Comparison and Assessment of Vendor Results for the 2016 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation Evaluation Team Report

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Introduction:
The 2016 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation included a bridging effort in which data were collected using traditional telephone and in-person methods by one vendor (Census) and mail methods by another (Rockville Institute). An evaluation team was formed to provide an independent and objective evaluation of the survey and provide recommendations for future surveys. The team compared the two surveys with focus on multiple sources of survey error as well as explaining differences in estimates produced by the two efforts. This report describes their findings.

Survey Estimates:
To provide context to the evaluation, comparisons were made between select estimates from the Rockville (50 State) survey and the Census (National) survey. Rockville estimates exceeded Census estimates. Differences across estimates were often fairly large and statistically significant (see Appendix B for statistical tests). Differential handling of nonparticipants at the screener across vendors was an immediate concern. Rockville's inclusion of nonparticipants (no hunting, fishing, or wildlife-associated recreation) in detailed surveys led to estimates that were larger than estimates for only those respondents who initially reported participation in the screener. However, removing the nonparticipants from the Rockville estimates did not account for all the difference that was observed between Rockville and Census estimates.

Coverage Error:
The two surveys differ in the sample frames used. Rockville used the address based U.S. Postal Service (USPS) Computerized Delivery Sequence file (CDS) and Census used its own Master Address File (MAF) with updates from the CDS. Both sample frames, when properly augmented with information from sample vendors, are considered to be industry standard and possibly the best frames available in the current time period for coverage of households for surveys in United States. The evaluation team considers after updates, both sample frames (the MAF used by Census and the CDS used by Rockville) have good coverage of the desired population. It is unlikely that coverage errors discussed would be responsible for any meaningful differences between Rockville and Census estimates.

Sampling Design/Error:
Both vendors used probability sampling designs to survey U.S. residents to draw inference to the U.S. population. The vendors incorporated the list of hunting licenses in the development of the adopted sampling designs to help improve efficiency of the estimates. However, further examination of the approaches used by both vendors to examine the impact of the gains in efficiency would be instructive.

Response Rates and Nonresponse Error:
The overall weighted response rate reported by Rockville for the screeners was 24.6%, with states varying between 17.4% (TX) and 36% (VT). The overall weighted response rate for Census was 82.8%. The main interview rates were in the mid-60s for Rockville and Census. Nonresponse bias (i.e., a selected response only from those with specific characteristics that bias the estimates of the survey) can occur at both the screener and the main interview stage for both

Rockville and Census. Neither vendor had sufficient information to fully assess nonresponse bias at the screener stage. Rockville found higher likelihood to respond in rural areas and in the high hunting license density stratum. They used the license density stratum variable in their screener nonresponse adjustment, but did not include a rural/urban indicator. Both Rockville and Census adhered to state of the art practice in their nonresponse adjustment, given the specifications required from each vendor. Rockville's nonresponse bias analyses found that the estimates would likely improve with nonresponse adjustments that explicitly model the response indicator. The inputs to such a model should include, at a minimum, race, rural/urban, and marital status. So far only MSA/non-MSA, age, and sex variables were used in the adjustment.

Item Nonresponse:
The two vendors used quite different criteria to determine if a case was complete and thus include it in the final data set. Rockville had the least stringent criteria and therefore was theoretically less likely to differentially screen out particular types of households; however, the evaluation team was not able to empirically assess the impact of the criteria on estimates given available data.

Both vendors used conventional, comparable, and acceptable imputation methods to fill in missing demographic data from the household screener. Due to a design oversight with a first-time method used in this data collection, it was necessary for Census to also impute demographic data for pre-screener non-participants. An unconventional imputation procedure was used for this limited subset of cases, limiting the accuracy of analyses that include the non-participant cases and rely heavily on demographic information (e.g., subgroup analyses of the percent of people who hunt, fish, or wildlife watch).

Where item nonresponse rates could be directly compared across the two surveys, the results were consistent with research in this area; the Rockville mail mode produced higher item nonresponse rates. The differences in rates did not contribute to the large differences in estimates across the two vendors.

Measurement Error and Mode Effects:
Both of the modes used have both strengths and weaknesses for measurement error. The conditions for optimal recall were likely better in the mail survey. Indirect evaluation suggests that the combination of the mail survey allowing all screener respondents more time for recall, Rockville obtaining more male screener respondents, and male screener respondents being more likely to identify a sportsperson in their household likely contributes to the higher Rockville participation estimates.

Given questions have to be written for the mode in which they are delivered, it is not surprising that there would be differences in estimates between data collected from a paper questionnaire and data collected by an interviewer (e.g., either by a telephone or personal visit). However, it isn't clear how the differences in wording would impact the overall difference in estimates. This would require further evaluation to examine differences attributed to the different delivery modes.

Estimation Methodology and Public Use Data Sets:
Both vendors used appropriate weighted survey estimation techniques to generate national- and state-level estimates of participation, effort, and expenditures, and both vendors used appropriate replication-based methods to estimate standard errors of estimates. Neither vendor implemented weight trimming or smoothing procedures, though there is some evidence of extreme weights. Future contracts should require delivery of a fully reproducible analysis, including data and code.

Evaluating Cost for the Comparison Surveys:
Information was used from technical reports and correspondence to develop a cost comparison on a per unit level (initial sample and completions) to help evaluate the cost effectiveness of changing from CATI/CAPI implementation to predominantly mail implementation. Each vendor had different assignments for the surveys, and total costs and expenditures are closely connected to survey methodology and production, yields at each stage, and to final yield of completions. The evaluation team found costs to be in alignment with expectations for the survey modes used by each vendor.

- Census utilized 44,078 initial sample cases (estimated) and obtained 18,855 completions. The cost per unit for the initial sample is $109.98 and for completions is $257.10.
- Rockville utilized 462,602 initial sample cases and obtained 142,149 completions. The cost per unit for the initial sample is $16.92 and for completions is $55.08.
- The Census implemented CATI/CAPI strategy is 4.7 times more expensive than the predominantly mail strategy implemented by Rockville based on the per unit completed costs.

Recommendations:
The evaluation team found that while the two surveys produced different estimates, there were positive and negative aspects of both approaches. With no benchmark available, the evaluation team cannot say whether one approach is more accurate than the other. Moving forward, the Census interviewer-administered approach is not affordable long term and the Rockville mail approach suffers from significant weaknesses that need to be overcome. Shorter term recommendations include: (1) shortening the questionnaire through a process of reconsidering which measures are necessary, what information can be gathered from other sources, and what variables need to be collected jointly and move toward a modular design; (2) shortening the screener questionnaire to only the most essential information; (3) conducting a nonresponse follow-up of screener nonrespondents; (4) using a web-push methodology to reduce costs and allow for more dynamic questionnaire designs while taking advantage of the high quality sample frames currently used; (5) eliminating compositing; (6) automating and fully documenting data edits; and (7) providing all information necessary for reproducing released estimates. Longer term recommendations include: (1) working with states to create a complete license frame; (2) considering development of a panel of respondents; (3) developing data collection apps; and (4) watching for opportunities to obtain needed data from other agencies.

Introduction

The National Survey of Fishing, Hunting, and Wildlife-Associated Recreation, which is conducted at the request of the Association of Fish and Wildlife Agencies (AFWA), has been conducted every five years since 1955. Because funding for the survey is fixed and not adjusted for inflation, the size of the sample for the survey has decreased over time as data collection costs have increased. As a result of these funding related challenges, AFWA, via its National Survey Technical Workgroup (hereafter "workgroup"), began exploring alternative ways to conduct the survey with the goal of increasing sample size enough to be confident in estimates at both the state and national level while staying within budget.

Most administrations of the National Survey have been conducted by the U.S. Census Bureau (hereafter "Census") under the sponsorship of the U.S. Fish and Wildlife Service (FWS). For the 2016 survey, the workgroup recommended carrying out a "bridging" effort in which the survey would be conducted two ways. In the first, the survey would be conducted largely as it had been in recent previous years, using similar sampling and data collection methods. It would produce national estimates and estimates for four states that were chosen as comparison states (Maine, Minnesota, Oklahoma, and Virginia). This survey is titled "National Survey of Fishing, Hunting, and Wildlife-Associated Recreation," and will be referred to in this report as the "National Survey." In the second, new methods could be used to produce estimates for the nation as well as all 50 states. This survey is titled "50 State Survey of Fishing, Hunting, and Wildlife-Associated Recreation" and will be referred to here as the "50 State Survey." Carrying out these two parallel survey efforts was intended to allow for exploration of more cost efficient ways to conduct the survey and for comparability to previous years' surveys. Following an RFP process, Census was selected to conduct the National Survey using previous years' methods and

Rockville Institute (hereafter "Rockville") was selected to conduct the 50 State Survey using new methods that they proposed. Census conducted their survey using primarily computer assisted telephone interviewing and computer assisted personal interviewing (CATI and CAPI). Rockville used a mail methodology. Both organizations documented their methods in technical documentation.

An independent evaluation team comprised of statisticians and survey methodologists was formed to evaluate the two survey efforts. Members of the team were:

- Dr. Jay Breidt – Professor – Colorado State University – Department of Statistics – Survey statistics
- Dr. Frauke Kreuter – Professor – Joint Program in Survey Methodology – University of Maryland – Professor – University of Mannheim – Head of Statistical Methods Research, Department at the Institute of Employment Research, Nuremberg, Germany – Survey error and analysis
- Dr. Virginia Lesser – Professor – Department of Statistics – Oregon State University – Survey statistics and mixed mode applications
- Dr. Danna Moore – Senior Research Fellow – Washington State University – Social and Economic Sciences Research Center – Survey design and management
- Dr. Jolene Smyth – Associate Professor – University of Nebraska-Lincoln – Department of Sociology – Director – Bureau of Sociological Research – Survey methodologist

The evaluation team was given the following broad goals:

1. Provide an independent and objective evaluation of the survey designs, methods, conduct, and analyses of the 2016 surveys used to generate estimates of participation, effort, and expenditures of fishing, hunting, and wildlife watching in the United States.
2. Provide the workgroup with guidance concerning methodologies and approaches for future National Surveys of Fishing, Hunting, and Wildlife-Associated Recreation.

In addition, the team was provided with a list of objectives and questions specific to each objective that were formulated by the workgroup and intended to encompass all of the sources of survey error that may have impacted the two survey efforts.

Evaluation Team Process

The evaluation team met with the workgroup in September 2017 at the AFWA offices in Washington, D.C. At this meeting, the evaluation team was presented with its goals and objectives, and provided history about how the survey has been funded, the funding challenges it currently faces, and how it has been conducted in recent years. The evaluation team also watched presentations by Census, Rockville, and FWS about the 2016 data collections and had a chance to ask questions. Following all presentations, the evaluation team reviewed the goals and objectives. In this review, the evaluation team reorganized and revised some of the objectives (e.g., creating a distinct measurement and mode effects section, covering weighting with estimation, etc.), discussed each objective and the expertise of evaluation team members, and assigned two evaluation team members to take the lead on each of the objectives. Thereafter, evaluation team members worked in pairs on each objective. In December 2017 the team met again at the AFWA offices for a one day workshop in which they shared their progress on each objective with the entire team to get feedback and further improve the work. They then

produced a draft version of their report, which they presented to AFWA and the workgroup in January 2018. A second draft was completed in early February and circulated to AFWA, the workgroup, FWS, Census, and Rockville for review and comment. Feedback from these organizations was taken into consideration in producing this final version of the report. Throughout the process, the evaluation team asked clarifying questions and requested information as needed from FWS, Census, and Rockville to aid their work and were graciously accommodated by all three organizations. Any opinions, findings, conclusions, or recommendations expressed in this report are those of the evaluation team and do not necessarily reflect the views of FWS, Census, or Rockville.

No data or documentation produced after March 8, 2018 were included in this report. As a result, estimates reported here may not match any estimates released by Census and/or Rockville at later dates.

The remainder of this report is organized around the evaluation teams' revised objectives as follows:

1. **Survey Estimates:** Compare key estimates between surveys in terms of precision and differences at the national and 4-state level.
    a. To what extent do the estimates for total numbers of participants, total days of participation and total expenditures by hunters, anglers and wildlife watchers differ between the two surveys at the 4-state levels and the national level?
2. **Coverage Error:** Compare differences between survey sampling frames used and completeness.
    a. What segments of the U.S. population (demographic and geographic) are missing from each sampling frame?

3. **Sample Design/Error:** Compare sampling designs used by each vendor.
    a. How was the resident hunter licensing information used by each vendor? Was it used properly with gain in sampling efficiency?
4. **Response Rates and Nonresponse Error:** Compare the overall response rates and other key survey metrics of both survey efforts, including respective screener and detailed questionnaires. Compare the impacts of unit non-response bias on each survey effort.
    a. What impact did this non-response have on the results?
    b. How did each vendor handle this non-response, and was it appropriate?
    c. What would be your recommendation to each vendor (re: handling unit non-response)?
5. **Item Nonresponse:** Compare impacts of item non-response bias on each survey effort at the household level and on the estimates for hunting, fishing, and wildlife watching.
    a. Were the definitions of partially completed and completed questionnaires appropriate? Were they appropriately used?
    b. What impact did the definitions have on the results? What about this impact in terms of comparability with previous National Survey results?
    c. Were imputations used, and were they properly used?
    d. If imputation was used, what recommendations would you have in terms of being able to make comparisons of results with previous National Surveys?
    e. What were item nonresponse rates in the surveys?
6. **Measurement error and mode effects:** Evaluate measurement error, including from differences in survey mode on estimates from both surveys.
    a. What impact did mode have on estimates?

b. What impact did questionnaire design have on estimates?

7. **Estimation methodology and public use data sets:** Evaluate the analytical approaches in each survey to generate national- and state-level estimates of participation, effort, and expenditures. This includes all generated reports and the public-use data sets.
    a. Were the weighting schemes appropriately developed and applied given each vendor's sampling design? Were the appropriate estimators applied?
    b. What would be your recommendation for computing variances of estimates for these data? Were the approaches used by each vendor for computing variances of estimates correct and appropriately explained?
    c. Key estimates should be able to be reproduced with publicly available data.
8. **Evaluating Costs for the Comparison Surveys:** Estimate and compare survey costs from Census and Rockville.
9. **Recommendations:** Make recommendations to the workgroup about future directions for the National Survey.
    a. Which of these methods is superior in terms of precision and bias, all things considered?
    b. For each method in a fully operational view (national- and state-level results), what could be done to further restrain costs?
    c. What improvements should be further considered by each vendor to reduce total survey error with no or minimal increases to survey costs?

Section 1: Survey Estimates

We start by comparing Census and Rockville estimates from the National Survey and 50 State Survey efforts. These comparisons provide context for the remainder of our evaluation. Upon initial comparison, the evaluation team found the Rockville estimates exceeded the Census estimates, and that the differences were surprisingly large.

Several factors related to both sampling and nonsampling errors may have contributed to these large differences, and we will discuss them throughout this report. However, one difference that stood out to the evaluation team immediately as a likely cause of some of the differences in estimates is that the two vendors treated non-participants at the screener stage (i.e., household members who it was reported had not participated in hunting, fishing, or wildlife watching and did not plan to in 2016) differently in subsequent follow-ups. Census did not further survey these people (U.S. Census Bureau 2017, p. 30), but Rockville did follow-up with a subsample of them to see if their status changed throughout the year (i.e., if they ultimately did participate despite initial reports of no plans to do so) (Edwards et al. 2017, p. 2-11). A sizeable number of the Rockville screener non-participants ultimately reported participating in hunting, fishing, and/or wildlife watching in their Wave 3 detailed survey follow-ups. They made up 7.61%, 13.20%, and 18.38% of detailed questionnaire respondents who reported participating in fishing, hunting, and wildlife watching respectively (Edwards et al. 2017, p. 2-11).

Upon seeing the large differences in estimates and learning of this significant difference in methods across the two vendors, the evaluation team wanted to know how this design difference impacted estimates and if excluding the screener non-participants' data from the final Rockville estimates would bring the two surveys' estimates more into alignment. Therefore, the evaluation team asked to review Rockville estimates calculated (1) with all respondents and (2)

with only those who initially reported participation in the screener (i.e., excluding the screener non-participants as Census did). These estimates and their comparison to Census estimates for a selection of the most important items are shown in the tables below (limited tables for the comparison states are shown in Appendix A); this is not an exhaustive comparison but only selected tables to provide a look at the range of differences and range of percentage changes in estimates.

We start by examining the impact of the screener non-participants on the Rockville estimates and then compare Rockville and Census estimates with and without these cases. Generally, we present the estimates for each vendor, the numeric difference in the estimates, and the percent change in estimate (i.e., (x-y)/y*100). These calculations show there was considerable variation in the magnitude of the differences (numeric and percentage points) across both main and subgroup items and sometimes variation in the direction of the differences.

Table 1.1 (and Figures 1.1.1 through 1.1.3) shows the difference in Rockville estimates of participation when all respondents are included ("Rockville All") versus participants only ("Rockville Participants Only"). Estimates for each type of participation could be calculated from each of the three surveys or by compositing the fishing and hunting surveys; all four estimates are shown here. In all cases, including the screener non-participants increases the Rockville estimates compared to excluding them, but the magnitude of the differences is survey dependent. The largest increase in the estimates occurs for wildlife watching on all three separate surveys (fishing, hunting, wildlife surveys). Including the screener non-participants leads to increases in estimates of wildlife watching. For the wildlife survey, the estimate for the number of participants increases 48,448,000, which changes the estimate by 37.9%. For the hunting survey, the number of participants wildlife watching increased 38,859,000, which is an increase

in the estimate by 55.6% when non-participants from the screener are included. Likewise, including the screener non-participants increases estimates of sportspersons from 8.9% (fishing survey) to 28% (wildlife survey) and estimates of anglers from 8.2% (hunting survey) to 26.6% (wildlife survey) across the three surveys. For hunters, including the screener non-participants increases estimates from 6.2% (hunting survey) to 22.7% (wildlife survey). The difference between the all participant and participant only two-way composite estimates (combining fishing and hunting surveys) falls between the differences from the fishing and hunting surveys.

