	.807	.792	-
ϕ	11113	12360	15656
MP1 x 10^{+3}	1.516	1.665	2.182

AP3/New Jersey

	Syn 2	Syn DA	Census
No. of EDs where $ARE(C_i) < ARE(E_i)$	3819	4611	
No. of EDs where $ADP(C_i) < ADP(E_i)$	1449	1670	
MARE	.0142	.0178	.0157
Max ARE	.6627	.677	.694
α	12881	14057	20337
SADP	.0197	.0193	.0255
RSADP	1.297	1.318	-
PI	.822	.791	-
ϕ	12449	14057	17953
MP1 x 10^{+3}	1.701	1.892	2.505

*12 EDs have no census count.

Table 5a. Measures of Improvement of Statistical Synthetic Estimators Compared to the Census at the Ed Level for New Jersey (7669 EDs)* Using AP2 and AP3 for Total Population Based on Known Factors

AP2/New Jersey Measures	Syn 2	Syn DA	Census
No. of EDs where $ARE(C_i) < ARE(E_i)$	4165	4457	-
No. of EDs where $ADP(E_i) < ARE(E_i)$	1549	1587	-
MARE	0.0148	0.0170	0.0153
Max ARE	0.6293	0.6373	0.6587
α	10774	12382	17809
SADP	0.0173	0.0187	0.0232
RSADP	1.3415	1.2413	-
PI	.719	.711	-
ϕ	10678	12379	15656
MP1 x 10^{+3}	1.4485	1.6694	2.1822

AP3/New Jersey	Syn 2	Syn DA	Census
No. of EDs where $ARE(C_i) < ARE(E_i)$	4192	4501	-
No. of EDs where $ADP(C_i) < ADP(E_i)$	1458	1638	-
MARE	0.0150	0.0173	0.0157
Max ARE	0.6643	0.6739	0.6930
α	12200	14029	20336
SADP	0.0181	0.0194	0.0255
RSADP	1.4111	1.3134	-
PI	0.818	0.793	-
ϕ	12097	14021	17952
MP1 x 10^{+3}	1.6399	1.8905	2.5044

*110 EDs have no census count.

Table 6. Measures of Performance for Synthetic Estimators for New Jersey 82, 434 Blocks with Known and Replicate Factors for AP2 and AP3

AP2 Measure	K** Syn DA	Syn DA	K** Syn 2	Syn 2	Smoothed Factor	Census
No. of blocks where $ARE(C_i) < ARE(E_i)$*	22869	10703	32685*	27419	34931	
No. of blocks where $ADP(C_i) < ADP(E_i)$*	19112	12165	27876*	24751	28652	
MARE	.0140	.0122	.0200	.0155	.0220	.0107
Max ARE	.8889	.8889	.8889	.8889	.8889	.8889
α	21606	19892	20003	19537	22929	25122
SADP	.0254	.0238	.0245	.0244	.0269	.0280
PI	.643	.749	.610	.632	.606	
ϕ	21383	19482	19990	19305	22911	22703
MP1 x 10^{+3}	2.909	2.660	2.682	2.627	3.073	3.168
RSADP	1.103	1.177	1.141	1.148	1.041	

AP3 Measure	K** Syn DA	Syn DA	K** Syn 2	Syn 2	Smoothed Factor	Census
No. of blocks where $ARE(C_i) < ARE(E_i)$	39441	10246	30847	24585	31378	
No. of blocks where $ADP(C_i) < ADP(E_i)$	22299	11859	28820	25587	29627	
MARE	.0219	.0121	.0214	.0157	.0249	.0103
Max ARE	.8889	.8889	.8889	.8889	.8889	.8889
α	25646	22087	22828	21876	27100	28206
SADP	.0292	.0246	.0267	.0256	.0306	.0300
PI	.545	.780	.612	.632	.609	
ϕ	24913	21759	22759	21668	26944	25557
MP1 x 10^{+3}	3.283	2.964	3.041	2.944	3.589	
RSADP	1.029	1.222	1.123	1.174	.982	3.569

* The count measures defined here are potentially misleading. To illustrate the K Syn 2 case has been examined. The measure is defined with an inequality. The number of cases where $ARE(C_i) < ARE(E_i)$ is 32685, however, if we look at $ARE(C_i) \leq ARE(E_i)$ there are 75212, implying that the census is the perferred method given this particular measure, this is in sharp countrast to the original conclusion using $ARE(C_i) < ARE(E_i)$.

** K = Known factor

III. County Coverage Estimates by State for Selected States (New York, North Dakota, Missouri, Mississippi, California

We selected five additional states to apply coverage estimation methods. The states were chosen principally because they included pre-test or dress rehearsal sites. New York was chosen because it was an urban, eastern state and the subject of litigation. For each state, measures of performance were computed for coverage estimates at the county level. This was done for both AP2 and AP3 and for known and estimated factors. In the known factor case, the two methods were Syn 2 and Syn DA. Results for the census are also presented. In the estimated (or replicate) factor case, a third method, smoothed factor (SF) was also considered. In both situations, the measures of performance for the census method are identical.

Individual state tables for both AP2 and AP3 by replication situation are provided in the Appendix. In Table 7 below we provide a summary of the "best" method by state and population/replication situation together with any competitor with at least three of the best measures of performance. (We treated each measure as equal in importance; RSADP is redundant.) When none is "best" the designation "mixed" is used. The method marked with a prime (') has the smallest MP1 measure. The MP1 measure is a popular one with statisticians working in this area.

Table 7.Summary of Coverage Estimate Performance at the County Level Within Selected States

Population/Replicate	State				
	N.Y.	N.D.	MO.	MS.	CA.
AP2/Replicate	Syn 2'(SF)	Cen(Syn 2')	Syn 2'(SF)	Syn 2'	Cen'
AP2/Known	Syn 2'(DA)	Cen'(Syn2')	Syn 2'	Syn 2'	Mixed (all 3)
AP3/Replicate	Mixed *	Cen'	Syn 2'	Syn 2'	SF'
AP3/Known	Syn 2'	Cen'	Syn 2'	Syn 2'	Syn 2'

Based on Table 7 it appears that Syn 2 is the coverage estimation procedure with the best performance overall. For N.D., the census is best. In the replicate situation, it is interesting to note that SF is not dominant, i.e., among county coverage estimates considered, Syn 2 (no coverage factor smoothing) does better than SF (smoothed coverage factor). California is another interesting situation for AP2 where the census is "best".

