Comparing Measure-Level Sampling and Bed-Level Sampling for Group Quarters Sample Redesign

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Abstract

Group Quarters (GQs) are one of several types of living arrangements sampled in demographic surveys. They include college dormitories, group homes, and religious quarters. For the first step of GQ sampling, individuals that reside in GQs are converted into Housing Unit Equivalents within a block to ensure that a unit of sample selected in a GQ corresponds to an average household (which in 2010 was 2.58 individuals). Several demographic surveys are undergoing redesign to address new and continuing data needs. For this redesign, research was conducted to determine whether bed-level sampling should replace measure-level sampling by examining whether bed-level sampling would allow for a decrease in clustering while avoiding a significant increase in advance listing procedures in the field.

This paper examines: measures, why they were used in the past and benefits and drawbacks; bed-level sampling, it's benefits and drawbacks; simulations to compare clustering effects and comparative field workloads of the two sampling methods. The result is a final recommendation to use a modified version of measure-level sampling.

Key Words

Sampling, Clustering, Demographic Surveys

Disclaimer

Any views expressed on methodological issues are those of the authors and not necessarily those of the U.S. Census Bureau.

1 Introduction – Household Surveys and Group Quarters

Household surveys are classified as such because the smallest unit of sample selection is the housing unit (HU). In general, the frame from which sample is selected is at the HU address level, meaning that one address record represents one housing unit, such as a house or an apartment. Survey designs of this type help produce a wide variety of household statistics regarding demographics, finance, unemployment, and social program participation.

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Group Quarters (GQs), such as college dormitories or group homes for adults, are a different kind of living arrangement and do not fit neatly into this design. A GQ, like a HU, is represented in an address frame by a single record, but a GQ could contain anywhere from one to hundreds of people. If GQs were sampled using the same method as HUs, a GQ record with 150 people would be given the same chance of selection as a single HU, since both are represented by a single address record on the sampling frame.

While the total GQ population accounts for only about one percent of the nation's population, certain types of GQs, such as college dormitories, contain a specific demographic that would not be well represented if they were not sampled. Therefore, GQs must be sampled in a way that weights them correctly with respect to the sample selection in HUs.

The 2010 Demographic Surveys Sample Redesign at the U.S. Census Bureau provided an opportunity to evaluate previous methodologies and consider refining solutions to GQ sampling.

2 Background and Motivation for Research

2.1 Basics of GQ Sampling Process

The GQ sampling process consists of three major steps. In the first step, geographic blocks are selected. Second, GQ buildings in selected blocks are listed by census listers who verify and update GQ information, including population. Finally, in the third step, GQ units (beds) are selected from the listed GQs and sent out for interviewing. This paper covers the first step of GQ sampling mentioned above, where blocks are selected.

2.2 Limitations of this Work

The methods evaluated in this paper are a narrow subset of all possibilities due to limitations on time and resources. As previously stated, this paper only considered modifications to the first step of GQ sampling. Because GQs account for only one percent of the nation's population, any method selected was not permitted to require additional field procedures or cause major changes to the sampling of beds within GQs (step 3 listed in above). In addition, the measure of size, which is a way of determining the size of a block in relation to other blocks and which will be explained in more detail later, was required to be an integer. Finally, the increase in listing workloads (the number of blocks sent out for listing) was not permitted to exceed 10%. In effect, this paper focuses on one potential improvement in the GQ sampling framework that has been in use since the 1980 design.

2.3 Use of Housing Unit Equivalents

As stated previously, sampling GQ records from the same address register as HUs is problematic due to the lack of equivalence between a HU and a GQ. Even among the

GQs, the sampling method should take into account the different GQ types and sizes. For example, a GQ housing 4 individuals should not receive the same probability of selection as a GQ housing 150 individuals.