Table 1.1. Differences and percent change for Rockville estimates of number of participants when all respondents are included versus screener participants only by survey (numbers in thousands)

	Sportspersons		Anglers		Hunters		Wildlife Watchers	
	Difference	% Change	Difference	% Change	Difference	% Change	Difference	% Change
Fishing Survey	5,208	8.9%	4,225	8.2%	1,935	8.3%	33,733	40.1%
Hunting Survey	7,494	11.2%	6,375	10.9%	1,545	6.2%	38,859	55.6%
2-way composite	6,132	9.9%	5,093	9.4%	1,778	7.4%	35,803	45.6%
Wildlife Survey	14,988	28.0%	12,874	26.6%	4,944	22.7%	48,448	37.9%

Note: Differences are calculated by subtracting the estimate when participants only are included from those when all respondents are included. The numbers come from Rockville Institute Tables D.0.a and D.0.b delivered from Sherm Edwards to the evaluation team on 12-13-2017

Figure 1.1.1. Rockville (RI) fishing survey comparison of estimates with all respondents versus screener participants only

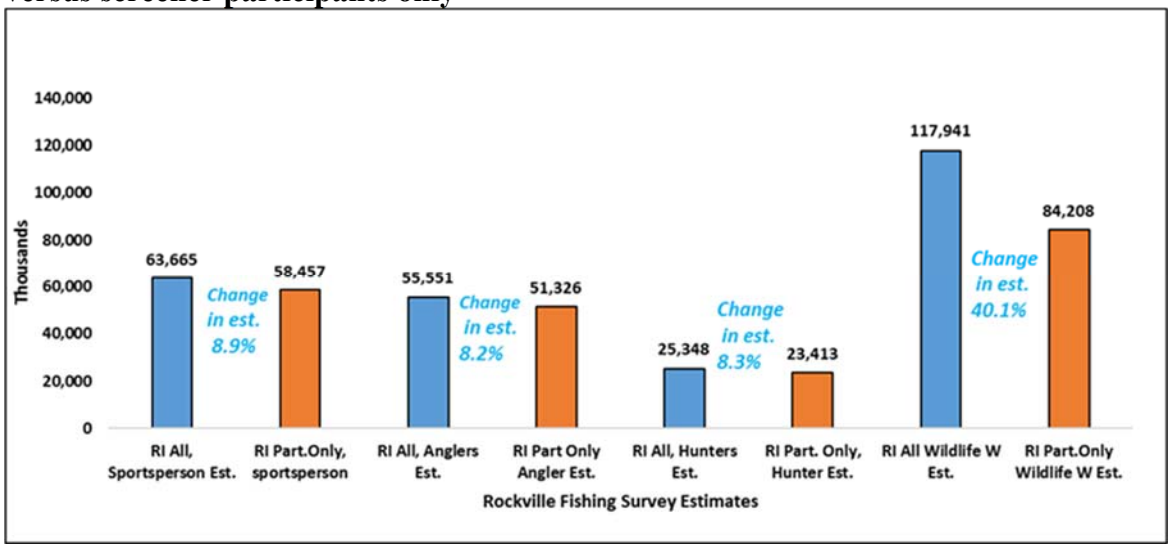


Figure 1.1.2. Rockville (RI) hunting survey comparison of estimates with all respondents versus screener participants only

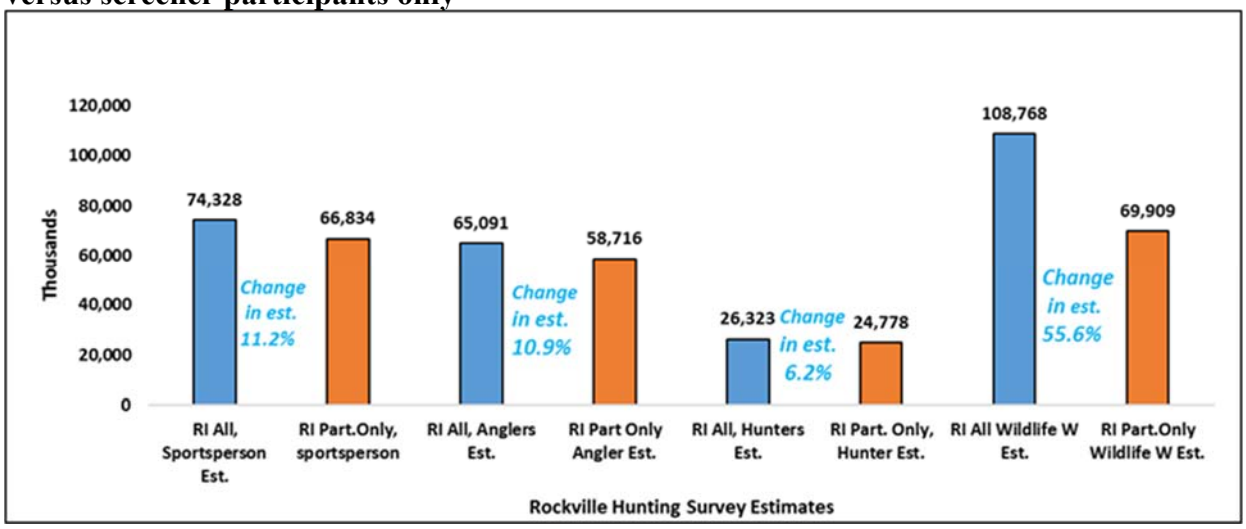


Figure 1.1.3. Rockville (RI) wildlife survey comparison of estimates with all respondents versus screener participants only

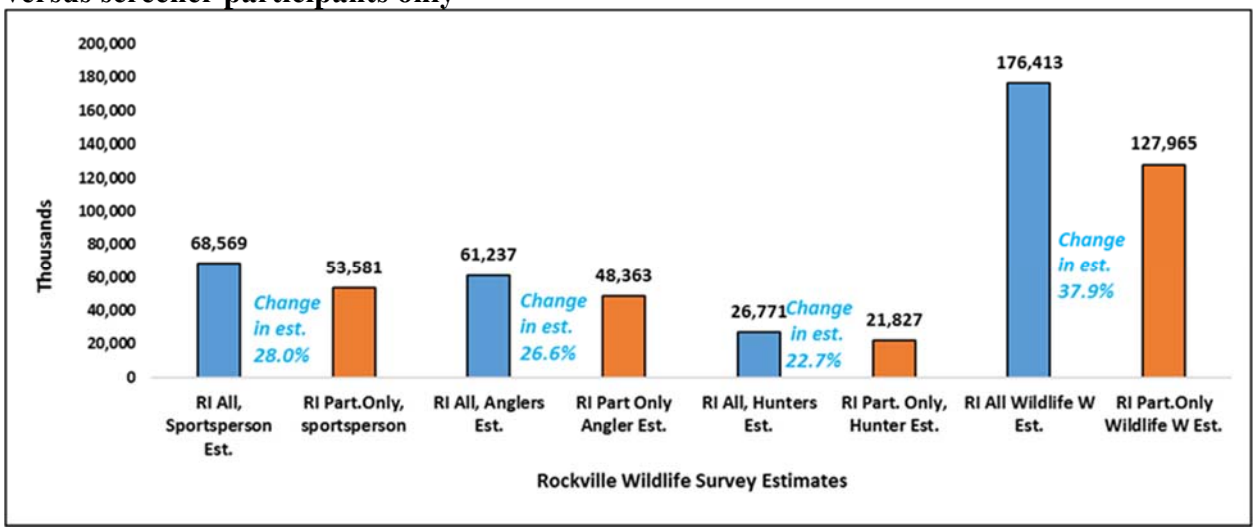


Table 1.2 shows the differences in "Number of Participants" estimates for Rockville All and Rockville Participants Only compared to Census estimates of anglers and hunters, 16 years old and older. For all types of participation, Rockville All estimates are larger than Rockville Participants Only estimates. Including the screener non-participants increases participation estimates for total sportspersons, total fishing, and total hunting between 9% and 10.6%

Moreover, Rockville Participants Only estimates exceed Census estimates for all three main category totals of sportspersons, all fishing, and all hunting by 51.9% to 109.2%. It is noteworthy that for the number of hunting participants, the Rockville Participants Only estimate is over twice that of the Census estimate (109% increase). Rockville estimates for number of participants hunting for small game and other animals are also considerably higher than Census (189.4% and 289% increases) as are their estimates of number of participants in saltwater fishing (94.6% increase).

Table 1.3 displays the estimates and differences in estimates for "Days of Participation" for total sportspersons, total all fishing, and total all hunting. The Rockville All estimates for "Days of Participation" exceed each of the Rockville Participants Only estimates with increases for the main three categories of 4.4% to 6.4%. Both Rockville All and Rockville Participants Only estimates exceed Census estimates. The range in increases in estimates of days of participation of Rockville (participants only) over Census for the main three categories is 84.2% for fishing to 188.3% for hunting. The two items with the greatest percentage point increases on "Days of Participation" between Rockville Participants Only and Census are other animals (471%) and Migratory birds (306%).

For number of hunting trips (Table 1.4 and Figure 1.2) we see the same trend with Rockville All estimates exceeding Rockville Participants Only estimates (increases in the estimates range from 4.7% for total all hunting to 7.1% for all fishing), and Rockville Participants Only estimates exceeding Census estimates (increases in the estimates range from 58.8% for all fishing and 181% for all hunting). In general, Rockville Participants Only increases in number of hunting trip estimates over Census were largest for hunting, especially migratory birds and other animals.

Table 1.2. Comparison of differences and percent change in estimate for Rockville (RI) and Census estimates for number of participants 16 years old and older, by type of fishing and hunting (numbers in thousands)

Type of Fishing and Hunting	Rockville All		Rockville Participants Only		Difference (RI All – RI Participants Only)		Census		Difference (RI Participants only – Census)	
	Number	Percent	Number	Percent	Number	Percent Change	Number	Percent	Number	Percent Change
Total sportspersons	68,192	100	61,840	100	6,352	10.3%	39,553	100	22,287	56.3%
FISHING										
Total, all fishing	60,082	100	54,311	100	5,771	10.6%	35,754	100	18,557	51.9%
Total, all freshwater	46,586	78	43,219	80	3,367	7.8%	30,137	84	13,082	43.4%
Freshwater, except Great Lakes	45,684	76	42,369	78	3,315	7.8%	29,490	82	12,879	43.7%
Great Lakes	3,218	5	3,048	6	170	5.6%	1,824	5	1,224	67.1%
Saltwater	17,903	30	16,191	30	1,712	10.6%	8,320	23	7,871	94.6%
HUNTING										
Total, all hunting	26,122	100	23,964	100	2,158	9.0%	11,453	100	12,511	109.2%
Big game	20,840	80	19,679	82	1,161	5.9%	9,208	80	10,471	113.7%
Small game	10,622	41	10,145	42	477	4.7%	3,505	31	6,640	189.4%
Migratory birds	5,557	21	5,269	22	288	5.5%	2,353	21	2,916	123.9%
Other animals	5,197	20	5,116	21	81	1.6%	1,315	11	3,801	289.0%

Table 1.3. Comparison of differences and percent change in estimates for Rockville (RI) All, Rockville Participants Only, and Census, anglers and hunters days of participation, 16 years old and older (numbers in thousands)

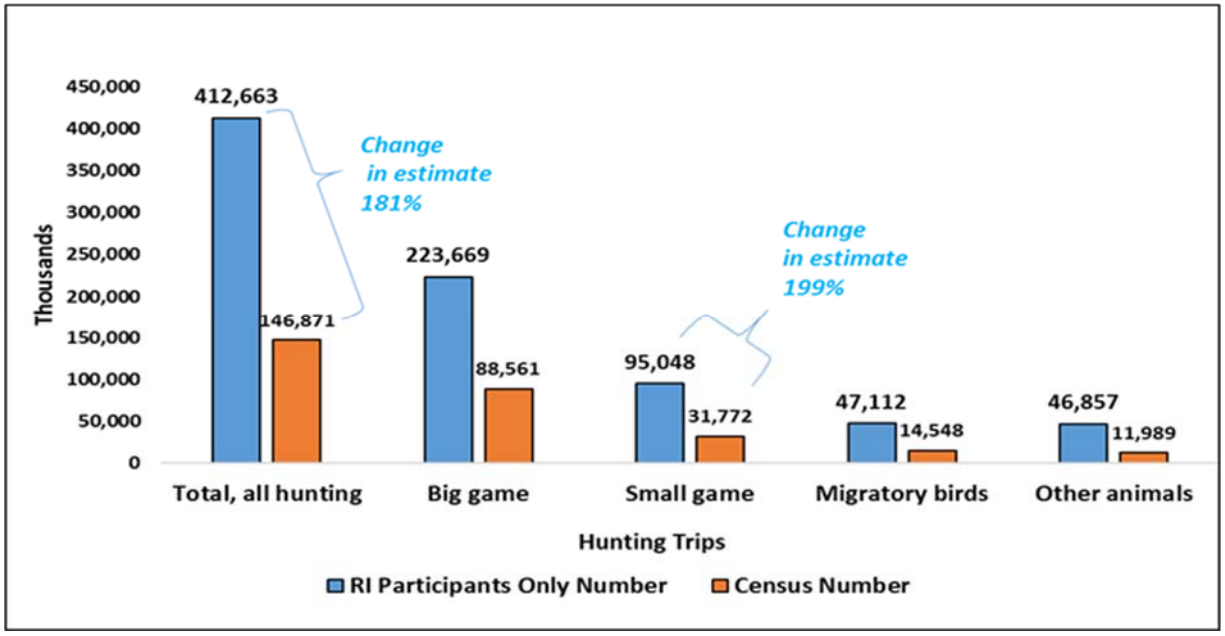
Type of Fishing and Hunting	Rockville All		Rockville Participants Only		Difference (RI All – Participants Only)		Census		Difference (RI Participants only – Census)	
	Number	Percent	Number	Percent	Number of Days	Percent Change	Number	Percent	Number of Days	Percent Change
Total sportspersons	1,454,711	100	1,376,731	100	77,980	5.7%	643,362	100	733,369	114.0%
FISHING										
Total, all fishing	900,763	100	846,216	100	54,547	6.4%	459,341	100	386,875	84.2%
Total, all freshwater	756,695	84	714,017	84	42,678	6.0%	383,192	83	330,825	86.3%
Freshwater, except Great Lakes	701,234	78	656,145	78	45,089	6.9%	372,660	81	283,485	76.1%
Great Lakes	37,751	4	35,636	4	2,115	5.9%	13,440	3	22,196	165.1%
Saltwater	187,306	21	176,966	21	10,340	5.8%	75,392	16	101,574	134.7%
HUNTING										
Total, all hunting	553,949	100	530,515	100	23,434	4.4%	184,021	100	346,494	188.3%
Big game	372,018	67	353,743	67	18,275	5.2%	132,665	72	221,078	166.6%
Small game	134,790	24	127,523	24	7,267	5.7%	38,306	21	89,217	232.9%
Migratory birds	66,185	12	63,553	12	2,632	4.1%	15,621	8	47,932	306.8%
Other animals	76,618	14	75,913	14	705	0.9%	13,275	7	62,638	471.8%

Census: Final National Tables rev with pop counts. Table 1 Anglers and Hunters 16 years and older, Days of Participation and Trips by Type of Fishing and Hunting. (Population 16 years old and older. Number in thousands. Rockville tables received 11-23-2017, Table 1.

Table 1.4. Comparison of differences and percent change in estimates for Rockville (RI) All, Rockville Participants Only, and Census, anglers and hunters number of trips, 16 years old and older (numbers in thousands)

Type of Fishing and Hunting	Rockville All		Rockville Participants Only		Difference (RI All – RI Participants Only)		Census		Difference (RI Participants Only – Census)	
	Number	Percent	Number	Percent	Number	Percent Change	Number	Percent	Number	Percent Change
Total sportspersons	1,084,015	100	1,021,734	100	62,281	6.1%	530,167	100	491,567	92.7%
FISHING										
Total, all fishing	651,885	100	608,835	100	43,050	7.1%	383,296	100	225,539	58.8%
Total, all freshwater	508,719	78	473,938	78	34,781	7.3%	322,266	84	151,672	47.1%
Freshwater, except Great Lakes	488,965	75	454,753	75	34,212	7.5%	311,237	81	143,516	46.1%
Great Lakes	19,754	3	19,185	3	569	3.0%	11,029	3	8,156	74.0%
Saltwater	143,166	22	134,897	22	8,269	6.1%	61,030	16	73,867	121.0%
HUNTING										
Total, all hunting	431,894	100	412,663	100	19,231	4.7%	146,871	100	265,792	181.0%
Big game	234,443	54	223,669	54	10,774	4.8%	88,561	60	135,108	152.6%
Small game	100,611	23	95,048	23	5,563	5.9%	31,772	22	63,276	199.2%
Migratory birds	49,745	12	47,112	11	2,633	5.6%	14,548	10	32,564	223.8%
Other animals	47,119	11	46,857	11	262	0.6%	11,989	8	34,868	290.8%

Figure 1.2. Comparison of Rockville (RI) and Census estimates of number of hunting trips



Even though the magnitude of the change in the percent change estimates are different across subgroup categories for Rockville Participants Only and Census reported in Table 1.4, the percent column shows the distribution across subgroups is fairly similar. For the main category of fishing, Rockville Participants Only has a slightly higher percentage reported for the subcategory of saltwater "number of fishing trips" compared to Census (22% versus 16%, respectively). For the main category of hunting, Rockville Participants Only has a slightly lower percentage reported for subcategory of big game (54% versus 60%, respectively), and slightly higher percentage reported for subcategories of small game (23% versus 22%), migratory birds (12% versus 10%), and other animals (11% versus 8%) compared to Census.

Table 1.5 displays the differences in Rockville's two sets of estimates for expenditures. The Rockville All estimate of the total all items amount spent exceeds the Rockville Participants Only estimate by 5.2%. That is, when the screener non-participants are included in the sample, the estimate of total expenditures is greater. However, it should be noted that the average

expenditure per sportsperson and average expenditure per spender estimates are higher in the participants only sample by $172 and $180 respectively (i.e., when the screener non-participants are excluded). Likewise, including the screener nonparticipants (i.e., Rockville All) increases estimates of total trip related expenditures by 4.2% but decreases estimates of the average amount spent per spender by 5.4%.

Table 1.6 (and Figure 1.3) shows the comparisons of selected expenditure estimates from Rockville Participants Only and Census. The estimated expenditure amounts for "Total, all items" more than triples (208% increase) for Rockville Participants Only estimates compared to Census estimates. Average spending per sportsperson and per spender also greatly increases (roughly doubling) between the Rockville Participants Only and Census estimates. Lodging, public transportation, special equipment, land leasing, and planting (for hunting) exhibit this same trend with Rockville Participants Only expenditure estimates much greater than Census estimates (percent increases exceed 100%).

Table 1.5. Comparison of differences and percent change in expenditure estimates between Rockville (RI) All and Rockville Participants Only samples

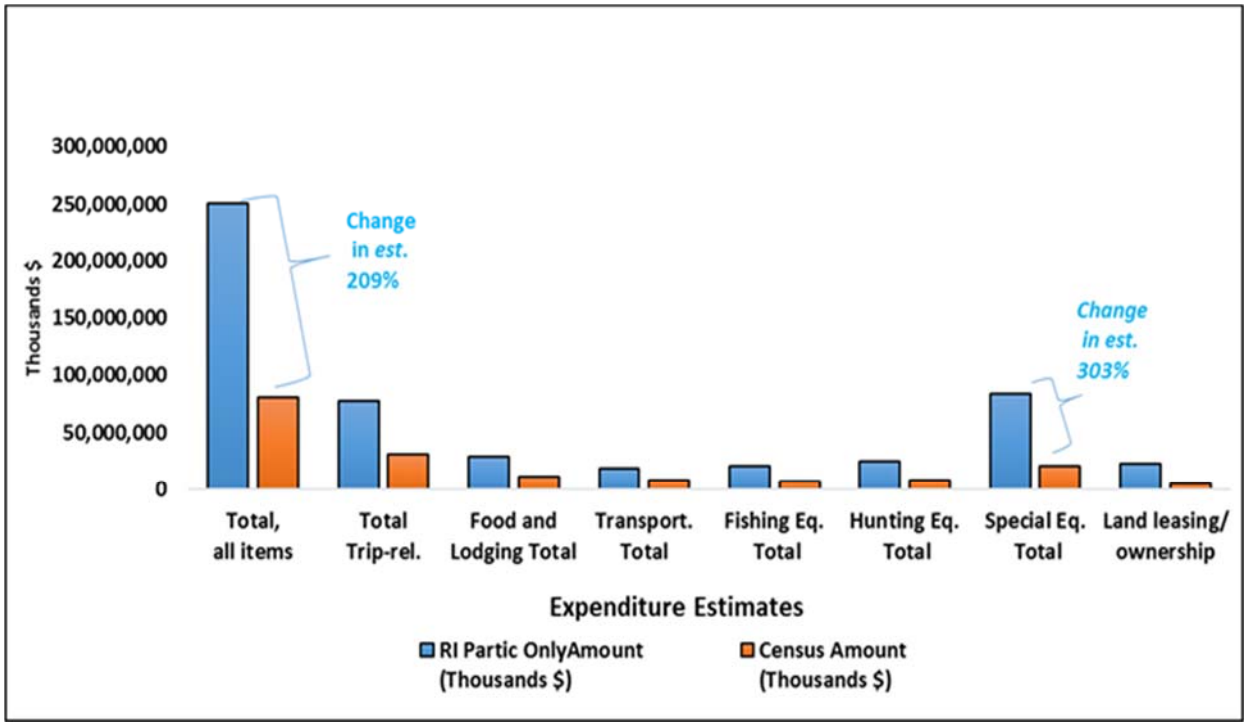
	Rockville All				Rockville Participants Only				Differences (RI All - RI Participants Only)			
Item	Amount ($1000)	Ave per Sports-person ($)	Number (1000)	Ave per Spender ($)	Amount ($1000)	Ave per Sports-person ($)	Number (1000)	Ave per Spender ($)	Amount ($1000)	% Change in Amount	Average per Spender ($)	% Change, Ave per Spender
Total, all items	263,489,970	3,876	66,013	3,991	250,346,825	4,048	60,024	4,171	13,143,145	5.2%	-180	-4.3%
Total Trip-related	80,472,402	1,184	59,556	1,351	77,231,710	1,249	54,070	1,428	3,240,692	4.2%	-77	-5.4%
Food & Lodging Total	30,494,897	449	52,220	584	29,263,603	473	47,508	616	1,231,294	4.2%	-32	-5.2%
Food	18,654,092	274	51,942	359	17,871,191	289	47,235	378	782,901	4.4%	-19	-5.0%
Lodging	11,840,805	174	15,795	750	11,392,412	184	14,785	771	448,393	3.9%	-21	-2.7%
Transportation Total	19,708,184	290	52,057	379	18,754,521	303	47,445	395	953,663	5.1%	-16	-4.1%
Public	2,580,189	38	5,181	498	2,497,737	40	4,782	522	82,452	3.3%	-24	-4.6%
Private	17,127,995	252	51,039	336	16,256,783	263	46,470	350	871,212	5.4%	-14	-4.0%
Other Trip Cost Total[2]	30,269,321	445	52,569	576	29,213,587	472	47,699	612	1,055,734	3.6%	-36	-5.9%
Fishing Equip. Total	21,149,938	311	41,739	507	20,436,917	330	38,664	529	713,021	3.5%	-22	-4.2%
Hunting Equip. Total	25,505,865	375	20,631	1,236	24,528,764	397	19,784	1,240	977,101	4.0%	-4	-0.3%
Auxiliary Equip. Total[3]	15,032,934	221	21,571	697	14,534,241	235	20,386	713	498,693	3.4%	-16	-2.2%
Special Equip. Total[4]	89,583,301	1,318	8,079	11,088	83,827,106	1,356	7,665	10,936	5,756,195	6.9%	152	1.4%
All fishing & hunting…												
Magazines, books, DVDs	532,450	8	8,277	64	495,722	8	7,665	65	36,728	7.4%	-1	-1.5%
Membership dues and contributions	1,221,934	18	10,953	112	1,151,281	19	10,100	114	70,653	6.1%	-2	-1.8%
Land leasing and ownership	24,706,599	363	5,056	4,887	23,190,826	375	4,680	4,955	1,515,773	6.5%	-68	-1.4%
Licenses, stamps, tags and permits	3,271,597	48	47,756	69	3,032,145	49	44,169	69	239,452	7.9%	0	0.0%
Plantings (for hunting)	2,012,951	30	3,962	508	1,918,112	31	3,799	505	94,839	4.9%	3	0.6%