IV. Place Coverage Estimates by State for Selected States (New York, North Dakota, Missouri, Mississippi, California)

The next smallest census geographic unit to counties is the place. Places are similar to counties in that they usually are administrative (governmental) units but on a smaller scale. While places are of interest on their own, they were also of interest with regard to another coverage estimate, termed smoothed state. In using smoothed state, an assumption is made that the method used to estimate for counties would also do well for places, at least the large places. This issue is not pursued further because

* All methods except the census has at least 3 "best" measures. Syn DA had the best IMP1.

** Syn 2 has the best IMP1 measure.

this is that the smoothed state approach required multiple passes of the census data file.

We continue with a summary of coverage estimation methods as they pertain to places. The results are provided in Table 8 below. All conditions remain as they pertained to Table 7 except now, places as opposed to counties are of interest.

Table 8. Summary of Coverage Estimate Performance at the Place Level Within Selected States

Population/Replicate	State				
	N.Y.	N.D.	MO.	MS.	
AP2/Replicate	Mixed*	Cen'	SF'(Syn 2)	Syn 2'	SF'(Syn DA)
AP2/Known	Syn 2'	Cen'	Syn 2'	Syn 2'	Syn 2'
AP3/Replicate	Mixed*	Cen'(Syn DA)	Syn 2(SF')	Syn 2'	SF'
AP3/Known	Syn 2'	Cen'	Syn 2'(Syn DA)	Syn 2'	Syn 2'

As in the previous section, the census is superior in N.D. In the known factor case, Syn 2 is superior outside of N.D. In the replicate factor case, we begin to show a mix of performance. Syn 2 is superior in MS. but in the remaining states, other methods do as well or better. The smoothed factors procedure appears to be entering as a viable candidate. When looked at by size of place - <10,000; 10,000-50,000; 50,000+ there is no definite pattern of SF doing well for the larger places as was hypothesized for the smoothed state approach.

*All three methods other than the census. Syn DA has smallest IMP1.

V. Enumeration District Estimates by State for Selected States (New York, North Dakota, Missouri, Mississippi, California)

The final geographic unit we considered was the enumeration district which averages around 700 persons. Table 9 presents a summary of the results.

Table 9. Summary of Coverage Estimate Performance at the Enumeration District Level Within Selected States

Population/Replicate	State				
	N.Y.	N.D.	MO.	MS.	CA.
AP2/Replicate	Mixed(Syn'DA,SF)*	Cen'(Syn2)	Syn 2'	Syn 2'(SF)	Syn DA**
AP2/Known	Syn 2'(Syn DA)	Cen'	Syn 2'	Syn 2'(Cen)	Syn 2'
AP3/Replicate	Mixed(Syn'DA,SF)	Cen'(Syn2)	Syn 2'	Syn 2'	SF'
AP3/Known	Syn DA'	Cen'	Syn 2'	Syn 2'(Cen)	Syn 2'(Cen)

In N.D., the census remains superior and also for some instances in M.S. Elsewhere, Syn 2 is superior almost always, except for N.Y. in the known factor case. In the replicate case, Syn 2, Syn DA and SF are competitors. In summary, the census is the better procedure for N.D. down to the ED level. For the other states Syn 2 is usually superior for the known factor situation from counties to EDs. This is true for both AP2 and AP3. When replicate factors are considered Syn 2 has Syn DA and SF as competitors. This is especially troublesome because the replicate situation assumed a sample size much larger than actually budgeted for use in 1990. Assuming SF is the procedure adopted, further work is necessary to evaluate its performance under more realistic conditions.

* Tied in performance measure count.
**SF has best IMP1 measure.

Appendix - Table III.A. Measures of Performance for County Coverage Estimators for AP2 and AP3 for Replicate Factors Within Selected States

New York - 58 counties

A. AP2

Measures	Syn 2	Syn DA	S F	Cen
No. of counties where $ARE(C_i) < ARE(E_i)$	17	37	23	
No. of counties where $ADP(C_i) < ADP(E_i)$	5	3	3	
MARE	0.0004	0.0056	0.0038	0.0058
Max ARE	0.0155	0.0116	0.0076	0.0278
α	401.2	432.3	549.5	6131.9
SADP	0.0026	0.0049	0.0055	0.0105
PI	0.8504	0.950	0.950	
ϕ	349.6	388.3	470.6	1634.4
MP1 x 10^{+3}	0.0241	0.0268	0.0327	0.1171
RSADP	4.033	2.141	1.901	

New York

B. AP3

Measures	Syn 2	Syn DA	S F	Cen
No. of counties where $ARE(C_i) < ARE(E_i)$	20	37	26	
No. of counties where $ADP(C_i) < ADP(E_i)$	3	2	2	
MARE	0.0030	0.0043	0.0031	0.0048
Max ARE	0.0160	0.0099	0.0084	0.0339
α	337.5	306.9	555.2	8819.6
SADP	0.0025	0.0036	0.0055	0.0139
PI	0.051	0.970	0.0704	
ϕ	322.8	214.8	462.4	2846.2
MP1 x 10^{+3}	5.468	0.0147	0.0321	0.2046
RSADP	5.648	3.902	2.550	

North Dakota - 53 Counties
A. AP2

Measures	Syn 2	Syn DA	S F	Cen
No. of counties where $ARE(C_i) < ARE(E_i)$	41	45	43	
No. of counties where $ADP(C_i) < ADP(E_i)$	36	32	34	
MARE	0.0038	0.0061	0.0043	0.0019
Max ARE	0.0105	0.0105	0.0103	0.0157
α	4.0	26.1	8.4	2.7
SADP	0.0012	0.0015	0.0012	0.0010
PI	0.503	0.381	0.3513	
ϕ	2.0	2.9	2.0	2.0
MP1 x 10^{+3}	0.0043	0.0064	0.0045	0.0044
RSADP	0.8185	0.6991	0.8375	