Housing Unit Equivalents (HUEs) were used in past designs to create equivalence between the individual beds within a GQ building and a HU for GQ sampling purposes. The GQ Block Population (GQBPOP) was calculated by combining the populations of individual GQs within a block, and then converted to HUEs using the formula below:

$$HUE = \frac{GQBPOP}{HU_{AVG}} \qquad \text{Equation (1)}$$

where:

- *GQBPOP* is the total population or total number of beds for relevant GQs [5] in a block;
- HU_{AVG} is the average size of a housing unit (2.58 people, based on the 2010 Census)

After the Decennial Census, the average HU size (HU_{AVG}) was determined which allowed GQ populations to be redefined as HUEs. As an example, if all of the relevant GQs in a block had 516 beds total, there would have been 200 HUEs in that block (516/2.58 = 200 HUEs). This made it possible to measure the size of a block in relation to other blocks for the first step of GQ sampling, and also make it possible to ensure the sampling rate used in GQ sampling could be related to the sampling rate used in HU sampling.

2.4 Use of Measures to Cluster GQ Samples Similarly to Housing Units

After populations within GQs were converted into HUEs, HUEs were then clustered into measures. One measure consisted of four HUEs, which was consistent with previous designs. A block's GQ Block Measure of Size (GQBMOS) was basically the number of measures in a block[6].

For the first step of GQ sampling, GQBPOP would be converted to HUEs using Equation (1). Then the HUEs would be grouped into measures, as shown below in Table 1.

Table 1: Population to Measure Conversion

GQBPOP	HUE = GQBPOP / 2.58	GQBMOS = HUE/4
516	200	50

Systematic sampling was used to sample the measures. Any block that had at least one measure selected would be sent out for listing. These selected measures corresponded to the GQ units that were sampled later for interviewing, which is another benefit of measure level sampling. GQ Units can be proportionally assigned to measures in order to

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[5] Non-institutional, in-scope GQs ("relevant GQs") are a subset of all GQs in the U.S., and are the only GQs interviewed in demographic household surveys.
[6] With some minimal modifications.

maintain a consistent block-level probability of selection. Above, the GQBPOP is 516. If, during listing, the FR found 600 people, rather than recalculating the GQBMOS, which would alter the probability of selection for one block versus another, the additional 84 individuals would be proportionally assigned to the existing 50 measures. This means that a measure may actually be made up of more or less than 4 HUEs, but each measure's probability of selection is the same within a block, and each block's MOS remains consistent before and after listing.

2.5 Problems with Measures in Previous Designs

Despite the benefits mentioned above, there was a significant problem with measure-level sampling. A GQBPOP was rarely an exact multiple of the HU_{AVG}, so rounding "to the nearest measure" occurred. While this was an issue using measure-level sampling in general, it was exacerbated in small GQ blocks, defined as blocks with a GQ population of less than four HUEs (one full measure, or approximately ten beds).

- For small GQBPOP (< 10 beds, or < 1 full measure), the partial measure was rounded to one full measure.
  - For example, if the GQBPOP is 3 units, it was rounded to a full measure.
  - 27% of 2000 Design blocks had a GQ block population of less than ten.
    - These block populations were rounded up 1 to 9 units
  - 12% of 2000 Design blocks had a GQ block population of 4 or less.
    - These block populations were rounded up 6 to 9 units

- For Blocks with GQ block populations of larger than 10, the partial measure was rounded as follows:
  - If the last digit of the GQBPOP ended in 1 to 4, the population is rounded down (1 to 4 units).
  - If the last digit of the GQBPOP ended in 5 to 9, the population is rounded up (1 to 4 units).
  - For example, a GQBPOP of 13 rounded down to 1 measure, whereas a GQBPOP of 26 rounded up to 3 measures.

Rounding created a discrepancy between the probability of selection of a block, based on the actual census population, and the probability of selection assigned to the block when the GQBMOS was calculated. Table 2 below shows the result of rounding in small blocks. Block 1002 is given the same probability of selection as block 1001 even though it has fewer than one-quarter of the units in Block 1001.

Table 2: Effect of Rounding on GQBMOS

Block Number	GQBPOP	GQBMOS
1001	9	1
1002	2	1
1003	32	3
1004	17	2

Rounding could not be entirely avoided due to the requirement that the GQBMOS be an integer. The first step of GQ sampling was used to select blocks, and measures could not cross blocks. Because a significant percentage (27%) of the 2000 Design GQ blocks had small populations, we explored other approaches of calculating the GQBMOS and sampling.