Table 1.6. Comparisons of differences and percent change in expenditure estimates for Rockville (RI) Participants Only, and Census (Population 16 years old and older)

	Rockville Participants Only				Census				Difference (RI – Census)			
Item	Amount ($1000)	Ave per Sports-Person ($)	Number (1000)	Average per Spender ($)	Amount ($1000)	Ave per Sports-Person ($)	Number (1000)	Ave per Spender ($)	Amount	% Change, Amount	Average per Sports-Person	% Change Ave per Sports Person
Total, all items	250,346,825	4,048	60,024	4,171	81,035,416	2,049	37,045	2,188	169,311,409	209%	1,983	90.6%
Total, Trip-related	77,231,710	1,249	54,070	1,428	30,926,023	782	35,300	876	46,305,687	150%	552	63.0%
Food & Lodging Total	29,263,603	473	47,508	616	10,962,927	277	30,859	355	18,300,676	167%	261	73.5%
Food	17,871,191	289	47,235	378	7,266,256	184	30,598	237	10,604,935	146%	141	59.5%
Lodging	11,392,412	184	14,785	771	3,696,672	93	9,922	373	7,695,740	208%	398	106.7%
Transportation Total	18,754,521	303	47,445	395	8,233,085	208	30,215	272	10,521,436	128%	123	45.2%
Public	2,497,737	40	4,782	522	736,002	19	3,667	201	1,761,735	239%	321	159.7%
Private	16,256,783	263	46,470	350	7,497,083	190	29,583	253	8,759,700	117%	97	38.3%
Other Trip Cost Total[2]	29,213,587	472	47,699	612	11,730,011	297	27,574	425	17,483,576	149%	187	44.0%
Fishing Equip. Total	20,436,917	330	38,664	529	7,445,695	188	22,584	330	12,991,222	174%	199	60.3%
Hunting Equip. Total	24,528,764	397	19,784	1,240	7,996,132	202	10,128	789	16,532,632	207%	451	57.2%
Auxiliary Equip. Total[3]	14,534,241	235	20,386	713	6,082,746	154	9,723	626	8,451,495	139%	87	13.9%
Spec. Equip. Total[4]	83,827,106	1,356	7,665	10,936	20,791,143	526	3,943	5,273	63,035,963	303%	5663	107.4%
All hunting & fishing…												
Mag, books, DVDs	495,722	8	7,665	65	383,617	10	5,382	71	112,105	29%	-6	-8.5%
Membership dues/contrib.	1,151,281	19	10,100	114	574,450	15	4,305	133	576,831	100%	-19	-14.3%
Land leasing and ownership	23,190,826	375	4,680	4,955	5,257,433	133	2,434	2,160	17,933,393	341%	2795	129.4%
Licenses, stamps, tags and permits	3,032,145	49	44,169	69	1,412,745	36	21,942	64	1,619,400	115%	5	7.8%
Plantings (for hunting)	1,918,112	31	3,799	505	165,432	*4	*1,020	162	1,752,680	1059%	343	211.7%

** Estimate based on a sample size of 10-29.*

Figure 1.3. Comparison of Rockville (RI) Participants Only and Census select expenditure estimates



Comparison of Differences and Change in Estimates of "Total, All Hunting" by Selected Characteristics

Continuing with the discussion of selected estimates, Table 1.7 displays the differences in estimates for "Total, all hunting" between Rockville Participants Only and Census by selected characteristics. The Rockville Participants Only estimates all exceed the Census estimates on all characteristics except for the category "education 8 years or less." For population density of residence, Rockville Participants Only compared to Census increases the estimate for urban 138% and increases the estimate for rural 84%. For geographic regions, all regions follow this same trend with Rockville Participants Only estimates higher than Census estimates. The region with the largest change in the estimate is the Middle Atlantic, with the Rockville estimate increasing 259% over the Census estimate. This represents a shift with 884,000 as the Census number for Total all hunting increasing to 3,173,000 with the Rockville Participants Only

estimate. For Middle Atlantic, this is a shift from 3% to 9%, nationally, of those who participated.

Estimates for all age categories are higher for Rockville Participants Only compared to Census. The age category with the largest change in number was 18 to 24 years with a 226% change in the estimate for Census compared to Rockville Participants Only.

One of the largest differences in this particular estimate occurs for the sex (gender) category and the inclusion of females in this measure. Rockville Participants Only greatly increases the number (4,935,000 compared to 1,113,000 for Census) and increases the proportion of females (21% female and 79% male for Rockville compared to 10% female and 90% male for Census).

Another category with large differences in the estimate of "Total, all hunting" is Hispanic and Non-Hispanic with a change in the estimate of 382%. The Rockville Participants Only estimate exceeds the Census estimate with the number of Hispanic at 1,827,000 versus 379,000, respectively. This changes the proportion from 3% Hispanic in the Census estimate to 8% for the Rockville Participants Only estimate. For Race, Rockville Participants Only report numbers in the thousands for categories of African American, Asian American, and All Others whereas the Census estimates have "no reported information" for these categories due to small sample size.

All annual household income categories showed increases for Rockville Participants Only compared to Census for the "Total, all hunting" estimate. Annual household income categories that show the largest percent change in the estimate were the categories of $30,000 to $34,999 (442% change in the estimate) and $25,000 to $29,999 (398% change in the estimate). For the most part, more lower-income households were included in the Rockville Participants Only estimate than in the Census estimate.

Education categories do not directly align between Rockville Participants Only and Census. Rockville's lowest education level is 8 years or less (we interpret this to mean no more than 8th grade education). Census's lowest category is 11 years or less. The largest anomaly for comparison between the two sets of estimates is that Census estimates are larger (1,086,000) for those in the lowest age category (for alignment we have labeled as 8 years or less of education) compared to the Rockville Participants Only estimate (347,000). The change in this estimate is 68%. The education category with the largest change is 1 to 3 years of college with this category experiencing a 187% change in the estimate, with the Rockville Participants Only estimate much larger than the Census estimate.

Table 1.7. Comparison of differences and percent change in Total, all hunting estimates for Rockville (RI) Participants Only and Census by demographic characteristics, population 16 years and older (numbers in thousands)

Characteristic	U.S. Population		Rockville Participants Only			Census			Difference (RI Participants Only-Census)	
	Number	Percent	Number	% Who Participated	Percent	Number	% Who Participated	Percent	Number	% Change
Total persons	254,962	100	23,964	9	100	11,453	4	100	12,511	109%
Population Density of Residence										
Urban	201,142	79	12,897	6	54	5,425	3	47	7,472	138%
Rural	53,819	21	11,068	21	46	6,028	13	53	5,040	84%
Population Size of Residence										
Metropolitan Statistical Area (MSA)	231,982	91	19,404	8	81	8,903	4	78	10,501	118%
1,000,000 or more	139,302	55	9,193	7	38	2,922	2	26	6,271	215%
250,000 to 999,999	54,266	21	4,701	9	20	2,375	5	21	2,326	98%
50,000 to 249,999	38,414	15	5,510	14	23	3,606	8	31	1,904	53%
Outside MSA	22,980	9	4,560	20	19	2,551	17	22	2,009	79%
Census Geographic Division										
New England	12,077	5	575	5	2	297	2	3	278	94%
Middle Atlantic	33,657	13	3,173	9	13	884	3	8	2,289	259%
East North Central	37,331	15	3,773	10	16	2,737	7	24	1,036	38%
West North Central	16,633	7	2,639	16	11	1,364	8	12	1,275	93%
South Atlantic	50,519	20	3,984	8	17	1,716	3	15	2,268	132%
East South Central	14,965	6	2,221	15	9	1,256	*8	11	965	77%
West South Central	29,966	12	4,434	15	19	1,556	5	14	2,878	185%
Mountain	18,315	7	1,733	9	7	946	5	8	787	83%
Pacific	41,500	16	1,432	3	6	697	2	6	735	105%
Age										
16 to 17 years	7,807	3	649	8	3	228	3	2	421	185%
18 to 24 years	26,858	11	3,293	12	14	1,009	4	9	2,284	226%
25 to 34 years	44,599	17	4,972	11	21	1,783	4	16	3,189	179%
35 to 44 years	37,210	15	3,573	10	15	1,609	4	14	1,964	122%
45 to 54 years	39,086	15	3,570	9	15	2,542	6	22	1,028	40%
55 to 64 years	43,816	17	3,890	9	16	2,702	6	24	1,188	44%
65 years and older	55,587	22	4,016	7	17	1,580	3	14	2,436	154%
65 to 74 years	36,392	14	2,936	8	12	1,201	4	10	1,735	144%
75 and older	19,195	8	1,081	6	5	379	*2	3	702	185%
Sex										
Male	127,255	50	19,029	15	79	10,340	8	90	8,689	84%
Female	127,706	50	4,935	4	21	1,113	1	10	3,822	343%

Characteristic	U.S. Population		Rockville Participants Only			Census			Difference (RI Participants Only-Census)	
	Number	Percent	Number	% Who Participated	Percent	Number	% Who Participated	Percent	Number	% Change
Ethnicity										
Hispanic	30,049	12	1,827	6	8	379	*1	*3	1,448	382%
Non-Hispanic	224,912	88	22,137	10	92	11,075	5	97	11,062	100%
Race										
White	205,159	80	21,569	11	90	11,123	6	97	10,446	94%
African American	16,869	7	407	2	2	...	...	...		
Asian American	13,550	5	*221	*2	*1	...	...	...		
All others	19,384	8	1,767	9	7	208	*3	*2	1,559	750%
Annual Household Income										
Less than $20,000	22,274	9	1,395	6	6	436	*2	*4	959	220%
$20,000 to $24,999	10,276	4	452	4	2	161	*2	*1	291	181%
$25,000 to $29,999	11,859	5	722	6	3	145	*2	*1	577	398%
$30,000 to $34,999	10,771	4	834	8	3	154	*2	*1	680	442%
$35,000 to $39,999	11,184	4	1,498	13	6	456	*5	*4	1,042	229%
$40,000 to $49,999	21,033	8	1,946	9	8	1,101	7	10	845	77%
$50,000 to $74,999	43,684	17	4,678	11	20	2,649	7	23	2,029	77%
$75,000 to $99,999	34,872	14	3,444	10	14	1,873	7	16	1,571	84%
$100,000 to $149,999	37,613	15	3,935	10	16	1,536	5	13	2,399	156%
$150,000 or more	28153	11	3,391	12	14	1,408	5	12	1,983	141%
Not reported	23,243	9	1,670	7	7	1,534	3	13	136	9%
Education										
8 years or less	5,883	2	347	6	1	1,086	3	9	-739	-68%
9-12 years	74,572	29	7,121	10	30	3,555	5	31	3,566	100%
1 to 3 years of college	74,125	29	8,578	12	36	2,984	4	26	5,594	187%
4+ years of college/Bachelor's	51,034	20	4,466	9	19	2,474	5	22	1,992	81%
Post-Baccalaureate	49,347	19	3,452	7	14	1,354	5	12	2,098	155%

Table 10 Census Final National Tables rev with pop counts. ** indicates Census Estimate is based on a sample size 10-29. Sample too small (less than 10) to report reliably and is indicated by ….* (Z) Less than 0.5 percent. *Note: Percent who participated columns show the percent of each row's population who participated in the activity named by the column. Percent columns show the percent of each column's participants who are described by the row heading. Demographic variables we could include but haven't are (1) relationship to head of household, (2) marital status, (3) whether or not participant has a job, and (4) whether or not participant is going to school, keeping house, or retired.*
Rockville Participants Only Tables 11-22-2017. Table 10. ** indicates for Rockville Estimates the estimate is based on a sample size of 10-29*
… indicates sample size too small (less than 10) to report data reliably. Note: Percent who participated columns show the percent of each row's population who participated in the activity named by the column. Percent columns show the percent of each column's participants who are described by the row heading. Demographic variables we could include but haven't are (1) relationship to head of household, (2) marital status, (3) population size of area participant grew up, (4) years participant lived in resident state, (5) whether or not participant has a job, and (6) whether or not participant is going to school, keeping house, or retired. Detail does not add to total because of multiple responses and nonresponse.

Summary

Rockville's decision to follow-up with screener non-participants led to increases in nearly all of their estimates. This decision explains some of the initial difference the evaluation team saw in the estimates between Rockville and Census. However, as the comparisons here demonstrate, it does not explain all of the differences. Even when the Rockville screener non-participants are excluded from the estimates, the Rockville estimates of number of participants, days of participation, number of trips, and expenditures exceed the Census estimates, and in some cases by a considerable amount.

Further testing of selected estimates shows, of the 25 angler estimates (Appendix B, Table D-1) compared between Census and Rockville, 21 were significantly different and 4 were not. For hunters, of the 25 estimates compared, 20 were significantly different and 5 were not (Appendix B, D-2). For the fishing and hunting expenditure estimates compared, 40 were significantly different and 3 were not (Appendix B, D-3). Of the 34 wildlife watching estimates, 33 were significantly different between Census and Rockville, and 1 was not (Appendix B, D-4).

The differences that are shown in this report are similar to those found in a similar comparison conducted by the National Oceanic and Atmospheric Administration – Marine Recreational Information Program (NOAA-MRIP) (Brick et al. 2012). NOAA Fisheries had a traditional approach of obtaining national estimates of fishing effort using a computer assisted telephone approach. Due to decreasing response rates in their telephone surveys and concerns of increasing coverage error, pilot studies conducted in a number of states compared this traditional method of collecting fishing effort with a mail mode. The National Academies of Science published a report in 2017 (The National Academies of Sciences, Engineering, and Medicine 2017) and concluded that the methodologies associated with the current Fishing Effort Survey,

including the address-based sampling mail survey design, are major improvements over the original Coastal Household Telephone Survey that employed random-digit dialing to contact anglers.

The comparison discussed in this report is somewhat similar to the two approaches compared in the National and 50 States surveys. The Census National survey, using the CATI and CAPI approach, was compared with the Rockville 50 States mail delivery approach. Similar to the 2016 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation, the NOAA study also showed large differences between the two data collection approaches. In a study comparing these methods in four states, mail survey estimates of fishing effort were 2 to 6 times higher than the telephone approach (Andrews et al. 2014; Brick et al. 2012). These differences were consistent among the states included in the study. The complete National Academies (2017) report discusses the differences noted between the two approaches.

The remainder of this report will explore other possible explanations for the large differences between the Census and Rockville estimates in the National and 50 States surveys.

Section 2: Coverage Error

Compare Differences between Survey Sampling Frames Used and Completeness

The two surveys differ in the sampling frames used. Rockville used a database of addresses based on the U.S. Postal Service (USPS) Computerized Delivery Sequence file. Census used its own Master Address File (MAF) with updates from the CDS. The two frames are each discussed briefly below before a final assessment is made.

What Segments of the U.S. Population (Demographic and Geographic) are Missing from CDS Frame?

To mail out questionnaires, Rockville used address based sampling with a sampling frame based on the United States Postal Service (USPS) Computerized Delivery Sequence (CDS). Using CDS based frames is very common for address based sampling and is currently the industry standard. The 2016 report of the American Association for Public Opinion Research (http://www.aapor.org/Education-Resources/Reports/Address-based-Sampling.aspx) explains address lists updated via the CDS file are the best possible frames for today's household surveys in the United States – if the CDS is properly augmented by the sample vendor. The CDS file contains information on all delivery point addresses serviced by the USPS, with the exception of general delivery (mail held at a main post office for recipients to claim within 30 days). The inclusion or exclusion of address types such as drop points or flags for vacant units can affect coverage.

The CDS does not contain addresses for on-base military housing but does contain addresses for off-base military housing. It should be noted that some addresses in the CDS are simplified addresses with a city and state and no street address. Such addresses cannot be used

for mailing materials to a specific household. Because of how these shortcomings are handled, national coverage estimates vary by vendor a bit. However, coverage rates are very high overall and nearly 100% in many areas, and coverage continues to improve. If there were one area of concern, it would be rural counties.

Rockville used an ABS frame created by Marketing Systems Group (MSG). MSG also starts with the CDS and since 2008, MSG has used non-USPS data sources to reduce the number of simplified addresses in their ABS sampling frame. Consequently, the current under-coverage of ABS is very low in the MSG files (English et al. 2010).

Speculating on the direction of any coverage error that might affect the resulting estimates, one would assume that any ABS frame under coverage of rural addresses and better coverage of hidden units in urban areas (compared to traditional housing unit listing) would lead to a reduction in estimates of hunting, fishing, and wildlife watching participants, given that urbanicity is negatively correlated with participation. However, given what is known from prior coverage research, it is unlikely that any coverage error on the MSG provided frame would be responsible for any meaningful differences found between Rockville and Census results.

What Segments of the U.S. Population (Demographic and Geographic) are Missing from MAF Frame?

Census defined the target population for the National Survey as the household population of the U.S. (similar to the 2011 National Survey). The sampling frame to cover the household population for Census consists of all valid housing units in the July 2015 Census Master Address File (MAF). The MAF is a comprehensive database for all housing units and group quarter addresses in the entire U.S. The MAF is updated twice a year with the help of a variety of

address sources, one of which is CDS. In the CDS-based updates, non-city-style addresses from the CDS are discarded and not used to update the MAF because of the low match rates.

After drawing the initial sample from the MAF, the sample was run through the National Processing Center (NPC) address standardization process. Any nonexistent or unmailable address was removed from the sample, and the standard format files were eventually sent to the Census Bureau's Center for Administrative Records Research and Applications (CARRA) where phone numbers were added to the addresses if available.

The combination of the MAF information based on traditional listings, with updates from the CDS, comes close to an ideal sampling frame. It is unlikely that any frame error in the Census frame would cause the observed differences between Rockville and Census final estimates.