North Dakota
B. AP3

Measures	Syn 2	Syn DA	S F	Cen
No. of counties where $ARE(C_i) < ARE(E_i)$	41	44	43	
No. of counties where $ADP(C_i) < ADP(E_i)$	37	36	34	
MARE	0.0023	0.0043	0.0027	0.0012
Max ARE	0.0105	0.0105	0.0105	0.0109
α	1.6	12.0	3.5	0.8
SADP	0.0008	0.0010	0.0009	0.0006
PI	0.166	0.415	0.2047	
ϕ	0.7	1.2	0.9	0.6
MP1 x 10^{+3}	0.0015	0.0027	0.0019	0.0013
RSADP	0.662	0.578	0.596	

Missouri - 115 Counties
A. AP2

Measures	Syn 2	Syn DA	S F	Cen
No. of counties where $ARE(C_i) < ARE(E_i)$	9	41	17	
No. of counties where $ADP(C_i) < ADP(E_i)$	33	32	28	
MARE	0.0058	0.0065	0.005	0.0096
Max ARE	0.0720	0.0681	0.0708	0.0766
α	232.2	284.4	267.1	1424.6
SADP	0.0049	0.0069	0.0066	0.0114
PI	0.729	0.679	0.893	
ϕ	230.6	269.2	238.1	702.4
MP1 x 10^{+3}	0.068	0.079	0.071	0.2133
RSADP	2.331	1.665	1.737	

Missouri
B. AP3

Measures	Syn 2	Syn DA	S F	Cen
No. of counties where $ARE(C_i) < ARE(E_i)$	14	43	25	
No. of counties where $ADP(C_i) < ADP(E_i)$	28	29	26	
MARE	0.0041	0.0048	0.0043	0.0067
Max ARE	0.0554	0.0528	0.0545	0.0588
α	135.0	206.9	184.2	1254.6
SADP	0.0041	0.0057	0.0054	0.0113
PI	0.756	0.695	0.920	
ϕ	135.0	197.7	174.3	688.4
MP1 x 10^{+3}	2.777	1.976	2.102	

Mississippi - 82 Counties
A. AP2

Measures	Syn 2	Syn DA	S F	Cen
No. of counties where $ARE(C_i) < ARE(E_i)$	46	54	54	
No. of counties where $ADP(C_i) < ADP(E_i)$	32	36	38	
MARE	0.0145	0.0192	0.0194	0.0154
Max ARE	0.0698	0.0604	0.0621	0.0898
α	338.2	506.9	499.7	796.8
SADP	0.0112	0.0116	0.0119	0.0129
PI	0.672	0.639	0.637	
ϕ	325.9	355.8	367.8	362.4
MP1 x 10^{+3}	0.239	0.257	0.266	0.2771
RSADP	1.147	1.114	1.081	

Mississippi
B. AP3

Measures	Syn 2	Syn DA	S F	Cen
No. of counties where $ARE(C_i) < ARE(E_i)$	44	56	50	
No. of counties where $ADP(C_i) < ADP(E_i)$	35	36	40	
MARE	0.0130	0.0183	0.0162	0.0133
Max ARE	0.0638	0.05870	0.0584	0.0821
α	274.1	457.6	373.3	640.5
SADP	0.0099	.0106	.0110	
PI	0.647	0.625	0.619	
ϕ	260.1	294.3	309.1	305.1
MP1 x 10^{+3}	0.191	0.213	0.225	0.233
RSADP	1.178	1.105	1.068	

California - 50 Counties
A. AP2

Measures	Syn 2	Syn DA	S F	Cen
No. of counties where $ARE(C_i) < ARE(E_i)$	11	19	29	
No. of counties where $ADP(C_i) < (ADP(E_i)$	31	15	15	
MARE	0.0065	0.0072	0.0087	0.0106
Max ARE	0.0854	0.0805	0.0787	0.0884
α	4394.2	1192.7	1408.9	4654.4
SADP	0.0109	0.0054	0.0054	0.0047
PI	0.259	0.371	0.396	
ϕ	3083.8	1093.8	1071.8	974.5
MP1 x 10^{+3}	0.145	0.052	0.051	0.0478
RSADP	0.425	0.868	0.854	

California
A. AP3

Measures	Syn 2	Syn DA	S F	Cen
No. of counties where $ARE(C_i) < ARE(E_i)$	14	31	30	
No. of counties where $ADP(C_i) < ADP(E_i)$	45	18	16	
MARE	0.0091	0.0095	0.0091	0.0124
Max ARE	0.0661	0.0621	0.0592	0.0690
α	16605.5	2838.7	1961.8	8230.7
SADP	0.0176	0.0072	0.0066	0.0069
PI	0.233	0.356	0.433	
ϕ	8958.0	1927.8	1629.3	1585.9
MP1 x 10^{+3}	0.410	0.0904	0.0768	0.0781
RSADP	.391	0.948	1.048	

Appendix - Table III.B. Measures of Performance for County Coverage Estimators for AP2 and AP3 for Known Factors Within Selected States

New York - 58 Counties

A. AP2 Measures	Syn 2	Syn DA	Census
No. of counties where $ARE(C_i) < ARE(E_i)$	26	36	
No. of counties where $ADP(C_i) < ADP(E_i)$	4	3	
MARE	0.0035	0.0055	0.0058
Max ARE	0.0142	0.0113	0.0278
α	209.3	491.0	6131.9
SADP	0.0022	0.0055	0.0105
PI	0.899	0.950	
ϕ	181.2	483.1	1634.4
MP1 x 10^{+3}	0.0125	0.0334	0.117
RSADP	4.817	1.907	

New York

B. AP3 Measures	Syn 2	Syn DA	Census
No. of counties where $ARE(C_i) < ARE(E_i)$	30	34	
No. of counties where $ADP(C_i) < ADP(E_i)$	2	2	
MARE	0.0030	0.0039	0.0048
Max ARE	0.0135	0.0094	0.0339
α	188.72	293.17	8819.4
SADP	0.0019	0.0040	0.0139
PI	0.970	0.970	
ϕ	153.3	268.9	2846.2
MP1 x 10^{+3}	0.0105	0.0185	0.2045
RSADP	7.339	3.443	