3 Options for Sampling

Multiple methods were researched for sampling, including bed-level sampling (eliminating measures altogether), continuing to use full measures (four HUEs), half-measures (two HUEs), and briefly, quarter-measures (one HUE).

Bed-level sampling was examined as a possible solution to the rounding issues that existed in past designs when measure-level sampling was used. At the bed-level, there would be no need to round as each record would signify a single bed. Rather than converting beds to HUEs and then clustering them into measures, clusters of beds could be sampled so the cluster was large enough to imitate a HUE or a measure, or clustering could be avoided entirely.

The various measure-level sampling methods would function similarly to past designs, but measures would be defined by different numbers of HUEs, reducing, though not eliminating, the rounding issues that existed in past designs.

4 Discussion of and Decision on Bed-Level Sampling

4.1 Positive Aspects of Bed-Level Sampling

The primary benefit of bed-level sampling would be the elimination of rounding to the nearest measure. Within a block, each bed would have the same probability of selection, and each block would have the correct size in relation to all other blocks. Referring back to Table 2, Block 1001 would have a probability of selection that was 4.5 times larger than Block 1002 if bed-level sampling was used, rather than the same probability of selection if measure-level sampling was used.

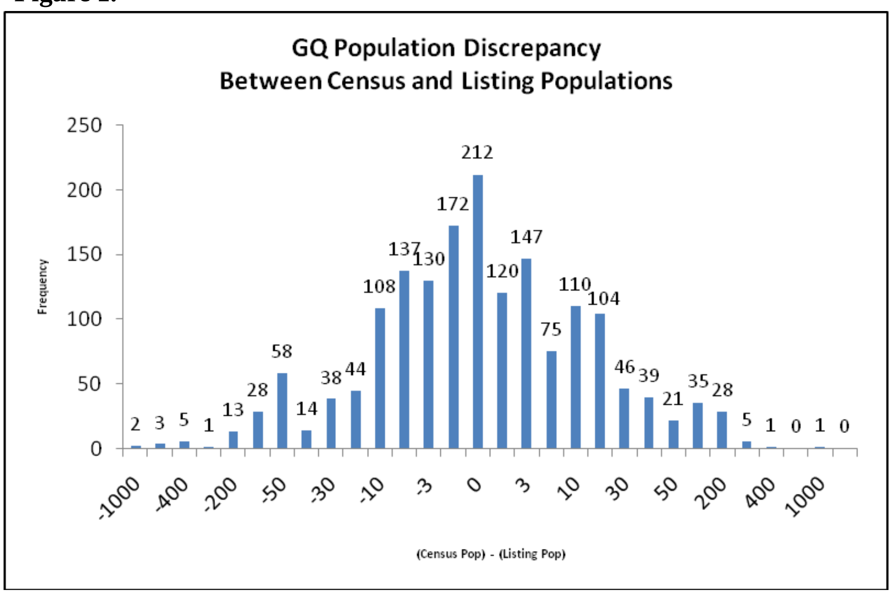
An additional benefit to bed-level sampling would be flexibility with clustering. When measure-level sampling is used, 4 HUEs, or approximately ten beds are clustered together to create a measure. With bed-level sampling, individual surveys would have the ability to choose the level of clustering that goes into their sample selection. While some surveys may choose to continue to cluster beds together (even choosing clusters of ten to imitate a measure), other surveys might choose smaller clusters, based on the balance required between sample design and cost.

4.2 Negative Aspects of Bed-Level Sampling

The major hindrance to using bed-level sampling is that there is no way to proportionally allocate extra or missing units to existing measures in order to maintain constant probability of selection, without affecting the third step of GQ sampling. As mentioned before, if a block was expected to have 500 beds, or approximately 50 measures, and the census lister found 600 people, there would still only be 50 measures, and each measure would consist of 12 beds. This would allow the probability of selection for measures within a block, and for one block versus another, to remain unchanged. If bed-level sampling was used, and 500 beds were expected in the block but 600 were found by the census lister, there would be no way to proportionally allocate them. Whereas one measure can be made up of varying numbers of beds, one bed cannot be made up of multiple beds without altering the third step of GQ sampling as well.