Section 3: Sampling Design/Error

Two topics are addressed in this section: the use of the resident hunter licensing information in each vendor's design, and the precision attained (in terms of coefficients of variation) by each vendor.

The guiding questions for addressing the first topic were: How was the resident hunter licensing information used by each vendor? Was it used properly with gain in sampling efficiency? Both Census and Rockville used the hunter license information to help in designing the survey but they used it in slightly different ways as described below.

Census

Census obtained 2013 hunter counts for each county, parish, borough, and municipal area in 49 states from the states' wildlife agencies. West Virginia did not report license counts so Census used the 2011 license counts for that state.

Census used these hunter counts to help in the formation of the primary sampling units (PSUs), however, these were used in a non-traditional approach. For example, in each county, the percent of hunters was obtained using the hunter counts divided by the population count times 100. A combined score was created for each county using the number of hunters, percent of hunters, and the number of valid housing units. Each of these three numbers was multiplied by a proportion set by Census to most accurately represent the sample area. Ward's hierarchical cluster methods were then used on the combined score to define the self-representing PSUs (Ward 1963). Strata and the non-self-representing PSUs were formed by incorporating the number and percent of hunters. A number of criteria were used in the PSU selection and stratification, which incorporated the numbers and percent of hunters. While the self-

representing PSUs were selected with certainty, the non-self-representing PSUs were selected with probability proportional to the size of the PSUs.

Census used the hunter information to assist in the sampling design, but the approaches were not the traditional steps as found in most sampling textbooks. A few steps were taken to incorporate not only the license information but also the number of valid housing units in a county. It seems reasonable to incorporate both of these numbers since they are features of a PSU that are important to consider. Census incorporated both of these along with multiplicative factors to form a combined score. However, there was no assessment provided by Census of the impact of using the combination of numbers in the combined score or of the multiplicative factors used in combined scores on the efficiency of the PSU creation. It is unclear how the rankings and hierarchical clustering dendogram impacted the PSU creation. In order to determine this, we would need to determine the design effect that would be generated using the various approaches to estimate the gain in efficiency across different scenarios.

Rockville

County-level hunting license counts were used for stratification by Rockville. The ratio of the number of hunting licenses to the population was calculated. Stratification was used for those states that had a ratio greater than 3% (n=35 states). Counties below the 75th percentile were placed in a low-density stratum while counties equal to or above the 75th percentile were placed in a high-density stratum. The high-density stratum had a sampling rate 1.5 times that of the low-density stratum. It is unclear why 3% was selected, why the 75th percentile was selected and why 1.5 was selected as the sampling rate as compared to other numbers.

Using these selected percent, percentile and sampling rates, a comparison was provided by Rockville comparing the variance of a proportion for the stratified design based on hunting prevalence compared to a simple random sample. Both the impact of the design and weighting effect were included in this comparison. The design effects that were provided for each state showed that for each state, the stratification provided a lower variance than a design with no stratification. The use of the hunter licensing information appeared to be proper and provide a gain in sampling efficiency. However, it would be informative to determine if a different percent of the number of hunting licenses to population (set at 3%), percentile (set at 75%), or sampling rate (set at 1.5) would further improve sampling efficiency.

Overall Comment on Licensing Information

Overall, the use of the hunting licenses in the sampling design would not impact the estimates but would have an impact on the efficiency of the estimators. It is not known what the extent of this would be without an evaluation, as discussed above. For example, Rockville could examine a range of cutoffs for each of the set measures that were adopted to determine if these were the optimum numbers to adopt in order to obtain the most efficient estimators. Likewise, Census used a number of tools in the formation of the strata, and it would be of interest to examine if adjustments to these procedures would impact efficiency. For example, it is not clear how other proportions used in the creation of the combined score would change the PSU and strata creation and subsequently impact the efficiency of the estimators.

Comparison of Coefficients of Variation

The coefficient of variation (CV) is the relative standard error of an estimate, expressed as a percent. It is computed as the estimated standard error of the estimate (square root of the estimated variance, computed using the replicate weights) divided by the estimate and multiplied by 100%. In the absence of non-sampling errors, the CV describes the relative precision of each estimate in unit-free terms that are comparable across estimates and across surveys. Non-sampling errors are, essentially, not reflected in the CVs.

We computed and compared CVs for Census and for Rockville on four national tables: D-1 - Anglers, Days, and Expenditures; D-2 - Hunters, Days, and Expenditures; D-3 - Fishing and Hunting Expenditures; and D-4 - Wildlife Watchers, Days, and Expenditures.

For D-1, Census CVs varied from 4.6% to 32.9%, with an average value of 14.8%. Rockville CVs for the same characteristics varied from 4.0% to 23.0%, with a mean of 10.5%. The average ratio of Census CV to Rockville CV was 1.5, meaning that on average, Census CVs were 1.5 times as large as Rockville CVs for fishing characteristics. The largest Census/Rockville ratio was 2.4, and the smallest was 0.8 (Census CV smaller than Rockville CV).

For D-2, Census CVs varied from 8.3% to 39.0%, with an average value of 21.2%. Rockville CVs for the same characteristics varied from 4.4% to 25.4%, with a mean of 10.2%. The average ratio of Census CV to Rockville CV was 2.3 for hunting characteristics. The largest Census/Rockville ratio was 3.3, and the smallest was 0.8.

The hunting participants in Table D-2 are a particularly important characteristic. In determining sample size, Census used a CV of 8% for the national-level estimate of hunting participants (U.S. Census Bureau 2017, p. 15). Census attained a CV of 8.3% for hunting

participants, very close to the target. Rockville developed its design to attain target CVs for state-level hunting participation estimates as described below.

For D-3, Census CVs varied from 15.4% to 55.3%, with an average value of 21.6%. Rockville CVs for the same characteristics varied from 6.0% to 38.3%, with a mean of 12.5%. The average ratio of Census CV to Rockville CV was 2.0 for hunting and fishing expenditures. The largest Census/Rockville ratio was 3.7, and the smallest was 0.5.

Finally, for D-4, Census CVs varied from 3.6% to 45.8%, with an average value of 15.5%. Rockville CVs for the same characteristics varied from 1.8% to 39.1%, with a mean of 11.0%. The average ratio of Census CV to Rockville CV was 1.8 for wildlife watching characteristics. The largest Census/Rockville ratio was 5.3, and the smallest was 0.5.

These CV ratios are somewhat consistent with expected behavior given the relative sample sizes of the two surveys. Because standard errors scale approximately like the inverse of the square root of the sample size, the ratio of CVs scales like the square root of the inverse ratio of sample sizes: Census CV over Rockville CV should be approximately the square root of Rockville sample size over Census sample size. The square root of Rockville fishing sample size over Census sportsperson sample size is 1.8; the square root of Rockville hunting sample size over Census sportsperson sample size is 1.5; the square root of Rockville wildlife watching sample size over Census wildlife watching sample size is 1.4.

We did not compute CVs for the state-level tables using Census and Rockville tables, since neither Census nor Rockville provided estimated standard errors for their state-level tables. We also did not compute state-level Census CVs from the survey data, since state was not identified in the survey data we have. We did, however, estimate a limited number of CVs for the Rockville estimates of state-level hunting participants (these CVs are identical to the CVs of

hunting participation rates if known rather than estimated state populations are used). Our estimates use only the Rockville hunting survey and do not composite with other surveys. Our estimates have not been extensively tested, but they do have the properties that (1) the sum of our state-level estimates is identical to the national estimate provided by Rockville; and (2) the sum of our variance estimates across states is very close to the national estimate provided by Rockville (as expected for a sample stratified within states).

The resulting CVs for the 50 states range from 13.6% to 47.2%, with a median value of 21.0%. Rockville had planned to obtain CVs for hunting participation ranging from 12% to 30%, with a median of 15% (see Table 2-1 in Edwards et al. 2017). Hence, in many cases Rockville failed to attain the desired CVs, and instead had much worse precision than anticipated.

Rockville specifically allocated sample sizes to attain CV's of 12.3% in Maine, Minnesota, and Oklahoma and 17.6% in Virginia (see Table 2-2 in Edwards et al. 2017). Rockville attained CVs of 16.5% for Maine, 14.2% for Minnesota, 17.4% for Oklahoma, and 18.8% for Virginia. In each case, the attained CVs are higher than the targets, sometimes substantially higher.

Section 4: Response Rates and Nonresponse Error

Nonresponse is a key concern for any survey data collection. Office of Management and Budget (OMB) standards and guidelines for statistical surveys (Office of Management and Budget, 2006) require that surveys with response rates that fall under the threshold of 80 percent provide a detailed protocol for evaluating errors. While nonresponse reduces the effective sample size and therefore reduces the stability of an estimate, the larger concern lies in the potential threat of nonresponse bias. Unfortunately, there is no standard reporting mechanism that quantifies the impact of nonresponse on statistical estimates, and any assessment of nonresponse bias requires information external to the survey. Typical sources used for nonresponse bias assessments are information from the sampling frame, or sources external to the survey (Valliant, Dever, and Kreuter 2013). In the case of multi-stage surveys with a screener component, biases in the main survey can be evaluated with respect to the information on the screener. It is important to note that any nonresponse bias analysis should ideally be an item-by-item analysis, since there is no direct relation between rates and biases. For any given response rate in a survey, each survey item may or may not suffer from nonresponse bias (Groves and Peytcheva 2008). In some instances, information on nonrespondents is gathered through a nonresponse follow-up.

Compare the Overall Response Rates and Other Key Survey Metrics of Both Survey Efforts, Including Respective Screener and Detailed Questionnaires.

Both Rockville and Census provided response rate calculations for screener and main detailed questionnaires. Both used AAPOR (2016) standards to communicate their response rate calculations. Given the different modes of data collection, the evaluation team would expect the response rates to differ considerably. CATI and CAPI surveys conducted by the U.S. Census

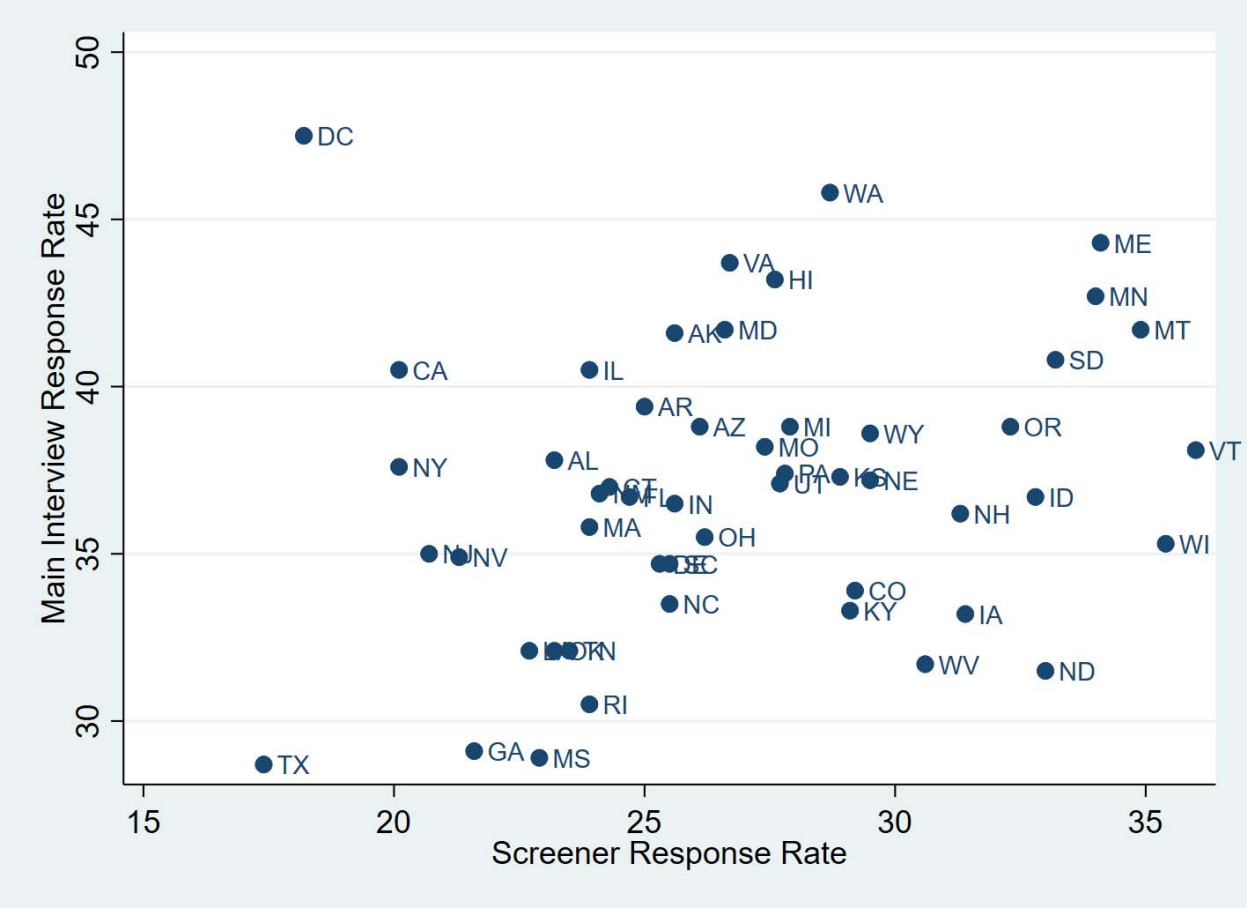
Bureau still show high response rates, and can (dependent on the survey length and topic) achieve over 80% response rates. Rates vary considerably for screener and main interviews. For example, in 2014 the National Survey on Drug Use and Health achieved a weighted response rate of 81.9% in the screening interview, 71.2% in the main interview, and a total (unconditional) response rate of 58.3%[1]. The 2016 National Health Interview survey response rates hover around 67.9% for the household module[2]. Address based samples conducted by mail have typically considerably lower response rates. The evaluation team would expect rates between 30-40% for such surveys.

Rockville reported response rates for both the 50 State Survey screener and the detailed questionnaire. All response rates were calculated as the ratio of the sums of base weights for respondents to the sums of base weights of respondents and nonrespondents. The screener response rate is subject to the unknown eligibility adjustment, and according to Rockville's report equates to AAPOR RR4 (AAPOR 2016), though the detailed Table (7-1) reports AAPOR RR3 for the screener (Edwards et al. 2017, p. 7-2 to 7-3), which are plotted in Figure 4.1. Rockville reports the detailed questionnaire response rate as the rate for Wave 3, since only respondents to Wave 3 are considered to have complete data for 2016 by Rockville (main interview AAPOR RR2, plotted in Figure 4.1 on y-axis).

The overall weighted response rate reported by Rockville for the screeners was 24.6%, with states varying between 17.4% (TX) and 36% (VT). The screener response rates for the four evaluation states (Maine, Minnesota, Oklahoma, and Virginia) were higher than average. The distribution of screener and detailed questionnaire response rates does not reveal any systematic patterns.

[1] https://www.samhsa.gov/data/sites/default/files/NSDUH-FRR1-2014/NSDUH-FRR1-2014.pdf
[2] ftp://ftp.cdc.gov/pub/Health_Statistics/NCHS/Dataset_Documentation/NHIS/2016/srvydesc.pdf

Figure 4.1. Screener and main interview response rates for each state Rockville



Overall response to the fishing questionnaire was 36.6 percent, to the hunting questionnaire 38.8 percent, and to the wildlife questionnaire 34.3 percent. In the Rockville detailed questionnaires, response was slightly higher among females than among males, among older individuals compared to those under 35, and Asians and African-Americans generally had the highest return rates. Those sampled as non-participants show higher response rates than those sampled as participants. Non-participants had a lower response burden as they received only one detailed questionnaire covering all of 2016, while participants received either two or three.

The overall main interview response rates are in the expected range. Some surveys report trade-offs between screener eligibility and main interview responses, with higher eligibility rates

in screener interviews leading to lower responses in the overall survey (Tourangeau, Kreuter, and Eckman 2015). Should changes to the screener be considered, this is something to keep in mind.

Census reports an overall screener interview response rate of 89.1% (AAPOR RR2 for Wave 1 and 2), and a detailed interview response rate of 66.3% for Wave 3. The corresponding weighted response rates were 82.8% and 64%. The response rate figures for Wave 1 and Wave 2 include the 2,772 pre-screener households that said that no one in the household was going to participate in any type of FHWAR activities.

In the four selected states, Census achieved the following response rates: Maine: 83.5% for the screener interview (combined Wave 1 and Wave 2) and 64.0% for Wave 3 detailed interview; Minnesota: 93% (combined Wave 1 and Wave 2) for the screener interview and 61.1% for the Wave 3 detailed interview; Oklahoma: 90.3% (combined Wave 1 and Wave 2) for the screener interview and 61.9% for the Wave 3 detailed interview; Virginia: 85.8% (combined Wave 1 and Wave 2) for the screener interview and 70.4% for Wave 3 detailed interview.

Vendor Efforts to Gain Additional Information about Nonrespondents

Rockville developed four nonresponse follow-up questionnaires to be administered during Wave 3—one for screener nonrespondents and one for each activity type of Wave 1 nonrespondents. The nonresponse follow-up questionnaires were abbreviated versions of the full screener and the detailed and annual questionnaires, respectively. In their nonresponse bias analysis, Rockville assessed the impact of including nonresponse follow-up respondents' data in their estimates and concluded that these respondents had very little impact. However, the report did not provide the type of information needed for the evaluation team to assess whether this conclusion is warranted (i.e., magnitude and direction of effects).

In their nonresponse bias analysis report, Rockville used, for the nonresponse bias analysis at the screener stage, information based on characteristics that are available from the address based sampling (ABS) frame, and data that can be appended to each address from an outside source, such as the American Community Survey (ACS) (at the aggregate level) (Dai, DeMatteis, and Green 2018). For Wave 3, the main questionnaire, the nonresponse bias analysis included characteristics reported in the household screener. Using this information Rockville compared: (1) household screener respondents to household screener nonrespondents, (2) estimates of activity participation (screener variables) based on household screener respondents, before and after adjusting the household screener weights for nonresponse, (3) detailed questionnaire respondents to detailed questionnaire nonrespondents, (4) subgroup estimates for ABS sampling frame, the ACS, and the household screener based on detailed questionnaire respondents, before and after adjusting the household screener weights for detailed questionnaire nonresponse, and included (5) a logistic regression analysis identifying the significant predictors of each of three key detailed questionnaire outcomes (detailed questionnaire response, detailed questionnaire activity-participation (fishing, hunting, wildlife watching), and activity related-expenditures).

A notable finding in the nonresponse bias analysis for the screener is that even after weighting, rural households had a higher screener response rate (32.7%) than urban households (22.8%) (Dai et al. 2018: p. A-1). Inasmuch as rural people hunt, fish, and wildlife watch more than their urban counterparts (U.S. Fish and Wildlife Service 2014), we would expect this over-representation of rural households vis-à-vis urban households to increase estimates of participation from the screener. Census does not appear to have the same differential representation of urban and rural households at the screener stage (Fuller 2018).

As a result of the differential response rates, 29.3% of Rockville screener households are rural compared to 21.7% of Census screener households. Table 4.1 shows the percent of screener respondents from the Rockville and Census surveys that reported at least one household member was a participant by activity and rural/urban status. It is clear that Rockville screener respondents in general were more likely to identify at least one participant household member. This is true for each activity, but especially for hunting and wildlife watching where Rockville respondents were 2.37 times and 4.46 times as likely as Census respondents to identify at least one participant.