North Dakota - 53 Counties

A. AP2 Measures	Syn 2	Syn DA	Census
No. of counties where $ARE(C_i) < ARE(E_i)$	43	45	
No. of counties where $ADP(C_i) < ADP(E_i)$	37	35	
MARE	0.0042	0.0059	0.0019
Max ARE	0.0097	0.0105	0.0157
α	6.0	24.7	2.7
SADP	0.0013	0.0015	0.0010
PI	0.459	0.213	
ϕ	2.0	2.9	2.0
MP1 x 10^{+3}	0.0044	0.0064	0.0044
RSADP	0.792	0.672	

North Dakota

B. AP3 Measures	Syn 2	Syn DA	Census
No. of counties where $ARE(C_i) < ARE(E_i)$	45	44	
No. of counties where $ADP(C_i) < ADP(E_i)$	36	37	
MARE	0.0030	0.0038	0.0012
Max ARE	0.0105	0.0105	0.0109
α	2.6	9.5	0.8
SADP	0.0008	0.0009	0.0006
PI	0.431	0.348	
ϕ	0.7	1.1	0.6
MP1 x 10^{+3}	0.0015	0.0023	0.0013
RSADP	0.693	0.595	

Missouri - 115 Counties A. AP2 Measures	Syn 2	Syn DA	Census
No. of counties where $ARE(C_i) < ARE(E_i)$	15	38	
No. of counties where $ADP(C_i) < ADP(E_i)$	27	32	
MARE	0.0056	0.0064	0.0096
Max ARE	0.0713	0.0686	0.0766
α	020.2	280.6	1424.0
SADP	0.0056	0.0069	0.0114
PI	.898	0.679	
ϕ	175.6	269.4	702.4
MP1 x 10^{+3}	.0521	0.0792	0.213
RSADP	2.052	1.666	

Missouri A. AP3 Measures	Syn 2	Syn DA	Census
No. of counties where $ARE(C_i) < ARE(E_i)$	17	39	
No. of counties where $ADP(C_i) < ARE(E_i)$	21	28	
MARE	0.0039	0.0045	0.0067
Max ARE	0.0551	0.0529	0.0588
α	123.0	199.4	1254.6
SADP	0.0043	0.0057	0.0113
PI	0.927	0.711	
ϕ	110.8	195.6	688.4
MP1 x 10^{+3}	0.0328	0.0577	0.2087
RSADP	2.616	1.992	

Mississippi - 82 Counties

A. AP2 Measures	Syn 2	Syn DA	Census
No. of counties where $ARE(C_i) < ARE(E_i)$	47	53	
No. of counties where $ADP(C_i) < ADP(E_i)$	32	35	
MARE	0.0150	0.0189	0.0154
Max ARE	0.0689	0.0606	0.0898
	338.7	493.8	796.8
SADP	0.0095	0.0116	0.0129
PI	0.637	0.642	
	282.2	355.6	362.4
MP1 x 10^{+3}	0.206	0.257	0.277
RSADP	1.360	1.113	

Mississippi

B. AP3 Measures	Syn 2	Syn DA	Census
No. of counties where $ARE(C_i) < ARE(E_i)$	47	54	
No. of counties where $ADP(C_i) < ADP(E_i)$	31	38	
MARE	0.0138	0.0179	0.0133
Max ARE	0.0625	0.0587	0.0820
	284.6	439.8	640.4
SADP	0.0083	0.0106	0.0117
PI	0.646	0.609	
	221.1	295.6	304.9
MP1 x 10^{+3}	0.161	0.214	0.233
RSADP	1.417	1.103	

California - 57 Counties

A. AP2 Measures	Syn 2	Syn DA	Census
No. of counties where $ARE(C_i) < ARE(E_i)$	18	18	
No. of counties where $ADP(C_i) < ADP(E_i)$	16	16	
MARE	0.0069	0.0068	0.0106
Max ARE	0.0807	0.0803	0.0884
α	984.6	1054.5	4654.4
SADP	0.0048	0.0052	0.0047
PI	0.383	0.368	
ϕ	981.2	1049.8	974.5
MP1 x 10^{+3}	0.0468	0.0501	0.0478
RSADP	0.976	0.896	

California

B. AP3 Measures	Syn 2	Syn DA	Census
No. of counties where $ARE(C_i) < ARE(E_i)$	20	24	
No. of counties where $ADP(C_i) < ADP(E_i)$	15	17	
MARE	0.0074	0.0084	0.0124
Max ARE	0.0626	0.0623	0.0690
α	1485.5	2191.5	8230.4
SADP	0.0058	0.0070	0.0069
PI	0.7560	0.391	
ϕ	1467.6	1802.8	1585.9
MP1 x 10^{+3}	0.170	0.085	0.078
RSADP	1.176	0.986	

Appendix - Table IV.A. Measures of Performance for Place Coverage Estimators for AP2 and AP3 for Replicate Factors Witnin Selected States

New York - 964 Places
A. AP2

Measures	Syn 2	Syn DA	S F	Cen
No. of places where $ARE(C_i) < ARE(E_i)$	511	603	528	
No. of places where $ADP(C_i) < ADP(E_i)$	120	112	103	
MARE	0.0062	0.0077	0.0062	0.0062
Max ARE	0.0931	0.0931	0.0931	0.1011
α	975	788	871	6615
SADP	0.0037	0.0058	0.0065	0.0117
PI	0.900	0.932	0.931	
ϕ	924	744	792	2188
MP1 x 10^{+3}	0.0637	0.0513	0.0550	0.1518
RSADP	3.2101	2.0329	1.8152	

New York
B. AP3

Measures	Syn 2	Syn DA	S F	Cen
No. of places where $ARE(C_i) < ARE(E_i)$	509	625	540	
No. of places where $ADP(C_i) < ADP(E_i)$	78	82	65	
MARE	0.0045	0.0060	0.0048	0.0046
Max ARE	0.0875	0.0860	0.0860	0.1005
α	796	624	816	9267
SADP	0.0032	0.0042	0.0061	0.0149
PI	0.916	0.033	0.037	
ϕ	781	532	723	3293
MP1 x 10^{+3}	0.0538	0.0365	0.0501	0.2367
RSADP	4.7140	3.5525	2.4222	