In order to see how often the probability of selection would be incorrect, we examined the 1,697 GQs from the 2000 sample design to see the difference between the values of census population and listing population. Figure 1 below illustrates the population found at the time of listing is only consistent with the census population approximately 12.5% of the time. This difference in listing and census populations is a major drawback to bed-level sampling.

Figure 1.



If the probabilities of selection are not changed to account for the discrepancies illustrated in Figure 1, blocks will not have the correct size relative to other blocks, because the correct population is not used when calculating the size. Unfortunately, the probabilities of selection cannot be changed to accommodate these additional beds, as the additional bedsare only discovered after the blocks are sampled and listed. If bed-level sampling was used, a procedure would need to be developed for subsampling in the field, or additional units would have to be sampled separately, after the initial sampling. In order to determine whether these options should be examined, despite the initial limitations on this project, a simulation of various bed-level sampling methods was conducted.

4.3 Simulation of Listing Requirements

The simulation below illustrates the difference in listing requirements that would arise if bed-level sampling was used compared to the listing requirements if measure-level sampling was used. The simulation was conducted using a subset of GQ records from the 2000 design. The first step of GQ level sampling was conducted using a random start, a take-every, and hit string length (HSL) for two current demographic surveys: Survey A and Survey B. The two surveys were chosen because Survey A used an HSL of 1 measure in the past design, and Survey B used an HSL of 21, making the design of Survey B much more clustered than that of Survey A. The simulation determined the number of blocks, and GQs within those blocks that would need to be listed depending on the sampling method used. The measure-level sampling in Table 3(a) below was the control. Because there were approximately 10 beds in a measure, multiplying the HSL by 10 in Table 3(b) was comparable to measure-level sampling. We also sampled beds with cluster sizes of 4, 2, and 1 to determine how substantially smaller cluster sizes would affect GQ listing requirements. The number of beds selected for each of the bed-level sampling methods was approximately ten times the number of measures selected, which was expected since there were approximately 10 beds in a measure.

Table 3.

Measure Level Sampling

(a)

Cluster = HSL	Survey A	Survey B
# Measures Selected	541	528
# Blocks Sent Out for Listing	379	175
# GQs in Listed Blocks	1556	322

Bed Level Sampling

(b)

Cluster = HSL x 10	Survey A	Survey B
# Beds Selected	5031	5250
# Blocks Sent Out for Listing	482	198
# GQs in Listed Blocks	1617	583

(c)

Cluster = HSL x 4	Survey A	Survey B
# Beds Selected	5038	5363
# Blocks Sent Out for Listing	769	265
# GQs in Listed Blocks	2559	964

(d)

Cluster = HSL x 2	Survey A	Survey B

# Beds Selected	5032	5250
# Blocks Sent Out for Listing	1103	320
# GQs in Listed Blocks	3309	1221

(e)

Cluster = HSL x 1	Survey A	Survey B
# Beds Selected	5033	5145
# Blocks Sent Out for Listing	1587	403
# GQs in Listed Blocks	4041	1503

Measure-level sampling (Table 3(a) above) was most similar to the bed level sampling with a cluster of 10 Exercise (b)). This was unsurprising, as they are nearly the same design. For example, the measure-level sample for Survey B used a design of 21 measures clustered together, or approximately 210 beds. Assuming the survey would not change their overall design, we kept the HSL of 21 consistent for Survey B. So when bed-level sampling was completed for Survey B with a cluster of 10, the total cluster was the HSL (21) times a cluster of 10 beds per hit, or 210 beds, which was the same as the measure-level sampling. It was also apparent how inversely proportional the clustering was to the number of blocks that would need to be listed. Moving to a cluster of 4 beds would increase the listing requirements substantially, more than doubling the listing requirements for Survey A, and increasing those for Survey B by a third. Examining Table 3(a) and 3(b) showed that keeping the same size of the total cluster but using bed-level sampling even caused an increase over the 10% limit imposed on this project. Survey A sent out 379 blocks when measure-level sampling was used versus 482 blocks when bed-level sampling was used, which is a 27% increase.