Table 4.1. Percent of screener respondents identifying at least one household member participant by activity and rural/urban

Activity	Total	Urban	Rural	Ratio Rural/Urban
Rockville				
Hunting	21.51	15.10	36.90	2.44
Fishing	41.13	36.52	52.20	1.43
Wildlife Watching	51.66	47.95	60.57	1.26
Hunting and/or Fishing	45.09	39.21	59.22	1.51
Hunting, Fishing, &/or Wildlife Watching	65.31	60.52	76.81	1.27
Census				
Hunting	9.06	5.77	20.97	3.63
Fishing	24.28	22.00	32.50	1.48
Wildlife Watching	11.58	10.55	15.31	1.45
Hunting and/or Fishing	27.80	24.45	39.89	1.63
Hunting, Fishing, &/or Wildlife Watching	32.97	29.38	45.93	1.56
Ratio (Rockville/Census)				
Hunting	2.37	2.62	1.76	
Fishing	1.69	1.66	1.61	
Wildlife Watching	4.46	4.55	3.96	
Hunting and/or Fishing	1.62	1.60	1.48	
Hunting, Fishing, &/or Wildlife Watching	1.98	2.06	1.67	

Notes: For Rockville, we assume that Person 1 is the screener respondent based on the design of the questionnaire/instructions and limit the analyses to only Person 1 respondents who are adults (eliminating children). However, there is no way to confirm that Person 1 was the screener respondent as this was a mail questionnaire. Census has an indicator for the screener respondent. All analyses are unweighted. Rockville n=63034; Census n=6112.

For both Rockville and Census, rural screener respondents were more likely to identify at least one participant in their household, as we would expect. Interestingly, the effect here seems stronger for Census, especially for hunting, as evidenced by the differences in the ratios (rural/urban) between the vendors. For Rockville, rural screener respondents were 2.44 times as likely as urban screener respondents to identify at least one hunting participant in the household, but for Census rural screener respondents were 3.63 times as likely as urban screener respondents to do so. The ratios for the rest of the activities are not as drastically different, although in all cases, the ratio is higher for Census than Rockville.

Rockville does not include the rural/urban variable in their screener nonresponse adjustment; thus, the overrepresentation of rural households vis-à-vis urban households among the Rockville screener respondents, as well as their increased likelihood to report participants compared to urban respondents, is likely contributing to Rockville's higher estimates.

Another notable finding in the Rockville nonresponse bias analysis is the higher likelihood to respond in the high hunting license density stratum, a likely source of nonresponse bias, with participants being more likely to respond than non-participants. Rockville uses this variable in their screener nonresponse adjustment; however, this only reduces nonresponse bias if this variable is a sufficient proxy for the participation mechanism.

Census reported difficulties reaching households for a fairly large portion of the Wave 1 CATI sample, and thus added a CAPI screener interview into Wave 2 and sent a subsample of the Wave 1 CATI nonresponse cases for a CAPI personal visit. The Census nonresponse bias analysis conducted by FWS is extensive and used several approaches to get a sense for a potential bias: (1) Comparison to population benchmarks, (2) Examination of variations in

response rates, (3) Comparison of distributions, and (4) Models for three outcome variables (Fishing, Hunting, Wildlife Watching) (Fuller 2018). Given the information available these analyses are sensible and well done. The report identifies several factors that are positively associated with survey response and higher participation, leading to increased estimates: rural residents, population density (less dense areas show higher participation), East North Central region (Census Geographic Division), higher age (though only for wildlife watching), male, non-Hispanic, white, higher income, and marital status (never married having the lowest participation and response rate). The demographic groups that were found to be more likely to participate were also more likely to respond. The resulting participation estimates would therefore (if not corrected) be inflated relative to their true levels. Thus, the nonresponse biases detected here do not account for the differences between Census and Rockville estimates.

How Did Each Vendor Handle This Non-Response, and Was It Appropriate?

Rockville adjusted for nonresponse in the screener by redistributing the weights of those that finalized as nonrespondents to those that finalized as respondents within weighting class adjustment cells – a common method that is deemed appropriate by the evaluation team. Adjustment cells were formed using classification trees and used the following variables: hunting license density stratum; percent Hispanic in census tract; percentage in census tract with education less than high school diploma; percentage low income in census tract, an indicator of whether the Metropolitan Statistical Area (MSA) is urban; USPS delivery route type—indicators of whether the address was flagged by the USPS as seasonal, vacant, or whether a telephone number was matched to the address. In the case of large adjustment factors (>5.0) or small n (< 30), cells were collapsed. To compute final person-level screener weights, the nonresponse-

adjusted household weights were also post stratified to control totals from the Census Bureau Population Estimates Program for each state (and DC respectively) by age (6-15, 16-25, 26-39, 40-54, 55-64, and 65+). The evaluation team considered the methods used appropriate, with the caveat that additional gains can likely be made by also including an indicator for rural/urban. The use of regression trees allows capturing differential nonresponse with respect to the variables used here.

At the detailed survey stage, Rockville used a similar approach to the 2011 National Survey, by forming weighting classes using the combination of MSA/non-MSA status and age by sex (males ages 16-44, males ages 45+, females ages 16+). Rockville noted that their detailed survey nonresponse bias analysis suggested that an approach to identifying weighting classes for detailed survey nonresponse adjustment that explicitly models the response indicator (e.g., a classification tree algorithm or logistic regression) might be worth considering in order to more effectively reduce nonresponse bias, and that the inputs to such a model should include, at a minimum, race and marital status in addition to the MSA/non-MSA, age, and sex variables that were used in the adjustment.

The Census nonresponse weights are made separately for four areas within each region/state. These areas are within: The central city of an MSA, balance of an MSA, urban area outside an MSA, and rural areas outside an MSA. The weights for each interviewed person are composed out of the base weight, multiplied by the pre-screener subsampling factor and the non-interview adjustment factor, which is the weighted count of interviewed households in a particular adjustment cell of region/state A and the weighted count of non-interviewed household in the same cell, divided by the weighted count of the interviewed household. More information

on the overall weights is given in that section of the report. The different detailed surveys had different nonresponse adjustment cells.

For both surveys, the evaluation team encourages an approach that integrates characteristics found significant in the nonresponse bias analysis given the design that was adopted.

Section 5: Item Nonresponse

Were the Definitions of Partially Completed and Completed Questionnaires Appropriate? Were They Appropriately Used?

There is no single definition of what constitutes a completed survey; rather this determination is made on a case-by-case basis depending on the anticipated survey data use. One option in defining a completed case is to determine the number of completed questions and set a percentage threshold. For example, one might define questionnaires with less than 50% of items answered a break-off and thus an incomplete, 50-80% answered a partial complete and more than 80% answered a complete (AAPOR 2016). Another widely used strategy is to determine which questions are essential and define completes based on whether or not these questions are answered. Census appears to have used the former while Rockville used a variant of the latter method.

Ultimately, two issues are important to consider when setting requirements for determining if a returned survey is a complete. First, given the costs of collecting data to both the data collector and respondent, one should make maximum use of the received data (i.e., avoid throwing away useful information). Second, one needs to ensure that complete and partial definitions do not privilege certain types of respondents such that the definition of an incomplete survey increases nonresponse bias. A third issue that should be considered is how clearly the definitions and procedures are described in the technical documentation that will be released with the public use data.

Although Census provided a description of the criteria they used to determine if a case was a complete in their technical documentation (U.S. Census Bureau 2017:37), the evaluation team sometimes found it difficult to understand the explanations given. For example, Census

states, “A screener case was classified as a *complete* if the household income contained a response.” It is not clear from this description whether questions leading up to the household income question also needed to be answered. It is also unclear whether “a response” means only a substantive response or could also include “don’t know” (DK) and “Refused” (REF). Upon further probing, Census clarified that what they meant is that the survey (in this case telephone or in-person survey) had to progress to the focal question (in this case the income question, but for other detail surveys, see Table 5.1 below) and the interviewer had to enter some response code into the CATI/CAPI system for that question, but that the response code did not necessarily need to belong to a substantive response; DK and REF counted as responses. So the focal questions identified by Census are really cut points for how far the survey progressed, and we assume that because this is a CATI/CAPI survey, all questions were answered in order, meaning that all questions appearing prior to the focal question would have been answered. Any technical documentation that will be released to data users or the public should be updated with more specific language to clarify these points.

Table 5.1 provides a side-by-side comparison of Census and Rockville criteria for defining a case as complete at each data collection. For Census, this included questionnaires defined as complete as well as “sufficient partial” completes. Our understanding is that Census included cases deemed as sufficient partials in the final data set.

Perhaps the biggest difference between the two organizations’ definitions of completes occurs on the screener where Rockville defines a survey as complete if any adult question is answered but Census requires that the household income question be completed (any response, including DK or REF constitute this question being answered). Based on the abridged list of screener questions in the Census technical report (U.S. Census Bureau 2017, Appendix 3-3), it

appears the household income question was the last item on the screener. Thus, Census appears to have a more stringent requirement for designating a screener questionnaire as complete. Theoretically, this difference in procedures for defining a complete means that Rockville will likely keep a larger proportion of their returned surveys in the data set, but possibly have higher item nonresponse rates, and for some variables, higher imputation rates as a result while Census will likely keep a lower proportion of their surveys in the data set but have lower item-nonresponse and imputation rates because they exclude breakoff cases. However, this implication is contingent on Rockville's mail survey respondents returning partially complete questionnaires (see below for comparison and discussion of item nonresponse and imputation).

Table 5.1. Criteria for defining returned surveys as complete

	Rockville	Census	
		Sufficient Partial	**Complete**
Pre-screener	N/A	All questions in the household composition section (Step 5) were completed OR all questions in the avidity section (Step 6 - did anyone in household hunt/fish/wildlife watch) were completed.	All sections, including providing a phone number, were answered. (DK and REF were considered valid responses).
Screener	Answered any adult question	N/A – No sufficient partials at this stage.	The household income question contained a response (DK and REF were considered valid responses).
Wave Surveys			
Census Detailed Sportsperson (includes fishing and hunting)		Completed questions up to and through the yes/no questions for the fishing equipment (or hunting equipment if the respondent did not fish)	Completed the FH_OBSRV question (did sportsperson respondent participate in wildlife-watcher activities at least 1 mile from home since last interview) (DK and REF were considered valid responses). This question came after all fishing and hunting questions; thus, all fishing

	Rockville	Census	
		Sufficient Partial	Complete
			and hunting question were administered and answered.
RI Fishing	Must have answered Q1, Q2, or Q3 (did you fish, how many days, first state fished in) or Q139 (any special interest in wildlife around home) If Q1 = yes, must have answered at least one question from Q122-Q131 (fishing equipment purchases)		
RI Hunting	Must have answered Q1 (did you hunt) AND/OR Q126 (any special interest in wildlife around home) If Q1 = yes, must have answered at least one question from Q108-118 (hunting equipment purchases)		
Wildlife Watching	Must have answered Q1 (any trips 1 mile from home for wildlife watching) or Q33 (observe wildlife around home) If Q1 = yes, must have answered Q6 or Q7 (on your trips did you observe wildlife [6] or photograph wildlife [7]) Must have answered at least one question between Q42 and Q52 (these are about feeding fish and wildlife around the home, visiting parks near home, and some purchases relevant to wildlife watching).	Completed the yes/no questions for the wildlife-watcher equipment purchases	Completed the NCU_FISH (did wildlife-watcher respondent participate in fishing activities)
Census Combination (sportsperson & wildlife-watcher)		Completed the yes/no questions for the wildlife-watcher equipment purchases	The interviewer reached the THANKYOU field. Because the combination cases did not receive the NCU_FISH or FH_OBSRV crossover questions

With regard to the first criteria above, the Rockville rule makes the most use of received data, setting a very low threshold for designating a screener survey as complete. With regard to the second criteria, the Rockville low threshold for screening out a case means they are unlikely to differentially screen out particular types of households, thus reducing the contribution of this data processing step to nonresponse error due to unit nonresponse (but possibly increasing error contributed through item-nonresponse and imputation procedures, see comparisons below). For Census, if we think that people who are likely to break off during the survey are also likely to hunt, fish, or wildlife watch at different rates or spend more or less time or money doing so than those who fully complete the survey, the stringent requirement of answering through the last question could have contributed nonresponse error to estimates. However, if breakoff-respondents do not differ on these measures from those who completed the survey, the stringent requirement would not contribute error to the estimates. Whether or not those who broke off differ from those who completed the survey is an empirical question that may be explored by comparing answers given to common questions between those determined to be incomplete and those determined to be complete, but the evaluation team cannot assess this with the available data.

In the wave surveys, Census designated surveys as incomplete, sufficient partial, or complete. Our understanding is that both sufficient partial and complete surveys were included in the final data set, so for the purposes of this report we will focus on the lower threshold – sufficient partials (by definition, all completes are also sufficient partials).

For the Census sportsperson survey (hunting and/or fishing), a case was defined as a sufficient partial (i.e., included in the data set) if the survey progressed through the yes/no questions about purchasing hunting equipment for those who only hunted or fishing equipment

for those who only fished or those who both hunted and fished. The technical documentation (U.S. Census Bureau 2017) is unclear about whether this includes equipment primarily used for these activities or also the equipment "primarily for use in either fishing or hunting," but Census clarified that it does not include the latter. Only the hunting and fishing equipment yes/no questions needed to be answered. In any technical documentation provided to the public, it would be useful to more clearly state this, providing the specific last question that needed to be administered/answered to avoid any confusion as well as the full questionnaire with exact question ordering, wording, and all follow-ups and on-screen interviewer instructions so it is absolutely clear what comes before and after the focal question.

In their comparable hunting and fishing questionnaires Rockville had less stringent definitions of a complete, likely in part because their surveys were conducted in the mail mode, allowing far less control over making sure that every question was administered and in the correct order and providing less information about which questions sample members were exposed to (i.e., which questions were read but not answered versus not read at all). In the fishing questionnaire, respondents must have answered Q1, Q2, or Q3, which ask whether they fished, how many days, and what was the first state fished in or Q139, which was the first wildlife watching question asking if they took special interest in wildlife around their home. If they reported "yes" to Q1, they also had to answer at least one question about fishing equipment purchases.

For the Rockville hunting questionnaire, the respondent had to answer Q1 (did they hunt) and/or Q126 (special interest in wildlife around the home). If they answered "yes" to Q1, they also had to answer at least one question about hunting equipment purchases to be considered

complete. It is not clear why the criteria for the hunting questionnaire differ from those for the fishing questionnaire with respect to Q2 and Q3 or how much of an impact this had.

Again, the lower threshold for defining a case complete used by Rockville reduces the likelihood of introducing nonresponse error due to unit nonresponse into estimates through this particular part of the process (i.e., the process of defining completes). It is also notable that even with stricter requirements in use for designating a case "complete," Census achieved reasonably high response rates as would be expected with CATI/CAPI survey modes, although it is unclear from both vendors how many nonresponding cases were designated as such because the surveys were never returned versus because returned surveys failed to meet the criteria for classifying them as a "complete."

Each organization's criteria for completes for the wildlife questionnaires are similar to their criteria for hunting and fishing such that Rockville has a lower threshold than Census.

What Impact Did the Definitions Have on the Results? What about This Impact in Terms of Comparability with Previous National Survey Results?

Because we do not have data from cases deemed ineligible for either survey, the evaluation team can only speculate on and cannot empirically assess the impact of these two sets of rules for determining completes. The effect of these rules should be empirically evaluated in the future.

With respect to comparability with previous National Survey results, we have no reason to believe that the Census procedures followed in this survey differed from procedures used in the past. Thus, the effect of the criteria used should be consistent with the previous National Surveys.

It is likely that the different Rockville criteria will impact comparisons with prior years' National Surveys in similar ways to its impact on comparison with the Census's 2016 National Survey as described above. However, the evaluation team does not have access to the data that would be needed to empirically evaluate or quantify this impact.

Were Imputations Used, and Were They Properly Used?

Imputations were used by both Census and Rockville. For the Census National Survey, imputation was done for age, race, sex, relationship to household respondent, marital status, and maximum schooling achieved when these values were missing from the household screener (U.S. Census Bureau 2017). Similarly, Rockville imputed age and sex (which they call gender) when these characteristics were missing from the screener (Edwards et al. 2017). Imputation rates for both organizations are shown in Table 5.2.

Table 5.2. Imputation rates for Census and Rockville

	Census	Rockville
Age	4.2%	2.5%[b]
Race	3.7%	
Sex	0.3%	1.5%[b]
Relationship to household respondent	0.2%	
Marital status	12.4%[a]	
Education	5.1%	

[a] *Only 10 people age 16+ had their marital status imputed. All other cases were children under 16 who accidentally had their status imputed to "5-never married." The accidental imputations were left in the data set.*
[b] *Rates provided are for adults. The rates for children are 2.3% for age and 2.1% for sex.*

Both organizations started their imputation processes for these variables with logical imputes, meaning they imputed plausible values based on what else they knew about the individual or other household members. For example, if respondent sex was missing but their spouse's sex was known, both Census and Rockville imputed the opposite of the spouse's sex to the respondent (assuming all heterosexual families). The Rockville technical documentation

details exact procedures used in their logical imputes (Edwards et al. 2017:6-6 to 6-8); the Census documentation provides an overview of the strategies used, but lacks detail (U.S. Census Bureau 2017: 115-116). This detail should be provided by Census in any further technical documentation.

After all possible logical imputations were made, both organizations appear to have imputed remaining missing data on these particular demographic variables using a hot deck imputation (Kalton and Kasprzyk 1986). Essentially this means they filled in missing data with values from other similar cases that were not missing the same data. Rockville seems to have used state, number of adults in the household, whether the person was an adult or child, and age of the household screener respondent to identify similar others for imputing age and state, number of adults in the household, and age of screener respondent for identifying similar others for imputing sex (Edwards et al. 2017). The Census procedure is less clear as the technical documentation explains that a hot deck value was "based on other households in related geographic areas" (U.S. Census Bureau 2017:115).

While not described in the Census technical document (U.S. Census Bureau 2017), Census explained to the evaluation team through September 2017 presentations, follow-up emails, and memos that because of an oversight associated with conducting the pre-screener for the first time in 2016, they lacked certain demographic characteristics for pre-screener non-participant cases. These are households that answered the pre-screener, but were not selected to proceed to the screener (where such demographic information was collected) because they were non-participants. Nevertheless, because they represent the portion of the U.S. population that does not engage in the activities of interest in the survey, they had to be included in the final data set. As a result, age, race, sex, Hispanic origin, income (at the household, not person level), and

education had to be fully imputed for this subset of cases. Roughly speaking, this imputation was done by comparing the demographics of the screener cases that had demographic information available to 2016 ACS estimates and then assigning demographic values randomly to the pre-screener non-participant cases to bring the total sample more in line with the ACS estimates. This procedure results in full demographic data in the data file for the pre-screener non-participant cases, but has several consequences that need to be considered.

First, the fact that this imputation was done and the procedure used to do it needs to be transparently discussed in any technical documentation that will be made publicly available. Because the data will be made public, data users need to know all relevant information to be able to determine if the data are appropriate for their planned uses. Also, for the sake of comparing the Census and Rockville survey efforts, it is necessary to know whether the imputation procedures were conducted only at the national level or also for each of the four comparison states.

Second, because no theoretically informed modeling was used to make decisions about what value to assign to each case for each demographic characteristic (rather, values were assigned randomly), the evaluation team has little faith in the quality of this demographic data. This procedure undermines nonresponse bias analyses relying on demographic data (the demographics of the final set of cases have artificially been made to look similar to ACS distributions) as well as subgroup analyses of hunting, fishing, and wildlife watching participation rates (e.g., percent of women in the population who hunt) and any multivariate analyses involving demographics and including the pre-screener non-participant portion of the cases. This imputation does not impact estimates or analyses that focus only on participants such as the number of participants, number of days participated, or participant expenditures. Census

has indicated any future cycles of the survey they conduct will collect demographic data in the pre-screener questionnaire to avoid this issue in the future.

If imputation was used, what recommendations would you have in terms of being able to make comparisons of results with previous National Surveys?

The logical and hot deck imputation likely had little impact on comparisons made between the current data and previous years' survey data. These types of procedures are fairly common, and although full detail is missing from the Census technical documentation, the evaluation team has no reason to believe that the procedures used in 2016 differed appreciably from those used in prior years.

The full imputation of all demographic characteristics for the Census pre-screener nonparticipant portion of the sample is a considerable departure from prior years and does have consequences for making some comparisons with prior years, particularly, any subgroup analyses comparing rates of any of the activities of interest here.