North Dakota - 368 Places
A. AP2

Measures	Syn 2	Syn DA	S F	Cen
No. of places where $ARE(C_i) < ARE(E_i)$	224	182	244	
No. of places where $ADP(C_i) < ADP(E_i)$	297	261	292	
MARE	0.0042	0.0045	0.0051	0.0016
Max ARE	0.0736	0.0701	0.0736	0.0782
α	11	35	16	9
SADP	0.0020	0.0020	0.0020	0.0014
PI	0.310	0.449	0.285	
ϕ	9	12	10	9
MP1 x 10^{+3}	0.0200	0.0250	0.0213	0.0189
RSADP	0.7069	0.6802	0.7219	

North Dakota
B. AP3

Measures	Syn 2	Syn DA	S F	Cen
No. of places where $ARE(C_i) < ARE(E_i)$	164	149	187	
No. of places where $ADP(C_i) < ADP(E_i)$	305	324	278	
MARE	0.0021	0.0029	0.0025	0.0010
Max ARE	0.0394	0.0358	0.0382	0.0418
α	4	16	7	3
SADP	0.0014	0.0015	0.0014	0.0008
PI	0.217	0.489	0.341	
ϕ	3	5	4	3
MP1 x 10^{+3}	0.0073	0.0116	0.0086	0.0054
RSADP	0.5794	0.5195	0.5760	

Missouri - 943 Places
A. AP2

Measures	Syn 2	Syn DA	S F	Cen
No. of places where $ARE(C_i) < ARE(E_i)$	333	373	410	
No. of places where $ADP(C_i) < ADP(E_i)$	242	260	220	
MARE	0.0084	0.0097	0.0088	0.0091
Max ARE	0.2568	0.2531	0.2568	0.2605
α	623	656	619	1859
SADP	0.0061	0.0081	0.0081	0.0136
PI	0.728	0.838	0.868	
ϕ	621	641	590	1137
MP1 x 10^{+3}	0.1834	0.1882	0.1748	0.3452
RSADP	2.2213	1.6926	1.6900	

Missouri
B. AP3

Measures	Syn 2	Syn DA	S F	Cen
No. of places where $ARE(C_i) < ARE(E_i)$	276	348	344	
No. of places where $ADP(C_i) < ADP(E_i)$	198	218	196	
MARE	0.0059	0.0071	0.0063	0.0064
Max ARE	0.2304	0.1992	0.2105	0.2399
α	433	489	439	1602
SADP	0.0048	0.0067	0.0065	0.132
PI	0.755	0.849	0.867	
ϕ	433	480	429	
MP1 x 10^{+3}	0.1280	0.1413	0.1271	0.3140
RSADP	2.7256	1.9625	2.0213	

Mississippi - 310 Places
A. AP2

Measures	Syn 2	Syn DA	S F	Cen
No. of places where $ARE(C_i) < ARE(E_i)$	195	203	216	
No. of places where $ADP(C_i) < ADP(E_i)$	134	143	148	
MARE	0.0172	0.0216	0.0223	0.0131
Max ARE	0.2435	0.2318	0.2341	0.2635
σ	544	734	709	1017
SADP	0.0124	0.0130	0.0132	0.0143
PI	0.648	0.620	0.640	
ϕ	532	582	578	582
MP1 x 10^{+3}	0.3901	0.4207	0.4177	0.4454
RSADP	1.1494	1.0968	1.0821	

Mississippi
B. AP3

Measures	Syn 2	Syn DA	S F	Cen
No. of places where $ARE(C_i) < ARE(E_i)$	195	202	201	
No. of places where $ADP(C_i) < ADP(E_i)$	130	145	142	
MARE	0.0152	0.0206	0.0186	0.0114
Max ARE	0.2348	0.2241	0.2277	0.2539
α	442	649	548	829
SADP	0.0109	0.0121	0.0122	0.0130
PI	0.6351	0.6136	0.647	
ϕ	428	485	483	493
MP1 x 10^{+3}	0.3140	0.3510	0.3525	0.3762
RSADP	1.1923	1.0755	1.0664	

California - 781 Places

A. AP2

Measures	Syn 2	Syn DA	S F	Cen
No. of places where $ARE(C_i) < ARE(E_i)$	327	383	425	
No. of places where $ADP(C_i) < ADP(E_i)$	350	247	246	
MARE	0.0104	0.0099	0.0111	0.0114
Max ARE	0.2433	0.2309	0.2367	0.2675
α	7976	3648	3869	7875
SADP	0.0121	0.0071	0.0074	0.0091
PI	0.473	0.687	0.719	
ϕ	6666	3549	3532	4886
MP1 x 10^{+3}	0.3133	0.1687	0.1673	0.2052
RSADP	0.7559	1.2745	0.2393	

California

B. AP3

Measures	Syn 2	Syn DA	S F	Cen
No. of places where $ARE(C_i) < ARE(E_i)$	446	438	431	
No. of places where $ADP(C_i) < ADP(E_i)$	429	267	239	
MARE	0.0214	0.0155	0.0145	0.0154
Max ARE	0.3303	0.3701	0.3753	0.4071
α	26855	8468	7435	15105
SADP	0.0212	0.0097	0.0096	0.0231
PI	0.395	0.657	0.733	
ϕ	19208	7558	7102	8460
MP1 x 10^{+3}	0.8792	0.3546	0.3349	0.4168
RSADP	0.6187	1.3469	1.3690	

Appendix - Table IV.B. Measures of Performance for Place Coverage Estimators for AP2 and AP3 for Known Factors Within Selected States

New York - 964 Places A. AP2 Measures	Syn 2	Syn DA	Census
No. of places where $ARE(C_i) < ARE(E_i)$	475	593	
No. of places where $ADP(C_i) < ADP(E_i)$	119	111	
MARE	0.0056	0.0076	0.0062
Max ARE	0.0931	0.0931	0.1011
α	548	844	6615
SADP	0.0032	0.0064	0.0117
PI	0.934	0.928	
ϕ	520	836	2118
MP1 x 10^{+3}	0.0359	0.0577	0.1518
RSADP	3.6795	1.8418	