4.4 Decision on Bed-Level Sampling

Bed-level sampling was abandoned after research showed eliminating measures would cause difficulties in the third step of GQ sampling. While measures have downsides, they do allow extra/missing units to be proportionally allocated without affecting later steps of GQ sampling in order to keep the probability of selection of blocks consistent. In addition, if surveys wanted smaller clusters, a simulation showed that the number of blocks that would be selected and sent out for listing increased very quickly. Even if surveys did not want smaller clusters, Table 3 showed that bed –level sampling using the same cluster sizes as measure-level sampling still caused more than 10% of an increase in listing workloads. With GQs making up only approximately one percent of the entire nation’s population, the additional listing outweighed the benefit of more flexibility with clustering.

5 Discussion of Current Measure Sampling with Other Size Measures

5.1 Advantages of Sampling Using Measure Size of Two HUEs (Half-measures)

Even though bed-level sampling was rejected, certain ideas associated with it were still useful. By reducing the size of the measure to two HUEs from four, it was possible to reduce rounding, making it less of an issue for small GQ blocks, while still retaining the measure-level sampling benefit of being able to proportionally allocate extra/missing units during the first step of GQ sampling. Deciding to continue to use measure-level sampling meant the goal was to improve our ability to assign the correct number of measures to a GQ block.

Table 4 shows the reduced values for rounding, if half-measures are used rather than full measures. Note that out of ten possible rounding distances shown in Table 4, four are the same for full and half-measures, while, for the other six (yellow in the table), rounding distances are smaller when the half-measures are used. Smaller rounding distances would reduce the discrepancy between the probability of selection of a block, based on the actual population, and the probability of selection assigned to the block when the GQBMOS was calculated.

Table 4. Rounding Patterns

Full Measures			**Half-Measures**		
Value	**Round-to**	**Rounding Distance**	**Value**	**Round-to**	**Rounding Distance**
For GQBPOP < 10			**For GQBPOP < 10**		
1 – 4	10	6 – 9 Units	1 – 4	5	1 – 4 Units
5	10	5 Units	5	5	0 Units
6 – 7	10	3 – 4 Units	6 – 7	5	1 – 2 Units
8 – 9	10	1 – 2 Units	8 – 9	10	1 – 2 Units
For GQBPOP ≥ 10, Last Digit Shown Below			**For GQBPOP ≥ 10, Last Digit Shown Below**		
_0	N/A	0 Units	_0	N/A	0 Units
_1 – _2	_0 (down)	1 – 2 Units	_1 – _2	_0 (down)	1 – 2 Units
_3 – _4	_0 (down)	3 – 4 Units	_3 – _4	5	1 – 2 Units
_5	_0 (up)	5 Units	_5	N/A	0 Units
_6 – _7	_0 (up)	3 – 4 Units	_6 – _7	5	1 – 2 Units
_8 – _9	_0 (up)	1 – 2 Units	_8 – _9	_0 (up)	1 – 2 Units

The assumption of this analysis is that the census population variable is correct. As shown in Table 1, this is not always true, but it is the only information available when calculating GQBMOS. In addition, if the GQ population is wildly incorrect, neither full measures nor half measures, nor bed-level sampling will be helpful. However, if the GQ populations are relatively close to their actual populations, a consistently smaller rounding distance will reduce the difference the probability of selection a block should receive based on its population versus what it actually receives because of rounding.

Figure 2 below shows an example of how using half-measures versus full measures would work. Half-measures are designed to act similarly to full measures through clustering (two half-measures = one full measure). The hit string length was four full measures, so it was doubled to 8 for half measures.

The Block Number and GQBPOP for both the full measure and half-measure figure are the same. Observing the relationship between the GQBPOP and the GQBMOS of blocks 102 and 103 shows the extent to which full measures affect, through rounding, the perceived size of the measure. Block 102 has a GQBPOP of 2, while Block 103 has a GQBPOP of 28. So Block 103 is 14 times larger than Block 102. However, when full measures are assigned, Block 102 receives a full measure, and Block 103 receives 3. So, in sampling, Block 103 only looks 3 times larger than Block 102, as is shown in the Measure column in Figure 2.

When half measures are used, Block 102 is assigned one half-measure, while Block 103 is assigned 6 half-measures, making Block 103 appear to be 6 times larger than Block 102. This is still not accurate when compared to the GQBPOPs of the two blocks, but the half-measure calculations are an improvement.