Comparison of item nonresponse rates on key variables

Item nonresponse rates tend to vary by mode. Generally, web and mail are expected to produce more item nonresponse and DK responses than CATI and CAPI (Heerwegh and Loosveldt 2008; Heerwegh 2009; Nicolaas and Tipping 2006) with the exception of sensitive questions. For sensitive questions, CATI and CAPI are expected to produce more item nonresponse (Nicolaas and Tipping 2006). Among CATI and CAPI, CATI is expected to produce more DK responses (Holbrook, Green, and Krosnick 2003). Among mail and web, mail

is expected to produce higher item nonresponse rates (Messer, Edwards, and Dillman 2012; Lesser, Newton, and Yang 2012; Israel and Lamm 2012; and Millar and Dillman 2012).

Comparable item nonresponse rates for many of the questions cannot be calculated for the Census and Rockville surveys because of inconsistencies in data processing and coding. In any comparison of item nonresponse rates, it is important to differentiate between true item nonresponse resulting from respondents skipping over or not answering questions and missing data due to respondents correctly skipping items, for example, as part of skip patterns in the questionnaire. An evaluation of item nonresponse should focus only on true item nonresponse. However, both Census and Rockville failed to record the final data for some variables in ways that allow one to differentiate item nonresponse from missing data due to skip instructions. In addition, for some Census variables, only positive responses were kept in the final data set; both negative responses and missing data were coded as ".", the value for missing data, making it impossible to calculate item nonresponse rates for these items.

Despite these difficulties, there are some variables on which we can compare item nonresponse across the two survey efforts. These are shown in Table 5.3. The table shows generally what we would expect, with Rockville's mail survey producing slightly higher item nonresponse rates than Census's CATI/CAPI survey. The discernable item nonresponse rates for both of these surveys are similar to what we would expect and do not appear to be concerning; however, future survey efforts should ensure that data are coded in such a way that true item nonresponse rates can be calculated for all questions in the survey to allow for a more exhaustive comparison. In particular, the evaluation team is concerned with the inability to evaluate item nonresponse for Rockville expenditure and all summation variables, as these are the questions where we would expect the highest item nonresponse, particularly in a mail survey.

Table 5.3. Item nonresponse rate comparison

Variable Name	Brief Variable Description	Census Item Nonresponse Rate	Rockville Item Nonresponse Rate	Difference (RI - Census)
Sportsperson Items				
USFISH	Any recreational fishing in 2016	0.10	1.18	1.08
USHUNT	Any hunting in 2016	0.05	0.72	0.67
BGHUNT	Hunted big game in 2016	0.00	0.31	0.31
SMHUNT	Hunted small game in 2016	0.00	0.23	0.23
MBHUNT	Hunted migratory birds in 2016	0.00	0.27	0.27
OAHUNT	Hunted other animals in 2016	0.00	0.23	0.23
MUZZHNT	Any 2016 muzzleloader hunting	0.42	0.84	0.42
FIREHUNT	Any 2016 non-muzzleloader firearm hunting	0.21	1.03	0.82
HUNTBOW	Any bow hunting in 2016	0.42	0.99	0.57
FLYFISH	Fly fished in 2016	0.40	1.43	1.03
HOWN	Own property primarily for hunting in 2016	0.42	2.72	2.30
HLEASE	Lease land primarily for hunting in 2016	0.63	3.64	3.02
FOWN	Own land primarily for fishing in 2016	0.80	2.83	2.03
FLEASE	Lease land primarily for fishing in 2016	0.88	3.86	2.98
EXEMPT_H	Exempt from buying hunting license in 2016	0.83	3.22	2.39
BUY_H	Buy hunting license in 2016	0.63	4.35	3.73
DUCK_H	Have federal duck stamp in 2016	1.04	0.00	-1.04
EXEMPT_F	Exempt from buying fishing license in 2016	1.67	2.79	1.12
BUY_F	Buy fishing license in 2016	1.19	4.48	3.29
H_PLCST	2016 costs of plantings primarily for hunting	0.00	0.00	0.00
FH_OBSRV	2016 wildlife watching one mile from home	0.25	2.15	1.90
Wildlife Watching Items				
FH_OBSRV	2016 wildlife watching one mile from home	0.00	2.15	2.15
WILDLIFE	2016 wildlife watching around home	0.00	0.04	0.04
TYPWLD1	Observe birds	0.00	0.11	0.11
TYPWLD2	Observe large mammals	0.00	0.22	0.22
TYPWLD3	Observe small mammals	0.00	0.24	0.24
TYPWLD4	Observe reptiles or amphibians	0.00	0.24	0.24
TYPWLD5	Observe insects or spiders	0.00	0.24	0.24
TYPWLD6	Observe fish or other wildlife	0.00	0.25	0.25
PHOTO	Photograph wildlife around home in 2016	0.00	0.19	0.19
FEEDBRD	Feed wild birds around home in 2016	0.00	0.16	0.16
FEEDFSH	Feed fish/other wildlife near home in 2016	0.00	0.30	0.30
PARKS	Visit public parks near home for wildlife	0.01	0.17	0.17
AOWN	Own land primarily for wildlife watching	0.01	0.47	0.46
ALEASE	Lease land primarily for wildlife watching	0.01	0.60	0.59
NATRAREA	Maintain natural areas at home for wildlife	0.01	0.51	0.50
MAINPLNT	Maintain plantings at home for wildlife	0.01	1.80	1.79

Note: This table contains the full set of variables from the detailed surveys on which item nonresponse could be compared across Rockville and Census, given variable coding and naming conventions. The item nonresponse rate is the percent leaving each item unanswered.

That said, it is unlikely that these differences in item nonresponse can explain the differences in most estimates between the Rockville and Census surveys. This is because most of the key estimates are counts or totals. For example, if a respondent with missing data on USHUNT had answered the requisite question, they could have said “no”, which would not change the Rockville estimate of the number of hunters in the U.S. in 2016, or “yes”, which would have added to that estimate, moving it even further from the Census estimate.

Section 6: Measurement Error and Mode Effects

The analysis of probability surveys includes examining sampling and nonsampling errors. Sampling errors arise due to sampling a subset of the population. Non-sampling error is the error due to deviations of the survey estimates from their true values that are not attributed to sampling a subset of the population. Coverage error, nonresponse error, and measurement error are three types of non-sampling error described in the literature. This section discusses the role of measurement error, particularly error that may have occurred due to the questionnaire and mode.

Survey Modes and Measurement

To answer survey questions, respondents must perceive and comprehend the question, retrieve relevant information, formulate a judgment, and then report that judgment (Tourangeau, Rips, and Rasinski 2000). Mistakes or incomplete processing in any of these steps can impact answers, and as a result, survey estimates. Survey modes have varying features that can make it easier or more difficult to complete each of these steps optimally (de Leeuw 2005). Survey mode is a key feature that differed across the Census and Rockville surveys and likely contributed to differences in estimates across these surveys.

For the National Survey, Census started with a pre-screener that was initially administered via web with nonrespondents sent a paper questionnaire. Thereafter all questionnaires were administered via CATI or CAPI. For the 50 State Survey, Rockville utilized all paper questionnaires mailed to households. Thus, the primary comparisons for these surveys are mail versus CATI and CAPI.

Three important ways in which these modes differ are in whether an interviewer is present, whether the questionnaire is computerized, and the channel of communication (visual

vs. aural). Generally, interviewers can be advantageous throughout the response process because they can be motivating, they can ensure that questions are asked and answered in the intended order, and they can provide helpful clarification or feedback throughout the survey. In addition, interviewers can probe incomplete or otherwise problematic answers. These abilities are generally expected to improve respondent comprehension, recall, judgment, and reporting, thereby reducing measurement error. However, interviewers can also increase measurement error (for overviews of interviewer error see Fowler and Mangione 1990 and West and Blom 2017). For example, respondents tend to be more likely to over report socially desirable behaviors or under report socially undesirable behaviors in an attempt to present themselves in a positive light in interviewer-administered modes (i.e., social desirability – Tourangeau and Smith 1996; Kreuter, Presser, and Tourangeau 2008).

Likewise, when interviewers go off-script, such as when providing clarification, feedback, and probing, they may increase measurement error, particularly in the form of interviewer variance (i.e., variance in responses that is due to interviewers, not true variance in the construct being measured) (Fowler and Mangione 1990, Biemer and Lyberg 2003). Interviewer probing, in particular, has been found to contribute substantially to interviewer variance (Fowler and Mangione 1990). It is well documented for interviewing that cooperation and motivation of the respondent, both of which influence accuracy of answers, are influenced by interaction with the interviewer, and that there is variation across interviewers in their interactions with respondents (West and Blom 2017). Mail surveys, which have no interviewers, lack the benefits that interviewers bring to surveying, but are also free of interviewer error.

Interviewer error such as described above is typically evaluated through experiments, behavior coding (a labor intensive and time consuming process), or statistical analyses of

interviewer variance that require, at the least, an interviewer indicator for each case in the data set. Because they are expensive, time consuming, and can have implications for sampling and field management of interviewers, experiments and behavior coding are rarely employed in production surveys, and were not used in the Census survey evaluated here. At best, an interviewer indicator could be appended to the existing data sets to allow some evaluation of interviewer variance, but this was not done on data made available to the evaluation team so the team cannot empirically assess the impact of interviewers on the estimates.

Computerization is generally considered to be a strength for the survey modes that have it because it can be used to standardize question order and ensure skip patterns are implemented correctly, it allows for the use of helpful fills in questions (i.e., inserting answers from a previous question into a later one), and it can be used to check for consistency across related questions and trigger follow-up when answers are inconsistent (Couper and Nicholls 1998; Couper 2005). Computerization also makes it easier to use dependent interviewing in which respondents are reminded of answers given in a previous wave of data collection to assist with recall in the current wave (Lugtig and Jackle 2014; Mathiowetz and McGonagle 2000). The Census CATI/CAPI instrument took advantage of computerization by using fills (e.g., referencing specific states respondents reported hunting in or specific species hunted to help focus follow-up questions) and dependent interviewing (discussed below). It does not appear to employ consistency checks, as the evaluation team was able to enter inconsistent reports across questions (e.g., reporting 4 days of hunting overall and then 7 days of hunting in a specific state) into the provided Blaise instrument without triggering any sort of follow-up or probing.

The communication channel can also potentially impact the response process. For example, modes in which questions are delivered orally, such as telephone and in-person, are

helpful for those with poor vision or low reading ability while visual modes like mail are helpful for those with hearing difficulty. No information about vision, reading, or hearing difficulties among sample members is available to assess how much of an impact these factors had on either vendor's survey efforts. Further factors associated with communication channel and specifically relevant to retrieval/recall are discussed below.

In a survey like the National Survey of Fishing, Hunting, and Wildlife-Associated Recreation, which asks respondents to recall specific behaviors and expenditures within specific time periods, the retrieval step of the response process is very important. Respondents need to be able to accurately remember what they did/spent and correctly place their behaviors in time and place. Doing so is difficult. Given this, two differences between the modes used by Census and Rockville seem particularly important.

First, in the Census CATI and CAPI surveys the interviewer controls the pace and flow of the survey. In contrast, the pace and flow of the Rockville mail surveys was controlled by respondents. Mail survey respondents can more easily slow the process down and take the time they need to retrieve relevant information (de Leeuw 2005). Having the questionnaire at-hand allows respondents to spend more time thinking and processing questions, ask questions of other relevant householders or pass the questionnaire to a more knowledgeable person in the household, and/or spend more time for memory retrieval or for checking records such as calendars, statements, or receipts. The paper questionnaire as a tangible aid allows for broader and deeper processing and allows for less top of the head spontaneous answers.

Second, the CATI and CAPI surveys were administered orally, meaning respondents had to devote some of their cognitive resources to holding the question and response options or response task in mind while also processing and answering the question. In contrast, the visual

mail survey allowed respondents to look back at the questionnaire as needed so they did not have to hold as much information in working memory, allowing them to devote their resources to answering.

Thus, the survey taking context was very different in ways that likely impacted recall for respondents to these two survey efforts. The CATI/CAPI respondents had to do the survey when the interviewer called or visited (often unscheduled and out of the blue, but sometimes at a scheduled callback time) and had to deal with the social pressures evoked by interviewer presence to answer reasonably quickly and avoid long silences, pressures that are particularly relevant in CATI surveys where there is no visual channel to help the interviewer and respondent communicate to each other what long silences may mean (de Leeuw 2005). In contrast, the mail survey respondents could answer the survey at their convenience and could take as much time as they needed on each question without these social ramifications. Thus, the mail survey respondents were more likely to have the time and resources they needed to fully recall their hunting, fishing, and wildlife watching activities and expenditures.

With the available data, the evaluation team cannot empirically assess whether the CATI/CAPI respondents felt more rushed than the mail respondents or whether the mail respondents took more time to retrieve relevant information or were more likely to look at records. The team also does not know how many of the CATI/CAPI interviews were conducted from cold calls versus scheduled callbacks or respondents initiating the call at their convenience, although our own experience is that scheduled callbacks and especially incoming calls from sample members are rare relative to outgoing calls from interviewers. However, based on what we know about interviewer- and self-administered surveys, we can say that all in all, the

conditions for optimal recall were likely better in the mail survey than the CATI/CAPI survey, and we can try to assess this to a limited extent through indirect means with the existing data.

Evidence of Recall Differences

For both Census and Rockville, the initial screening step to select sample members for the detailed questionnaires relied on a household screener respondent to accurately report the hunting, fishing, and wildlife watching activities of all household members. The screener respondent thus serves as a "gatekeeper" for the household (Andrews et al. 2014). To the extent that Rockville and Census recruited different types of household screener respondents (i.e., people with different levels of knowledge of household members' hunting, fishing, and wildlife watching activities or for whom the salience and thus memorability of these activities varies), we would expect different levels of measurement error in the screener responses.

Because hunting and fishing are male gendered activities (i.e., more prevalent among men than women and they signify masculinity – Smalley 2005; Stedman and Heberlein 2001; U.S. Fish and Wildlife Service 2014), *on average*, we expect men to be more knowledgeable about these activities among household members and to have an easier time recalling them because they are more salient and memorable for men. Thus, we expect male screener respondents to be more likely to identify at least one household member who engages in hunting and fishing than female screener respondents.

Table 6.1 shows the proportion of screener respondents who were male and female for Rockville and Census. These same data, but expressed as percentages, are shown graphically in Figure 6.1. Examining all households in the screener reveals that Rockville's mail screener resulted in a 6.5 percentage point increase in male screener respondents compared to Census's CATI/CAPI screener. In single-person households, there is no choice about who will be the

screener respondent; such a choice only applies in households with two or more adults. In these households, Rockville's mail screener resulted in an 8.8 percentage point increase in male screener respondents relative to Census's CATI/CAPI screener. This makes sense in-as-much-as mail survey respondents have more latitude to pass a questionnaire on to the most knowledgeable or interested household member while the person answering the phone or door is typically interviewed in CATI and CAPI surveys (the evaluation team confirmed that Census interviewed the first eligible person contacted rather than using any within-household selection technique). Among households in which the screener respondent is in a heterosexual spousal relationship, the difference in the percent of screener respondents who are male gets just slightly larger at 9.1 percentage points.

Table 6.1. Proportion of screener respondents who were male or female

	Male	Female	Standard Error
All Households			
Rockville	0.597	0.403	0.002
Census	0.532	0.468	0.006
Difference	0.065	-0.065	
2+ Adult Households			
Rockville	0.648	0.352	0.002
Census	0.560	0.440	0.008
Difference	0.088	-0.088	
Screener respondent is in heterosexual spousal relationship			
Rockville	0.696	0.304	0.002
Census	0.605	0.395	0.009
Difference	0.091	-0.091	

Notes: For Rockville, we assume that Person 1 is the screener respondent based on the design of the questionnaire/instructions and limit the analyses to only Person 1 respondents who are adults (eliminating children). However, there is no way to confirm that Person 1 was the screener respondent as this was a mail questionnaire. Census has an indicator for the screener respondent. All analyses are unweighted. Rockville n=63034; Census n=6112.

Figure 6.1. Percent of male screener respondents by vendor

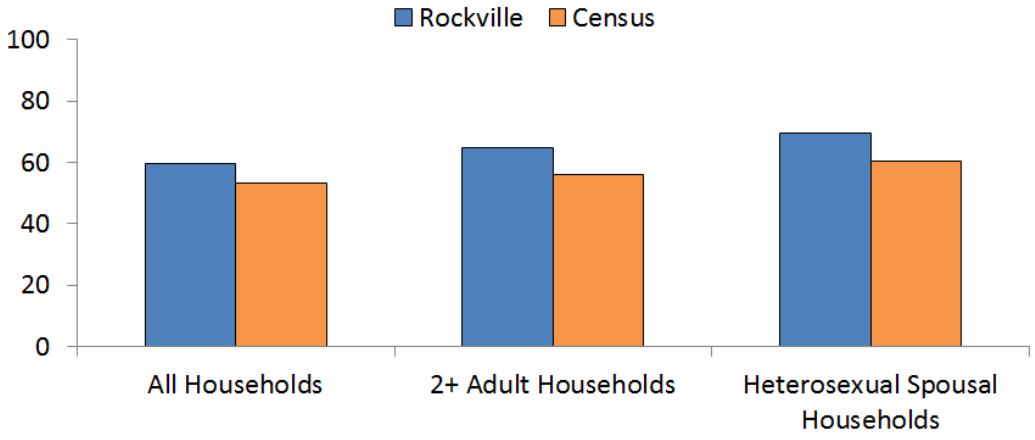


Table 6.2 and Figure 6.2 show that both male and female screener respondents in the Rockville screener were more likely than their counterparts in the Census screener to identify at least one household member who hunted, fished, or wildlife watched, suggesting that the slower survey pace with more respondent freedom in the mail survey allowed for more thorough recall. Moreover, the differences between the Rockville and Census screeners are largest for wildlife watching, which likely required the most extensive recall and retrieval because it is the most varied of the three types of behaviors, evidenced by the extensive clarifications and instructions provided for this item in the questionnaires:

> Next, I would like to ask about SPECIAL INTEREST in wildlife in ways OTHER THAN hunting and fishing. We are interested in whether you closely observe, photograph, feed, or maintain natural areas or plantings for wildlife. Please do not include noticing wildlife while doing other activities. Do not include trips to zoos, circuses, aquariums, museums, or scouting for game. By wildlife I mean birds, mammals, fish, insects, reptiles such as snakes and lizards, and amphibians such as frogs. DO NOT include farm animals and pets. (Census screener questionnaire)

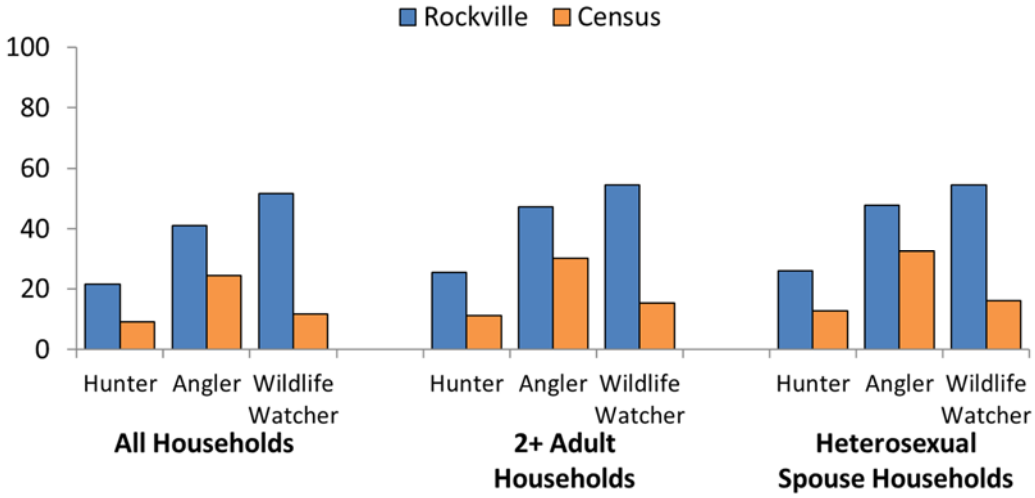
For all of these items, but especially for wildlife watching, the finding of more households identified as having at least one hunter, angler, or wildlife watcher is consistent with

the notion that the reduced cognitive and working memory demands and increased time to respond in the mail survey increased recall and reporting.