New York B. AP3 Measures	Syn 2	Syn DA	Census
No. of places where $ARE(C_i) < ARE(E_i)$	503	598	
No. of places where $ADP(C_i) < ADP(E_i)$	73	78	
MARE	0.0043	0.0056	0.0046
Max ARE	0.0931	0.0931	0.1011
α	449	603	9267
SADP	0.0027	0.0047	0.0149
PI	0.938	0.934	
ϕ	414	579	3293
MP1 x 10^{+3}	0.0284	0.0398	0.2367
RSADP	5.5503	3.1901	

North Dakota - 368 Places

A. AP2 Measures	Syn 2	Syn DA	Census
No. of places where $ARE(C_i) < ARE(E_i)$	241	179	
No. of places where $ADP(C_i) < ADP(E_i)$	302	262	
MARE	0.0049	0.0044	0.0016
Max ARE	0.0724	0.0701	0.0016
α	13	33	9
SADP	0.0021	0.0021	0.0014
PI	0.249	0.346	
ϕ	9	11	9
MP1 x 10^{+3}	0.0204	0.0245	0.0189
RSADP	0.6721	0.6708	

North Dakota

B. AP3 Measures	Syn 2	Syn DA	Census
No. of places where $ARE(C_i) < ARE(E_i)$	202	140	
No. of places where $ADP(C_i) < ADP(E_i)$	306	320	
MARE	0.0028	0.0026	0.0010
Max ARE	0.0382	0.0258	0.0418
α	5	13	3
SADP	0.0014	0.0015	0.0008
PI	0.303	0.360	
ϕ	3	5	3
MP1 x 10^{+3}	0.0067	0.0107	0.0054
RSADP	0.5725	0.5325	

Missouri - 943 Places

A. AP2 Measures	Syn 2	Syn DA	Census
No. of places where $ARE(C_i) < ARE(E_i)$	400	361	
No. of places where $ADP(C_i) < ADP(E_i)$	211	255	
MARE	0.0087	0.0096	0.0091
Max ARE	0.2568	0.2531	0.2606
α	571	652	1859
SADP	0.0073	0.0081	0.0137
PI	0.8776	0.8394	
ϕ	544	641	1137
MP1 x 10^{+3}	0.1614	0.1883	0.3452
RSADP	1.8648	1.6891	

Missouri

B. AP3 Measures	Syn 2	Syn DA	Census
No. of places where $ARE(C_i) < ARE(E_i)$	348	325	
No. of places where $ADP(C_i) < ADP(E_i)$	176	216	
MARE	0.0060	0.0069	0.0064
Max ARE	0.2217	0.1979	0.2399
α	393	482	1602
SADP	0.0058	0.0067	0.0132
PI	0.8938	0.8578	
ϕ	381	478	1036
MP1 x 10^{+3}	0.1128	0.1408	0.3139
RSADP	2.2814	1.9684	

Mississippi - 310 Places

A. AP2 Measures	Syn 2	Syn DA	Census
No. of places where $ARE(C_i) < ARE(E_i)$	197	196	
No. of places where $ADP(C_i) < ADP(E_i)$	112	142	
MARE	0.0179	0.0212	0.0134
Max ARE	0.2424	0.2318	0.2635
α	53	719	1017
SADP	0.0107	0.0130	0.0143
PI	0.6584	0.6501	
ϕ	496	580	582
MP1 x 10^{+3}	0.3615	0.4195	0.4454
RSADP	1.3400	1.0973	

Mississippi

B. AP3 Measures	Syn 2	Syn DA	Census
No. of places where $ARE(C_i) < ARE(E_i)$	204	199	
No. of places where $ADP(C_i) < ADP(E_i)$	114	144	
MARE	0.0164	0.0201	0.0114
Max ARE	0.2324	0.2241	0.2539
α	464	629	828
SADP	0.0092	0.0121	0.0130
PI	0.6665	0.6466	
ϕ	401	484	493
MP1 x 10^{+3}	0.2921	0.3508	0.3760
RSADP	1.4076	1.0712	

California - 781 Places

A. AP2 Measures	Syn 2	Syn DA	Census
No. of places where $ARE(C_i) < ARE(E_i)$	354	345	
No. of places where $ADP(C_i) < ADP(E_i)$	230	252	
MARE	0.0092	0.0094	0.0114
Max ARE	0.2436	0.2320	0.2674
α	3417	3545	7865
SADP	0.0069	0.0071	0.0091
PI	0.738	0.678	
ϕ	3414	3540	4185
MP1 x 10^{+3}	0.1628	0.1689	2.0524
RSADP	1.3135	1.2927	

California

B. AP3 Measures	Syn 2	Syn DA	Census
No. of places where $ARE(C_i) < ARE(E_i)$	356	407	
No. of places where $ADP(C_i) < ADP(E_i)$	203	257	
MARE	0.0125	0.0143	0.0154
Max ARE	0.3858	0.3747	0.4071
α	6688	7681	15104
SADP	0.0089	0.0095	0.0131
PI	0.7354	0.6690	
ϕ	6670	7293	8459
MP1 x 10^{+3}	0.3165	0.3437	0.4168
RSADP	1.4735	1.3825	

Appendix - Table V.A. Measures of Performance for ED Coverage Estimators for AP2 and AP3 for Replicate Factors Within Selected States

New York - No. of EDs = 18,585

A. AP2

Measures	Syn 2	Syn DA	S F	Cen
No. of EDs where $ARE(C_i) < ARE(E_i)$	9707	9427	9106	
No. of EDs where $ADP(C_i) < ADP(E_i)$	4757	4592	4231	
MARE	0.0161	0.0157	0.0148	0.0165
Max ARE	0.6708	0.6764	0.6778	0.6931
α	15981	15322	15614	24183
SADP	0.0139	0.0139	0.0143	0.0183
PI	0.747	0.757	0.776	
ϕ	15924	15242	15566	19923
MP1 x 10^{+3}	0.9009	0.8618	0.8868	1.1673
RSADP	1.3138	1.3230	1.2830	