Figure 2.

Full Measure Sampling

Block #	GQB POP	GQB MOS	Meas #	Hit	Hit Pop
101	8	**1**	**1**		
102	2	**1**	**2**	**X**	**2**
103	28	**3**	**3**	**X**	**10**
			4	**X**	**10**
			5	**X**	**8**
104	44	**4**	**6**		
			7		

Half-Measure Sampling

Block #	GQB POP	GQB MOS	Meas #	Hit	Hit Pop
101	8	**2**	**1**		
			2		
102	2	**1**	**3**	**X**	**2**
103	28	**6**	**4**	**X**	**5**
			5	**X**	**5**
			6	**X**	**5**
			7	**X**	**5**
			8	**X**	**5**
			9	**X**	**3**
104	44	**9**	**10**	**X**	**5**
			11		
			12		
			13		
			14		

When the measures are selected using the random start and HSLs mentioned above, the 4 full measures and half-measures selected are shown in Figure 2 in the Hit column. Each of the full and half-measures are expected to contain approximately ten and five beds, respectively. So an HSL of 4 full measures or 8 half- measures should yield a GQ population of approximately 40. The Hit Pop column in Figure 2 shows that, using full measures, the GQ population that was selected is 30, while, when half-measures were used, the selected GQ population was 35. Again, the half-measure method was more accurate. Less rounding in small GQ blocks means that the probabilities of selection at the measure-level will be more consistent with the actual block population.

5.2 Disadvantages of Sampling Using a Measure Size of One HUE

Because half-measures were more efficient than whole measures, quarter-measures were investigated to determine whether they resulted in further increased efficiencies. As has been demonstrated, the census population from the census, when the GQBMOS is calculated, is often different than the population from listing. If the two population values are different enough, a block is assigned the wrong number of measures. Although measures allow for the proportional allocation of additional/missing units, assigning the correct number of measures is still desirable in the sample design.

As an example using full measures, if the census population for a block is 20 and the listing population is 16, two full measures will be assigned either way, so even though the population values are not identical, the number of measures the block would receive remains consistent. If the listing population for the same block is 26, however, the block will have been assigned two measures, when it should really have been assigned three.

In trying to balance the desire to have smaller measures (in order to deal with small GQ block populations) with assigning the correct number of measures to a block, the change in population from the MAF to listing was examined. As a guide, we used the following chart to determine the tolerance for changes in population while still assigning the correct number of measures to a block. This chart is an estimate and not exact (due to decimal points representing a partial person). The tolerances were determined through simply dividing the number of people in a measure by 2, and rounding to the nearest integer.

Table 5: Rounding Tolerance for Assigning Measures

Measure Size	HUEs in a Measure	Approx. # People in a Measure	Tolerance
Full Measures	4	10.32	-5 to +5
Half-measures	2	5.16	-3 to +3
Quarter-measures	1	2.58	-1 to +1

Figure 1 on page 6 shows the difference between the census population and the listed population, for the 1697 GQs on the 2000 design sample database. It was possible to see how often we would be assigning the correct number of measures by looking at the frequency with which GQs are within the tolerances listed above. The bed-level numbers are included below for reference.

Table 6: Percent of GQ Records within Tolerances

Measure Size	HUEs in a Measure	Approx. # People in a Measure	Tolerance	Records within Tolerance	Percent within Tolerance
Full Measures	4	10.32	-5 to +5	993	58.5%
Half-measures	2	5.16	-3 to +3	781	46.0%
Quarter-measures	1	2.58	-1 to +1	504	29.6%
Bed-level	0	1.00	0	212	12.5%

Using full measures, the correct number of measures was assigned nearly 60% of the time, due to a larger tolerance than the other two methods. If we were to bypass half-measures and instead use quarter-measures, that percentage would be reduced *by half* to just 30%. Assigning the correct number of measures only 30% of the time would reduce the benefit of moving to smaller-sized measures. Half-measures were a good compromise between using smaller measures and still assigning the correct number of measures to a block.