Table 6.2. Proportion of screener households reporting any household member participating in hunting, fishing, and/or wildlife watching by screener respondent sex (standard errors in parentheses)

	Hunting		Fishing		Wildlife watching		Hunting and/or fishing		Hunting, fishing, and/or wildlife watching	
	M	**F**	**M**	**F**	**M**	**F**	**M**	**F**	**M**	**F**
All Households										
Rockville	0.297	0.094	0.501	0.279	0.528	0.500	0.555	0.297	0.710	0.568
	(0.002)	(0.002)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.002)	(0.003)
Census	0.124	0.053	0.287	0.193	0.121	0.110	0.339	0.209	0.389	0.263
	(0.006)	(0.004)	(0.008)	(0.007)	(0.006)	(0.006)	(0.008)	(0.008)	(0.009)	(0.008)
Difference	0.*173*	0.*041*	0.*214*	0.*086*	0.*407*	0.*390*	0.*216*	0.*088*	0.*321*	0.*305*
2+ Adult Households										
Rockville	0.314	0.143	0.526	0.376	0.550	0.539	0.581	0.403	0.739	0.661
	(0.003)	(0.003)	(0.003)	(0.004)	(0.003)	(0.004)	(0.003)	(0.004)	(0.003)	(0.004)
Census	0.137	0.080	0.329	0.264	0.152	0.150	0.381	0.289	0.442	0.357
	(0.007)	(0.006)	(0.010)	(0.010)	(0.007)	(0.008)	(0.010)	(0.011)	(0.010)	(0.011)
Difference	0.*177*	0.*063*	0.*197*	0.*112*	0.*398*	0.*389*	0.*200*	0.*114*	0.*297*	0.*304*
Screener respondent is in heterosexual spousal relationship										
Rockville	0.309	0.140	0.522	0.379	0.549	0.541	0.578	0.406	0.738	0.670
	(0.003)	(0.004)	(0.003)	(0.005)	(0.003)	(0.005)	(0.003)	(0.005)	(0.003)	(0.005)
Census	0.147	0.098	0.346	0.285	0.161	0.161	0.400	0.317	0.465	0.386
	(0.008)	(0.008)	(0.011)	(0.013)	(0.008)	(0.010)	(0.011)	(0.013)	(0.011)	(0.014)
Difference	0.*162*	0.*042*	0.*176*	0.*094*	0.*388*	0.*380*	0.*178*	0.*089*	0.*273*	0.*284*

Figure 6.2. Percent of screener respondents identifying at least one participant



As expected, Table 6.2 also shows that in both surveys, male screener respondents were more likely to identify at least one household member who engaged in each activity of interest in 2015 than female screener respondents (this holds when accounting for screener respondent age and number of people in the household). For example, looking at all households, in the Rockville screener, 29.7% of male screener respondents identified at least one household member who hunted, but only 9.4% of female screener respondents did so. Likewise, 50.1% of Rockville male screener respondents identified at least one household member who fished compared to only 27.9% of female screener respondents. The differences by screener respondent sex were considerably smaller for wildlife watching in both surveys.

These differences for all households, however, may be driven in part by women in single adult households doing these activities less often than men in single-adult households (i.e., not a recall issue). As a result, we subset the analyses to both households with two or more adults and to households where the screener respondent is in a heterosexual spousal relationship. If sex-based recall differences do not occur, we would not expect male and female screener respondents from heterosexual spousal households to identify hunters, anglers, and wildlife watchers at

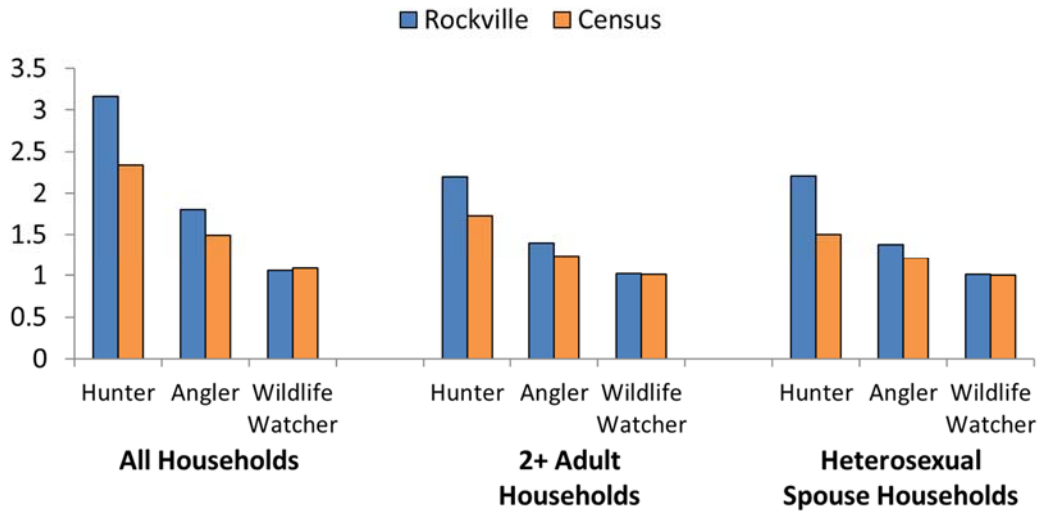
different rates. However, Table 6.2 reveals that the differences by sex of the screener respondent persist in households with two or more adults and in those where the screener respondent was in a heterosexual spousal relationship.

Importantly, the difference in likelihood of identifying a hunter or angler within a household between men and women was larger in the Rockville screener than the Census screener. Table 6.3 shows the ratio of male to female screener respondent reports of at least one household member participating in each activity (shown graphically in Figure 6.3). For both hunting and fishing, the ratio is higher in the Rockville survey than the Census survey, meaning that male screener respondents were even more likely than female screener respondents to identify a hunter or angler in the household in the Rockville mail screener than in the Census CATI/CAPI screener. These differences are particularly pronounced for hunting, where Rockville male screener respondents were over three times as likely to report that a member of the household hunted in 2015 than female screener respondents, but Census male screener respondents were 2.34 times as likely to do so as female screener respondents. Sub-setting to households with two or more adults or those in which the screener respondent is in a heterosexual spousal relationship attenuates the difference across Rockville and Census somewhat. But even in these households, Rockville male screener respondents are over two times as likely as female screener respondents to identify at least one household member who hunts while Census male screener respondents are only 1.5 to 1.71 times as likely to do so.

Table 6.3. Ratio of male screener respondents reporting any activity among household members to female screener respondents reporting any activity among household members

	Hunting	Fishing	Wildlife watching	Hunting and/or fishing	Hunting, fishing, and/or wildlife watching
All Households					
Rockville	3.16	1.80	1.06	1.87	1.25
Census	2.34	1.49	1.10	1.62	1.48
2+ Adult Households					
Rockville	2.20	1.40	1.02	1.44	1.12
Census	1.71	1.25	1.01	1.32	1.24
Screener respondent is in a heterosexual spousal relationship					
Rockville	2.21	1.38	1.01	1.42	1.10
Census	1.50	1.21	1.00	1.26	1.20

Figure 6.3. Ratio of male to female screener respondents reporting at least one participant in the household



Thus, the combination of the mail survey allowing all screener respondents more time for recall, Rockville obtaining more male screener respondents, and male screener respondents being

more likely to identify a sportsperson in their household likely contributes to the higher Rockville participation estimates.

This analysis does not account for the Census pre-screener, which was conducted by web and paper. Census did not collect demographic data for the pre-screener, making such an analysis impossible. However, given that the pre-screener was self-administered, we would not expect the sex composition of Census pre-screener respondents or the finding that men identify more sportsperson households to differ substantially from what we see in the Rockville screener.

Questionnaire Development

The 2016 Data of Interest document was used as the primary resource to develop the questionnaire by Rockville, along with the 2011 public use file codebook. A number of changes were made on the 2016 survey on both the screener and detailed surveys in order to clarify or add questions. In addition, other changes were made to accommodate the mail mode. For example, the 2011 sportsperson questionnaire was split into two instruments in order to avoid presenting a 70-page questionnaire.

However, a review by AFWA and FWS noted inconsistencies in item wording between the Rockville and Census instruments (Edwards et al. 2017, p 3-13). It was discovered that the item language in the 2016 Data of Interest Document was from a 2001 survey, and not 2011. This resulted in a thorough examination of each item in the detailed questionnaires used by Rockville and Census. This document comparing the detailed questionnaires, referred to as "cross-walking", was provided by Rockville and a comparison of the screener was drafted by Richard Aiken (U.S. Fish and Wildlife Service).

A number of examples are mentioned below that might have led to differences in responses between the two organizations due to the design of the questionnaire.

1. First Screening Step: Question on wildlife-associated recreation

Sampled households were first surveyed by Rockville in their mail screener questionnaire and by Census in their mail and web mixed-mode pre-screener. This was the first chance sampled households had to indicate that either one or more household members engaged in hunting, fishing, or wildlife watching or that no household members did so. Households that indicated no such activities and no plans for them among household members in the next year were not followed up again by Census; they were permanently screened out of all follow-up surveys. Rockville did follow up with some of these "nonparticipating" households. Because this first screening step for both organizations strongly influenced the chance that a household would be further surveyed, differences in measurement and quality of reporting at this point likely influenced final estimates of prevalence of these activities and overall response rates.

As noted above, wildlife-associated recreation was measured. The following instructions and questions were used in the first contact by Rockville and Census to determine the extent of wildlife-associated recreation.

Located in Screener from Rockville, Appearing after Question 19:

The next questions ask about SPECIAL INTEREST in wildlife in ways OTHER THAN hunting and fishing. We are interested in whether you closely observe, photograph, feed or maintain natural areas or planting for wildlife. Please do not include trips to zoos, circuses, aquariums, museums, or trips for hunting fishing, or scouting for game. By wildlife we mean birds, mammals, fish, insects, reptiles, such as snakes and lizards, and amphibians such as frogs. Do not include farm animals or pets.

Question 20. During 2015, did this person take any SPECIAL INTEREST in wildlife? *Do not include trips to zoos, circuses, aquariums, museums, or trips for hunting fishing, or scouting for game*.

Located in pre-screener from Census, Appearing in Step 6:

The next questions ask about different kinds of wildlife-related activities. We are only interested in recreational activities, that is, activities done for pleasure or sport and not for earning money or other compensation.

1-Did you or anyone in your household closely observe, feed, or photograph, wildlife recreationally or maintain natural area for the benefit of wildlife in 2015 or so far in 2016? Please include activities around your home and on trips away from home. *Please do not include trips to zoos, circuses, aquariums, museums, or trips for hunting fishing, or scouting for game*.

2-Do you or anyone in your household anticipate closely observing, feeding, or photographing wildlife recreationally or maintain natural area for the benefit of wildlife in 2016? Please include activities around your home and on trips away from home. *Please do not include trips to zoos, circuses, aquariums, museums, or trips for hunting fishing, or scouting for game*.

Comment 1: The underlined sentence used by Rockville was not used by Census in this initial screening step. This sentence, with its inclusion of fish, insects, reptiles, and amphibians, gives a broader definition of wildlife than many people likely conjure on their own and may have resulted in households in the Rockville screener being more likely to report that members of the household took special interest in wildlife. Census pre-screener respondents would likely have been less likely to think of some of these as wildlife and thus more likely to report no household members taking special interest in wildlife, thus removing them from further follow-up. Wave 1 and Wave 2 screener Census interviews included the more detailed description of wildlife that was used by Rockville, but by this point some households may have already been screened out.

Comment 2: In addition to these differences, Census provided more details in the interviewer manual to explain definitions for terms or phrases used in the wildlife-watching section. These details would assist the interviewer to isolate those individuals who were specifically watching wildlife, describing definitions of a “trip”, “feeding wildlife”, “maintaining natural areas”,

"photographing wildlife", and "special interest" (e.g., U.S. Census Bureau, 2016 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation, Waves 1 and 2 CATI Interviewer Manual, pp. 4-29 to 4-31). Due to the mail mode used by Rockville, providing this much detail to explain each term is not possible. It is unclear whether or not or how often Census interviewers provided these details to respondents or what impact the additional details had on results.

2. <u>Monetary amounts, expenditures, and recall.</u>

A number of questions were asked to obtain expenditures on hunting, fishing or wildlife-associated recreation equipment. Not surprising when moving from a telephone to a mail survey, changes in the mode led to changes in the wording of these items. For example, in the 50 State survey, Rockville asks about hunting purchases as follows:

Section 6. Hunting Equipment These questions are about equipment and other items you may have purchased in the United States PRIMARILY for use in hunting since you filled out the survey we sent you in September. Include the purchase of both new items and items previously owned by others. Do NOT include gifts you purchased for others or hand me downs and inherited items.
Since the last survey, did you purchase or acquire...
Q107 Rifles?

Census set their questions up as:

INTRO3 Now, I would like to ask you about hunting and fishing equipment purchases. Include only those items purchased in the United States. Include both new items and items that were previously owned by others.
From Date of last Sportsperson interview to December 31, 2016, did you purchase or acquire -
H_EQP_A Rifles?
RIFLPREV On Date of last Sportsperson interview, you reported buying RIFLE(S) in 2016. Is/Are the RIFLE(S) you reported today the same you reported previously?

When asking people to place events such as activities or purchases in time, a common problem is telescoping where respondents misplace the events in time. For example, respondents might report recent events further back in time than they actually occurred or distant events more recently. In longitudinal surveys, this can result in mistakenly reporting activities at the wrong time and possibly double reporting where the same purchase is reported in two separate waves. To reduce double reporting, Census included the follow-up item RIFLPREV (i.e.: On Date of last Sportsperson interview, you reported buying RIFLE(S) in 2016. Is/Are the RIFLE(S) you reported today the same you reported previously?). This was possible because the computer-assisted interviewing system used by Census had the capability to check for previously reported items and insert this information into the Wave 3 questionnaires. In the Crosswalk documentation, it is noted that Rockville does not have a similar question to catch double reporting. While Rockville recognized the value of such a question, it would have been difficult and costly to insert this information into the mail questionnaire. Rockville does note in the survey instructions at the beginning of the list, “Do NOT include any activities or expenditures you reported on the previous survey.”

After the above question on whether the item was purchased, a series of questions follow that ask about the state of purchase, type of game hunted or location of fishing for the fishing questionnaire, and the cost. For the hunting questionnaire, this similar set of questions was repeated for ten other items including shotguns; muzzleloaders; pistols or handguns; bows, arrows, or other archery equipment; telescopic sights; decoys or game calls; ammunition; hand loading equipment and components (such as powder, shot, etc.); hunting dogs and associated items; and any other merchandise (such as cases and carriers for equipment or game, hunting knives, etc.). Questions on fishing expenditures included a list of seven types of equipment, while the wildlife-associated recreation questionnaire asked about 15 types of equipment. In this long series of items that were examined, the respondent in the Rockville study was only reminded at the beginning of the list that he/she should report on information "**Since the last survey...** ". However, Census asks for each item, "Is/Are the SPECIFIC ITEM you reported today the same you reported previously?"

Comment: The instructions used in the Rockville questionnaire were likely less effective than the explicit Census follow-up question at reducing duplicate reporting because as the respondent goes down the list in the Rockville questionnaire, it is unclear whether or not he/she would recall that only items that were not purchased prior to the last survey should be included. Moreover respondents may not have remembered whether they had reported a purchase in the previous survey. However, as mentioned by Rockville, the mail mode does not provide an easy way to include previously entered data into subsequent requests for information from that same respondent.

Census provided quite a bit more detail in the interviewer manuals to explain definitions for terms or phrases on expenditures. For example, definitions were provided to the interviewer if needed in the interview to clarify what items would be included as "household income", (e.g., wages and salaries, pensions, and unemployment compensations, were included while other examples of those items not to be used as income were noted such as lump sum inheritances, withdrawals from savings, etc.) (U.S. Census Bureau, 2016 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation, Waves 1 and 2 CATI Interviewer Manual, p. 4-32 to 4-33). Other sections of the interviewer manuals also provide more details on expenditure definitions for the various activities. Due to the mail mode used by Rockville, providing this much detail to explain each term is not possible.

Comment: It is unclear what impact the additional details that could have been provided by the Census interviewers had on the results.

3. Additional Differences

A number of other items that appeared on the questionnaires have slight differences. A few of these are mentioned below. We are not clear if these would have an impact on the results without further comparison and testing.

1. In the Wave 1 fishing questionnaire, a question was asked:

   Rockville:
   Question 14: On your Great Lakes trip(s) in or to this state since January 1, 2016, was one type of fish you fished for…..

   Census:
   Refer to Reference 3, "Types of Great Lakes Fish: if you have it available. On your Great Lakes trip(s) over this period in/to STATE, what types of fish were you primarily fishing for? Please do not report what you caught unintentionally.
   Response options.

Comment 1: The added statement used by Census “Please do not report what you caught unintentionally” may have an impact and reduce the number of types of fish reported caught.

Comment 2: Note that in the Crosswalk documentation it was noted that: "Census includes the word primarily in the question. Rockville cognitively tested the surveys with the phrase primarily fished for but found that it confused respondents especially with regards to the note on the days questions to Please include days when you fished for something else. After consulting with Richard Aiken (U.S. Fish and Wildlife Service), the decision was made to remove the word primarily." (explanation obtained from Crosswalk of Census and Rockville Institute Surveys, Wave 1 Fishing, p.4).

This same wording was used for freshwater and saltwater trips. However, anglers do target certain fish on trips (e.g., red snapper in the Gulf), and it is not clear if dropping “primarily fished for” would have led to reporting more species of fish.

2. Additional details added by Rockville on shellfish (Crosswalk of Census and Rockville Institute Surveys, Wave 1 Fishing, p. 9):

> Rockville:
> Question 96: On your saltwater trip(s) in or to this state since January 1, 2016, was one type of fish you fished for……. Shellfish such as crabs, clams, oysters, lobsters, etc.?
>
> Census:
> Refer to Reference 5, “Types of Saltwater Fish” if you have it available. On your trip(s) from January 1 to Date of interview in/to STATE, what types of fish were you primarily fishing for? Shellfish was a response option but no definition of what this meant was included.

Comment: It is not clear if the additional description about shellfish used by Rockville would provide more information to remind the respondent about shellfish and increase a positive response. Rockville included this language based on findings from the cognitive testing.

4. Questions on Great Lakes Fishing (also had similar questions for saltwater and freshwater) Expenditures

   Rockville:
   Question 41: What percentage or how much of the total amount you spent on your trip in or to this state was spent in your home state of residence? In other words, how much of what you paid for your trip to another state was paid for in your home state?

   Census:
   GLSHAR5_1: The total amount you spent on your Great Lake fishing trip to STATE was TOTAL DOLLARS (not including airfare). How much of this was spent in your resident state of Resident State?

   Comment: Census has a note about not including airfare. It was not in the 2016 Data of Interest document or the 2011 survey specs and codebooks. Rockville did not use this phrase about airfare.

5. Clarifications for public and private land questions

   Rockville:
   Private land use or access fees? (include entrance, privilege, or admittance fees for fishing on private lands or fishing preserves. Do not include leases.)

   Census:
   Private land use or access fees? Do not include leases.

And

Rockville:
How many acres did you lease? If less than 1 acre, enter 1. Include land and water in acre total.

Census:
How many acres did you lease?

Comment: Rockville includes additional details on what types of access fees to include and what to count in the acre total that is not provided by Census. It is unclear if the additional details impacted responses.

6. Differences in expenditure reporting process

Because they used the mail mode, the Rockville questionnaire required respondents to write expenditure amounts in answer boxes. Rockville conducted multiple phases of testing on the design of these boxes to minimize measurement error and included an example of how to report expenditures at the beginning of the questionnaire. Despite this extensive work, Rockville reported that a number of survey respondents misused the answer boxes, for example, entering cents into the dollar boxes. Where reported expenditure amounts do not seem plausible in the Rockville survey, a subjective decision has to be made about whether to accept the reported amount or edit it.

Census respondents reported expenditure amounts directly to interviewers who could immediately follow up and resolve any implausible amounts with respondents.

Comment: As a result of this mode difference, we expect fewer expenditure reporting errors of this type in the Census survey and a difference in measurement error for these

questions. Rockville addressed this issue in their presentation and the need for more examination to further minimize error for expenditure amount questions.