New York

B. AP3

Measures	Syn 2	Syn DA	S F	Cen
No. of EDs where $ARE(C_i) < ARE(E_i)$	9527	9788	9246	
No. of EDs where $ADP(C_i) < ADP(E_i)$	4177	4172	3844	
MARE	0.0170	0.0172	0.0161	0.0184
Max ARE	0.8889	0.8889	0.8889	0.8889
α	20216	19600	19924	31928
SADP	0.01522	0.0149	0.0157	0.0222
PI	0.779	0.779	0.796	
ϕ	20199	19484	19864	26604
MP1 x 10^{+3}	1.1426	1.0986	1.1300	1.5616
RSADP	1.4578	1.4873	1.4158	

North Dakota - No. of EDs = 2546

A. AP2

Measures	Syn 2	Syn DA	S F	Cen
No. of EDs where $ARE(C_i) < ARE(E_i)$	997	785	1212	
No. of EDs where $ADP(C_i) < ADP(E_i)$	864	2240	2142	
MARE	0.0034	0.0037	0.0044	0.0016
Max ARE	0.4317	0.4372	0.4317	0.4372
α	153	177	160	153
SADP	0.0037	0.0050	0.0039	0.0033
PI	0.500	0.185	0.378	
ϕ	152	161	154	150
MP1 x 10^{+3}	0.2352	0.2469	0.2381	0.2341
RSADP	0.8935	0.6613	0.8480	

North Dakota

B. AP3

Measures	Syn 2	Syn DA	S F	Cen
No. of EDs where $ARE(C_i) < ARE(E_i)$	618	634	754	
No. of EDs where $ADP(C_i) < ADP(E_i)$	587	2338	2235	
MARE	0.0016	0.0023	0.0020	0.0010
Max ARE	0.3087	0.3087	0.3087	0.3087
α	56	68	58	55
SADP	0.0022	0.0034	0.0025	0.0019
PI	0.511	0.200	0.322	
ϕ	55	61	57	54
MP1 x 10^{+3}	0.0855	0.0939	0.0880	0.0837
RSADP	0.8532	0.5571	0.7643	

Missouri - No. of EDs = 7201

A. AP2

Measures	Syn 2	Syn DA	S F	Cen
No. of EDs where $ARE(C_i) < ARE(E_i)$	2897	3410	3206	
No. of EDs where $ADP(C_i) < ADP(E_i)$	2130	1852	2099	
MARE	0.0145	0.0155	0.0141	0.0142
Max ARE	0.7029	0.7085	0.7122	0.7251
α	5422	5482	5463	7184
SADP	0.0140	0.0142	0.0142	0.0167
PI	0.682	0.731	0.683	
ϕ	5391	5474	5403	6312
MP1 x 10^{+3}	1.1005	1.1086	1.1105	1.3170
RSADP	1.1989	1.1801	1.1747	

Missouri

B. AP3

Measures	Syn 2	Syn DA	S F	Cen
No. of EDs where $ARE(C_i) < ARE(E_i)$	2713	3296	3031	
No. of EDs where $ADP(C_i) < ADP(E_i)$	1979	1698	1752	
MARE	0.0115	0.0123	0.0113	0.0113
Max ARE	0.7035	0.7090	0.7109	0.7256
α	4428	4554	4476	6134
SADP	0.0111	0.0114	0.0114	0.0145
PI	0.7040	0.7594	0.7500	
ϕ	4422	4546	4459	5556
MP1 x 10^{+3}	0.9024	0.9231	0.9114	1.1562
RSADP	1.3113	1.2715	1.2783	

Mississippi - No. of EDs = 3610

A. AP2

Measures	Syn 2	Syn DA	S F	Cen
No. of EDs where $ARE(C_i) < ARE(E_i)$	2137	2000	2319	
No. of EDs where $ADP(C_i) < ADP(E_i)$	1362	1414	1448	
MARE	0.0234	0.0264	0.0278	0.0173
Max ARE	1.000	1.000	1.000	1.000
α	5336	5986	5780	5959
SADP	0.0200	0.218	0.0206	0.0210
PI	0.593	0.556	0.574	
ϕ	5306	5679	5518	5233
MP1 x 10^{+3}	2.0746	2.1873	2.1286	2.1316
RSADP	1.0541	0.9639	1.0232	

Mississippi

B. AP3

Measures	Syn 2	Syn DA	S F	Cen
No. of EDs where $ARE(C_i) < ARE(E_i)$	2066	1998	2101	
No. of EDs where $ADP(C_i) < ADP(E_i)$	1312	1404	1413	
MARE	0.0206	0.0243	0.0233	0.0151
Max ARE	1.000	1.000	1.000	1.000
α	4555	5221	4872	5099
SADP	0.0178	0.0208	0.0193	0.0192
PI	0.611	0.559	0.578	
ϕ	4530	4904	4741	4540
MP1 x 10^{+3}	1.7761	1.8921	1.8436	1.8455
RSADP	1.0821	0.9218	0.9945	

California - No. of EDs = 25,799

A. AP2

Measures	Syn 2	Syn DA	S F	Cen
No. of EDs where $ARE(C_i) < ARE(E_i)$	14039	12437	14645	
No. of EDs where $ADP(C_i) < ADP(E_i)$	10575	7355	8085	
MARE	0.0207	0.0165	0.0180	0.0152
Max ARE	0.7692	0.7692	0.7692	0.7692
α	35277	27252	27424	32495
SADP	0.0168	0.0144	0.0145	0.0258
PI	0.560	0.701	0.672	
ϕ	34374	27211	27179	28121
MP1 x 10^{+3}	1.4303	1.1433	1.1376	1.2174
RSADP	0.9383	1.0917	1.0855	

California

B. AP3

Measures	Syn 2	Syn DA	S F	Cen
No. of EDs where $ARE(C_i) < ARE(E_i)$	15983	13950	14821	
No. of EDs where $ADP(C_i) < ADP(E_i)$	10363	8035	7787	
MARE	0.0310	0.0216	0.0212	0.0177
Max ARE	0.8125	0.8125	0.8125	0.8125
α	72572	46699	45440	55035
SADP	0.0265	0.01924	0.0191	0.0219
PI	0.568	0.663	0.683	
ϕ	65500	45951	45200	47465
MP1 x 10^{+3}	2.6550	1.9060	1.8838	2.0637
RSADP	0.8266	1.1385	1.1450	