4.3 Simulation Using a Subset of the 2000 Sample Cases

Because most surveys will be keeping their sampling design, half-measures would be clustered together to behave like full measures. Because of this, we did not expect field costs, particularly from listing, to increase a great deal. To support this, simulations were completed for 16 PSUs from the 2000 sample comparing full measures and half-measures.

Three metrics were examined: the number of blocks sent out for listing, the number of GQs sent out for listing, and the number of measures (or half-measures) selected. The first two metrics compare listing requirements, which were not allowed to increase by more than 10%. The third metric confirms that approximately the same amount of sample is being selected. Again, these simulations were done for Survey A and Survey B to determine the effect on surveys with different hit string lengths. Forty paired simulations were done for each survey comparing these metrics using full and half-measures. The take-every and hit string length were fixed for a survey, so the only variable that changed was the random start value. The ranges for all of the figures are at the 90% confidence level.

Figures 3 and 4 below show the 90% confidence intervals for blocks sent out for listing for Survey A and Survey B. The simulation estimates a modest (though statistically significant) increase in the number of blocks sent out for listing when half-measures are used as opposed to full measures. For Survey A, using half-measures instead of full measures changed the mean number of blocks sent out for listing from 389 to 417, which represents a 7% increase. This increase is not greater than the 10% maximum constraint. The number of blocks listed for Survey B is not statistically significantly different when half-measures are used instead of full measures.

Fig 3. Number of Blocks Sent Out for Listing (Survey A)

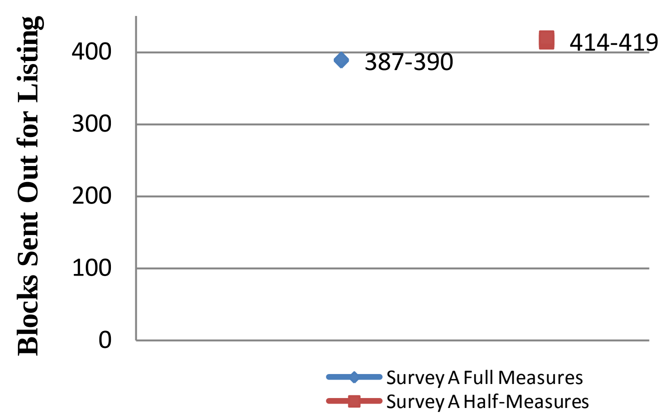
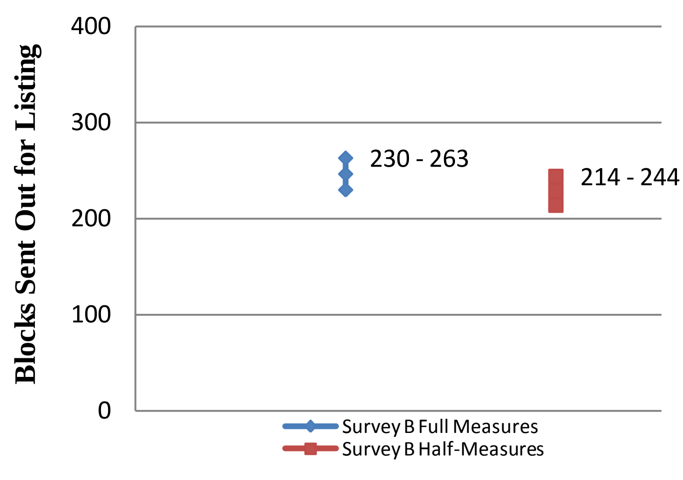
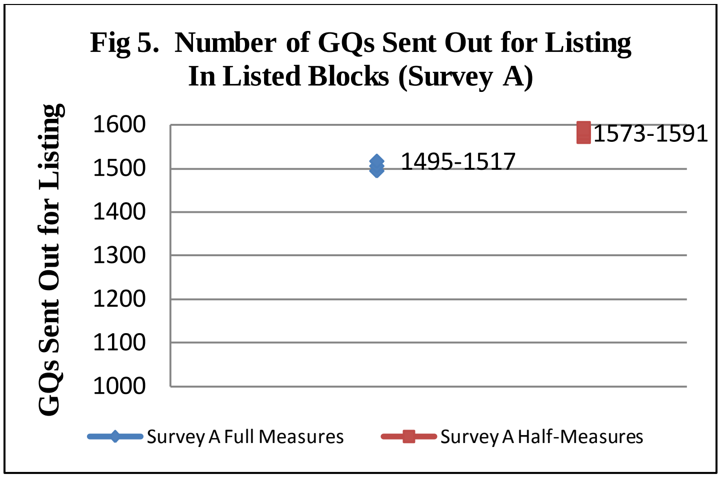
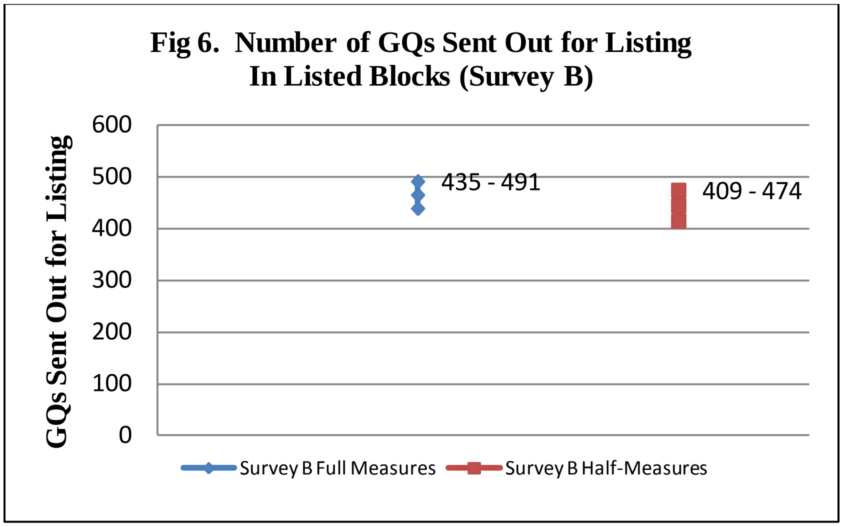


Fig 4. Number of Blocks Sent Out for Listing (Survey B)



The same pattern was observed in Figures 5 and 6 below for the number of GQs that would have to be listed within those blocks sent out for listing. Again, Survey A showed a modest, though statistically significant, increase in the number of GQs that it would have to list. For Survey A, the listing workload increased, on average, to 1,582 GQs using half-measures versus 1,506 GQs using full measures. This represents a 4.8% increase, which again, is not greater than the 10% maximum constraint. The increase in the number of GQs listed for Survey B is not statistically significant when half-measures are used instead of full measures.





Survey A behaved notably differently from Survey B in Figures 3 - 6. Half-measures caused an increase in the GQs and blocks sent out for listing in Survey A, while Survey B experienced a decrease (though it was not statistically significant). This was due to the different clustering patterns in these surveys. Survey A had a hit string length of 1, whereas Survey B clustered their hits into hit string lengths of 42 (21 for full measures). As shown in Example 2 on page 8, moving to half-measures can effectively "shrink" the size of blocks in relation to each other.

Finally, Table 7 below shows the 95% CI for the number of measures selected when using whole and half measures. The half-measures selected were approximately twice the number of full-measures selected, which showed approximately the same amount of sample was drawn.

Table 7: Full and Half- Measures Selected

Measure Size	SURVEY A	SURVEY B
Full Measures	(545, 547)	(662, 731)
Half-Measures	(1008,1013)	(1182, 1309)

In summary, the simulation showed that there would not be extreme changes in listing requirements when half-measures were used instead of full measures, while approximately the same number of sample was selected whether half-measures or full measures were used.

5 Conclusion

After evaluating several alternatives for GQ Sampling, the 2010 design will be conducted using half-measures. Not only will this help solve design-based issues that arise from uncertainty in GQ populations but measure assignments for small GQ block populations (total block population is < 10) will be more efficient. This design-based efficiency is necessary due to the fact that 27% of blocks from the 2000 Sample had a small GQ population. Furthermore, half-measures still provide a tolerance to population estimates that allow for the inevitable differences between the census population and listing population. Finally, the improved efficiency of using half measures should not increase the number of listed blocks by more than 10%, which was the largest increase permitted by the redesign project.