Appendix - Table V.B. Measures of Performance for Place Coverage Estimators for AP2 and AP3 for Known Factors Within Selected States

New York - No. of EDs = 18,585

A. AP2 Measure	Syn 2	Syn DA	Census
No. of EDs where $ARE(C_i) < ARE(E_i)$	9445	9169	
No. of EDs where $ADP(C_i) < ADP(E_i)$	4639	4588	
MARE	0.0155	0.0156	0.0165
Max ARE	0.6708	0.6750	0.6931
α	15241	15377	24183
SADP	0.0135	0.0141	0.0183
PI	0.754	0.759	
ϕ	15215	15349	19923
MP1 x 10^{+3}	0.8618	0.8693	1.1673
RSADP	1.3617	1.3019	

New York

B. AP3 Measure	Syn 2	Syn DA	Census
No. of EDs where $ARE(C_i) < ARE(E_i)$	9774	9437	
No. of EDs where $ADP(C_i) < ADP(E_i)$	4108	4100	
MARE	0.0169	0.0168	0.0184
Max ARE	0.8889	0.8889	0.8889
α	19559	19490	31927
SADP	0.0148	0.0150	0.0222
PI	0.783	0.792	
ϕ	19542	19452	26602
MP1 x 10^{+3}	1.1034	1.0992	0.5615
RSADP	1.5007	1.480	

North Dakota · No. of EDs = 2536

A. AP2 Measure	Syn 2	Syn DA	Census
No. of EDs where $ARE(C_i) < ARE(E_i)$	1190	778	
No. of EDs where $ADP(C_i) < ADP(E_i)$	2190	2238	
MARE	0.0042	0.0036	.0018
Max ARE	.4317	.4372	.4372
α	156.9	175.1	152.7
SADP	.0039	.0050	0.0033
PI	0.351	.185	
ϕ	153.3	159.9	150.1
MP1 x 10^{+3}	0.237	0.2460	0.2341
RSADP	.862	.669	

North Dakota

B. AP3 Measure	Syn 2	Syn DA	Census
No. of EDs where $ARE(C_i) < ARE(E_i)$	805	610	
No. of EDs where $ADP(C_i) < ADP(E_i)$	2255	2341	
MARE	0.0021	0.0021	0.0010
Max ARE	0.3087	0.3087	0.3087
α	57.0	65.1	54.6
SADP	0.0024	.0033	0.0019
PI	.334	0.201	
ϕ	55.5	59.4	53.7
MP1 x 10^{+3}	0.0860	.0919	.0837
RSADP	0.791	0.587	

Missouri - No. of EDs = 7201

A. AP2 Measure	Syn 2	Syn DA	Census
No. of EDs where $ARE(C_i) < ARE(E_i)$	3115	3359	
No. of EDs where $ADP(C_i) < ADP(E_i)$	1729	1850	
MARE	0.0139	0.0153	0.0142
Max ARE	0.7066	0.7085	0.07251
α	5284	5473	7184
SADP	0.0137	0.0142	0.0167
PI	0.759	0.732	
ϕ	5225	5467	6312
MP1 x 10^{+3}	1.0686	1.1080	1.3170
RSADP	1.2198	1.1791	

Missouri

B. AP3 Measure	Syn 2	Syn DA	Census
No. of EDs where $ARE(C_i) < ARE(E_i)$	3000	3184	
No. of EDs where $ADP(C_i) < ADP(E_i)$	1555	1688	
MARE	0.0110	0.0121	0.0113
Max ARE	0.7066	0.7085	0.7251
α	4334	4539	6133
SADP	0.0109	0.0114	0.0145
PI	0.787	0.762	
ϕ	4314	4536	5555
MP1 x 10^{+3}	0.8819	0.9223	1.1560
RSADP	1.3322	1.2737	

Mississippi - No. of Eds = 3595

A. AP2 Measures	Syn 2	Syn DA	Census
No. of EDs where $ARE(C_i) < ARE(E_i)$	2215	1980	
No. of EDs where $ADP(C_i) < ADP(E_i)$	1349	1404	
MARE	.0245	0.0261	.0173
Max ARE	1.000000	1.000000	1.000000
α	5418.8	5952.3	5959.0
SADP	0.0198	0.0217	0.0210
PI	.603	.562	
ϕ	5335.3	5667.9	5233.1
MP1 x 10^{+3}	2.0765	2.1848	2.1316
RSADP	1.0653	0.0679	

Mississippi

B. AP3 Measure	Syn 2	Syn DA	Census
No. of EDs where $ARE(C_i) < ARE(E_i)$	2189	1966	
No. of EDs where $ADP(C_i) < ADP(E_i)$	1293	1399	
MARE	0.0219	.0240	0.0151
Max ARE	1.000000	1.000000	1.000000
α	4659.3	5181.0	5098.1
SADP	.0177	.0208	0.0192
PI	0.616	0.560	
ϕ	4574.3	4897.0	4539.5
MP1 x 10^{+3}	1.784	1.892	1.845
RSADP	1.0862	0.924	

California - No. of EDs = 25689

A. AP2 Measure	Syn 2	Syn DA	Census
No. of EDs where $ARE(C_i) < ARE(E_i)$	13105	11727	
No. of EDs where $ADP(C_i) < ADP(E_i)$	7220	7195	
MARE	.0162	.0159	0.0152
Max ARE	0.7692	0.7692	0.7692
α	26776.1	27185.0	32495.0
SADP	.0143	0.0145	.0158
PI	0.719	.711	
ϕ	26774.1	27182.2	28121.0
MP1 x 10^{+3}	1.1285	1.1458	1.2174
RSADP	1.1027	1.0863	

California

B. AP3 Measure	Syn 2	Syn DA	Census
No. of EDs where $ARE(C_i) < ARE(E_i)$	13869	13358	
No. of EDs where $ADP(C_i) < ADP(E_i)$	7426	7833	
MARE	0.0195	0.0204	.0177
Max ARE	0.8125	0.8125	0.8125
α	44414.1	45690.7	55030.0
SADP	0.0189	0.0191	0.0219
PI	0.697	0.669	
ϕ	44413.9	45417.4	47460.2
MP1 x 10^{+3}	1.8630	1.8921	2.0635
RSADP	1.157	1.145	