In summary, there were a number of questions that were not identical between Rockville and Census. This is not surprising given questions have to be written for the mode in which they are delivered. It is also not surprising that there would be differences in estimates between these versions given the examples shown above. However, it is not clear how the differences in wording would impact the overall difference in estimates. This would require further evaluation of these differences along with other errors that may have arisen due to sampling design and analyses that were adopted by each organization.

Section 7: Estimation Methodology and Public Use Data Sets

Estimation Methodology and Public Use Data Sets: Evaluate the Analytical Approaches in Each Survey to Generate National- and State-Level Estimates of Participation, Effort, and Expenditures. This Includes All Generated Reports and the Public-Use Data Sets.

In addressing this question, our approach was to use the provided documentation and public-use data sets to attempt to reproduce key estimates and their standard errors. In doing so, we assessed the appropriateness of the weighted estimation methods, the appropriateness of the variance estimation methods, the quality of the documentation for these estimation methods, and the quality of the public-use data sets and their documentation.

In discussion of the public-use data sets, we focus on reproducibility of estimates, recognizing that both Census and Rockville provided deliverables as requested by the sponsor, and could easily accommodate other deliverable specifications. This discussion is primarily (though not exclusively) aimed at future deliverable specification, as opposed to critique of the current deliverables.

Were the Weighting Schemes Appropriately Developed and Applied Given Each Vendor's Sampling Design? Were the Appropriate Estimators Applied?

Overview on weighting schemes.

In evaluating whether the weighting schemes were appropriately developed and applied given each vendor's sampling design, we considered three questions:

1. Does the weighting scheme appropriately weight the sample data so that approximately design-unbiased point estimates would be obtained, in the absence of non-sampling errors?
2. Does the weighting scheme appropriately weight the sample data to account, as well as possible, for known sources of non-sampling error including coverage and nonresponse error?
3. Have the weights produced by the weighting scheme been subject to smoothing or trimming procedures, to mitigate the impact of extreme weight variation on estimation and variance estimation?

Implicitly, we also ask whether the weighting is documented in sufficient detail to allow a knowledgeable reader to answer each of the above questions.

If the weighting schemes are appropriate, then the weighted estimators used by both vendors are the appropriate estimators, and the question "Were the appropriate estimators applied?" is not considered further.

Appropriateness of weighting schemes in the absence of non-sampling errors.

Steps in the weight construction that would be present even in the absence of adjustments for nonresponse or other non-sampling errors include (1) formation of base weights to account for unequal probabilities of selection, and (2) ratio or post-stratification adjustments to base weights to account for known population information. The first step is required for unbiased estimation and the second step is useful in gaining some estimation efficiency. The second step can also be used in coverage error adjustments.

Both Census and Rockville form base weights at the screener level and at the person level as inverse inclusion probabilities, and both adjust these base weights at each level to account for known population information. The population information includes population by age group information at the state level for both vendors, and PSU numbers of license holders at the screener level for Census.

Appropriateness of weighting schemes in the presence of non-sampling errors.

Survey weights are routinely subjected to a series of adjustments to account for non-sampling errors, primarily nonresponse. Both Census and Rockville adjust for household-level nonresponse at the screener level and person-level nonresponse at the detail level. Perhaps the most important difference is in the formation of weighting classes at the screener level to account for household-level nonresponse. The Census adjusted at the screener level within four fixed weighting classes in each state (central city of an MSA), balance of an MSA, urban areas outside an MSA, and rural areas outside an MSA). Rockville did not use fixed weighting classes, but instead modeled the probability of a household-level response using a classification tree-based algorithm, so that the resulting tree generated the weighting classes. The variables used in the classification tree algorithm (described in section 4 of this report) include not only geographic factors, but also demographic and economic characteristics. If the propensity to respond varies by these factors, and not just by the geographic factors used by the Census, then the Rockville approach would be more effective in reducing potential bias due to differential nonresponse. However, it seems unlikely that this difference in nonresponse adjustment methodology would contribute much to the large observed differences in estimates.

Weight trimming or smoothing.

Neither Census nor Rockville described any attempt to identify outlying or extreme weight values or to trim or smooth the weights. Large variation in the survey weights does not necessarily lead to large variation in the survey estimators, but estimators for study variables that have low correlation with the survey weights do tend to be unstable (see, for example, Section 2 of Chen et al. 2017). It is therefore common in practice to assess the stability of the survey weights and trim large weights if deemed necessary. We considered four diagnostic summaries of the detail weights for each vendor and survey:

1. **Range:** The minimum and maximum weight.
2. **% Simple:** The percentage of weights that are more than 3.5 times the median weight.
3. **% Potter:** Following Potter (1988, 1990) as described in Chen et al. (2017, Sec. 2.2.1), we used the method of moments to fit a beta distribution to the reciprocals of the scaled survey weights. We then determined the percentage of weights that exceed the upper 0.99 quantile of the fitted distribution.
4. **% NAEP:** Following the National Assessment of Educational Progress (NAEP) weighting method, as described in Chen et al. (2017, Sec. 2.2.1), we constructed the boxplot of $\left(\frac{nw_i}{\sum w_i^2}\right)^{1/2}$ and determined the percentage of outlying values; that is, the percentage of these values that are greater than the third quartile (75th percentile) plus 1.5 times the interquartile range (75^{th} percentile minus 25^{th} percentile).

These four diagnostic summaries are given in Table 7.1. The weights have considerable variation. All the Rockville weights vary across four orders of magnitude, while the Census wildlife watching weights vary by three orders of magnitude. There is evidence of extreme

weights by each of the diagnostic criteria considered. All sets of weights are remarkably consistent with respect to the percentages of large values by the various criteria considered, and all are suggestive of the presence of extreme weights. Weight trimming (e.g., by Potter or NAEP methods) would proceed by choosing a threshold value, setting all weights above this threshold equal to the threshold, then ratio-adjusting the remaining weights so that the sum of the original weights (with extremes) equals the sum of the trimmed weights. The procedure would be iterated until no further weights were identified as extreme.

Table 7.1. Diagnostic summaries of detail weight distributions

Vendor	Weights	Range	% Simple	% Potter	% NAEP
Census	Sportsperson	1,354.2 : 603,256.1	23.2%	3.5%	5.4%
	Wildlife watching	1,321.6 : 2,224,847.3	19.8%	2.7%	5.5%
Rockville	Fishing	173.8 : 1,497,661.7	17.6%	2.2%	5.7%
	Hunting	183.3 : 1,731,544.3	20.0%	2.4%	6.0%
	Wildlife watching	406.7 : 1,510,030.6	16.1%	2.4%	6.4%

While we do recommend that extreme weights be assessed formally, none of the above diagnostics suggests an obvious difference in extreme weight behavior between the vendors. Without further analysis, it is not possible to say what effect comparable weight trimming procedures would have on the two sets of estimates.

What Would Be Your Recommendation for Computing Variances of Estimates for These Data? Were the Approaches Used by Each Vendor for Computing Variances of Estimates Correct and Appropriately Explained?

Variance estimates should be computed using best practices to account for features of complex survey data, including stratification, unequal probabilities of selection, and clustering. Best practices could include linearization methods or replication methods. Methods should be

documented in sufficient detail and design information provided in sufficient detail to allow knowledgeable users to reproduce standard errors of key estimates.

Census variance estimation.

Census used the successive difference replication method with 160 replicates for constructing variance estimates. This methodology is entirely appropriate and correctly accounts for the complex survey design. Census also provided a simple illustration of the successive difference replication method (U.S. Census Bureau 2017, p. 142-143), which is helpful for a user reproducing the variance estimates.

For publication of at least some key estimates, however, Census did not use the replicate variance estimates directly, but instead used generalized variance functions (GVFs), which are models fitted by regressing variance estimates on point estimates. The Census argues (U.S. Census Bureau 2017, p. 133) as follows in favor of the GVFs:

> *Although the replicate weights have advantages over GVF models, GVF models are easier to use than replicate weights because these models provide an easy way to obtain an approximate standard error on numerous characteristics. In addition, these GVF models have the stability in variance estimation and are more efficient in computation than using replicate weights.*

We are not convinced by this argument. Given modern software and computing power, GVFs are neither easier to use nor more efficient in computation than replicates. Their "stability" comes at the price of bias, as they approximate the replication-based variance estimates with smooth functions of the point estimates. Said another way, the replicate weights are the basis for construction of the GVFs, so any GVF is simply an approximation to the results from the replicate weights. The quality of this approximation will vary in unknown ways, depending on how far users "push" the GVFs.

The replicate weights, on the other hand, apply directly to any estimates for which the GVFs would be appropriate and apply to many estimates for which no GVFs have been or will be constructed. Such estimates include not only weighted totals, means, proportions, and other ratios, but also estimated coefficients from fitted linear models, generalized linear models, etc. Further, the replicate weights can be used in constructing comparison estimates (e.g., average fishing expenditures for those who both hunt and fish minus average fishing expenditures for those who fish only), while GVFs cannot be used for such purposes.

Even in the simple tables we have in hand from Census, it is not clear how to use the provided GVFs to estimate standard errors for all parameters of interest. The Technical Report provides guidance on standard error estimation for participation levels and for certain aggregates (U.S. Census Bureau 2017, p. 142):

> *Formula (9) is used to calculate the standard errors of levels of hunting, fishing, and wildlife-watching participation. Formula (10) is used for standard errors of aggregates, i.e., trips, days, and expenditures.*

But the Technical Report provides no guidance at all on estimation of standard errors for other parameters of interest: for example, average hunting days per hunter, angling days per angler, or food and lodging expenditures per wildlife watcher.

Only the most naïve users would want the GVFs as opposed to the replicate weights. Software is now widely available for analysis of complex survey data with replicate weights. It is much easier to conduct the weighted analysis to get the point estimates and standard errors in one step than it is to conduct the weighted analysis to get the point estimates, then plug (one or more) point estimates into a GVF to get the standard errors. The one-step analysis is also less error-prone, since GVFs require an extra coding step by the user, including choice of the correct GVF for the point estimate of interest. Even the Census made at least one error in the choice of

GVF in the preliminary tables provided to us (standard errors for *non-residential* wildlife watching participants in Table D-4 have been computed with the GVF for *residential* wildlife watching participants, as provided in Table D-5).

We propose releasing only the replication-based standard errors in all publications. Nearly all point estimates should have published standard errors, but if the resulting tables are prohibitively large, provide any missing standard errors in on-line supplementary tables. Looking up a standard error in a table will be easier for a user than plugging point estimates into a GVF. Further, release the full set of replicates with the public-use data, so that users can compute their own proper standard errors for any custom analysis. Users can also verify their computations by comparison to published replication-based standard errors, instead of by approximate comparison to published GVF-based standard errors. Providing code to compute replication-based standard errors would be far less onerous than building GVFs.

Rockville variance estimation.

Rockville used the unstratified jackknife with 160 replicates, in which 160 groups are formed, each crossing the original design strata (that is, each group looks like a stratified sample), and one group is deleted for each jackknife replicate. This is a standard methodology that is entirely appropriate and correctly accounts for the complex survey design, within each of the hunting, fishing, and wildlife surveys.

When combining information across two or three of the surveys, however, there are covariances to be accounted for because the three samples are each subsamples of the original screener. The documentation provided does not discuss variance estimation for the composite estimators. It should be possible to estimate the composite variance appropriately by using the

replicate screener weights (to estimate the variance of the expectation of the composite, given the screener) along with the two or three sets of survey-specific replicate weights (to estimate the expectation of the variance of the composite, given the screener). Details of the computation used by Rockville for the composite estimators should be provided.

Key Estimates Should be Able to be Reproduced with Publicly Available Data

We first offer some overview comments on best practices for reproducibility with publicly available data. These are adapted from the author guidelines for *the Journal of the American Statistical Association Applications and Case Studies* reproducibility initiative: http://www.tandfonline.com/action/authorSubmission?journalCode=uasa20&page=instructions

1. Publicly available data and code (see below) should be deposited in a suitable repository, where they can in fact be found by the public.
2. The publicly available data should be in a non-proprietary format and should include clear metadata, including a data dictionary describing all variables relevant to the production of key estimates. Variable names should follow naming conventions that are readily transferable across computing platforms and software systems: for example, many statistical software systems are case-sensitive, so naming conventions and associated metadata should recognize this fact and not ignore case. Most software will have difficulty with spaces within variable names, and some software may have difficulty with periods within variable names.
3. The entire workflow from public use data to published key estimates should be documented and reproducible. For example, if the public use data include edited or imputed data that are used to produce key estimates, then the edit and imputation

procedures should be documented and those edited or imputed cases should be flagged in the public use data set. If the public use data cannot reproduce key estimates without some editing or imputation, then details of the workflow needed to conduct the editing or imputation must be provided to the user.

4. Working and well-commented code should be provided to reproduce key estimates and corresponding standard errors, as published in any reports. In the absence of working code, clear pseudo-code should be provided. In either case, the code or pseudo-code should be understandable to a knowledgeable user, and the published key estimates to which to compare the output of the code should be unambiguous. For example, suppose a key estimate corresponds to an aggregated expenditure by hunters, and the aggregated expenditure variable is obtained by summing several disaggregated expenditures. The workflow must document exactly which disaggregated variables make up the aggregated expenditure variable.

Census Bureau: format and contents of the publicly available data.

We first provide a few comments on the format of the Census public-use data sets. The files that were provided to us were formatted ASCII text files (with variables in specified column numbers, hence containing long lines of numeric values, with no spaces, tabs, or other delimiters), together with SAS programs to read these formatted files. This is true of the screener, sportsperson and wildlife-watcher survey data files and of the corresponding replicate weights files that we received upon request. In addition, we were provided by Matt Fuller (U.S. Fish and Wildlife Service) with .csv (comma-separated value) files for the survey data files.

We would argue that, for simplicity and cross-platform functionality, the public use data should be released as .csv files. The combination of formatted text and SAS code for import of the Census files means that anyone using a program other than SAS will need to convert the SAS code, as noted in the documentation:

> *We have provided three SAS programs that can be used to create SAS data sets from the three ASCII files. The modifications that you will need to make are specified in each program. Convert2.sas is for converting the screening ASCII file (fh2.txt), convert3.sas is for converting the sportsperson ASCII file (fh3.txt), convert4.sas is for converting the wildlife watching ASCII file (fh4.txt). The information in these programs specifies variable names and locations in the ASCII file, thus the programs could be modified for use in other statistical packages.*

This emphasis on one, proprietary format is not appropriate for public release, in our view. By contrast, .csv files are simply ASCII text files that can be read easily, and usually without modification, into SAS (proc import), R (read.csv), Stata (import delimited), SPSS, Python, etc. Further, .csv files can be viewed directly with spreadsheet software including Microsoft Excel (Windows and elsewhere), Numbers (iOS and Macintosh), or Google Sheets. Indeed, uncompressed .csv files are one of two standard data submission formats for Kaggle Competitions (www.kaggle.com), a site that hosts predictive modeling contests for statisticians and data scientists. If the variable names are included in the first line, and follow standard formatting conventions (case sensitive, no spaces or special characters other than underscore in variable names), then a read of 2,036 formatted variables with names (as in convert3.sas, used to read in the sportsperson detail survey file) can be replaced by a single line of unformatted read. Further, with such .csv files with names in the header, there would be no need for Census or FWS to provide data in any other format (e.g., .dta for Stata, .sav for SPSS, etc.)

A second general comment on the data and metadata from Census concerns variable naming conventions. In the flat files created by Census, such as fh3.txt, there are no variable

names. The SAS file that reads fh3.txt is convert3.sas, also created by Census. This SAS file includes lower-case variable names huntstd1, huntstd2, huntstd3 in the input statement, but the codebook, fh3_2016_codebook.pdf, refers to all-uppercase versions of these variables, e.g.:

HUNTSTD1 2 1648 1649 In which division or divisions did you hunt?

The readme files, README.docx and README.txt, also refer to the all-uppercase versions:

> *So, when examining small game hunting in the Pacific division for example, the first place you must look is in HUNTSTD1 through HUNTSTD3 to see if the respondent hunted in the Pacific division and in which hunt division variable that data will be reported (HUNTSTD1 through HUNTSTD3).*

In this example, and in many others, the SAS code, the codebook, and the readme documentation, all provided by Census, are inconsistent. SAS is not case-sensitive, but most other statistical software is, so these inconsistencies need to be fixed.

Census Bureau: reproducibility of key estimates.

We were able to reproduce key estimates for angling participants, days of angling, angling days per angler, hunting participants, days of hunting, hunting days per hunter, residential wildlife watching participants, nonresidential wildlife watching participants, and some expenditures for wildlife watchers without apparent error using the provided data sets. This required reading in the data sets and replacing missing values by zeroes (which do not affect the weighted estimates). We were not able to reproduce the days of participation by non-residential wildlife watchers, despite using what appeared to be the correct variables. We were also not able to reproduce most expenditure variables, since it was unclear which variables needed to be combined to match the Census analysis.

Sufficient information was provided to allow merging of the replicate weights with the analysis data sets. Hence, we were able to construct proper standard errors, though we could only compare these to the GVF-estimated standard errors from Census. We were able to reproduce the GVF standard errors for participants and days, but some GVFs were in error (non-residential wildlife watching participants in Table D-4). For ratios like hunting days per hunter, it was unclear from the documentation how to use GVFs to estimate the standard error. Further, the GVFs for expenditures were three-parameter models, but it was unclear what variable was to be used as the basis.

Rockville: format and contents of publicly available data.

Rockville provided data as sas7bdat files, a proprietary binary format used by SAS. Other statistical software can read these files; for example, R can read these files using custom functions from the haven or foreign packages. However, these packages are provided by a community of users, with no guarantees of performance; indeed, the earliest versions of these packages were "hacks" of the SAS binary files. The SAS files cannot be viewed or edited with standard spreadsheet software. We recommend that Rockville release the data in a non-proprietary format, such as .csv, as described above for Census.

As with the Census release, Rockville provided a codebook that uses all-uppercase variable names, but the sas7bdat files contain several variables that use a mix of upper and lowercase. These inconsistencies need to be addressed.

The released data in the Rockville files include some, but not all, of the analysis variables, along with the components of the analysis variables. Constructing an analysis variable involves (at a minimum) finding non-missing information from a component variable in each

wave of one survey, and removing overlap, if necessary. If the estimate involves compositing, then the analysis variable is constructed using data from two or more surveys.

For example, consider estimating fishing participation. First, from the fishing survey, one needs to collect non-missing information from FQ1_W1, FQ1_W2 and FQ1_W3 (fishing participation from the fishing survey in waves one, two, and three) and compute the union of these three variables. Second, from the hunting survey, collect non-missing information from HQ128_W1, HQ128_W2, and HQ128_W3 (fishing participation from the hunting survey in waves one, two, and three) and compute the union of these three variables. Third, from the wildlife-watching survey, collect non-missing information from WQ61_W1, WQ61_W2, and WQ61_W3 (fishing participation from the wildlife watching survey) and compute the union of these three variables. Next, compute the weighted total of the three constructed variables within each survey, and finally compute the composite across surveys.

There is considerable potential for error in constructing these analysis variables for each estimate of interest. Derived variables used in the construction of key estimates should be included in the data release. This appears to be the case for many but not all of the key variables, though we may have missed some variables in the 879-page codebook, and we may have been unable to reproduce some key estimates due to changes (edits) in the data after we received preliminary data sets. In any event, code for construction of the derived variables should also be provided, so that users can construct their own custom estimates.

A small edit that would improve the usability of the Rockville data would be recoding (Yes = 1, No = 2) variables as (Yes = 1, No = 0). Without this recoding, the variable must be declared as a categorical variable or tested for equality to 1, both of which are avoided by

recoding. Based on requests from researchers using the public use data, Census has recognized this issue and does the recoding (see U.S. Census Bureau 2017, section 5.4.3).

A final comment is that Rockville provides all three detail data sets (fishing, hunting, and wildlife watching) in one file, with some potential for double or triple counting of cases since all three surveys represent the same population. Only a small number of composite estimates ever combine data across surveys. It seems simpler and less error-prone to provide three separate data sets.

Rockville: reproducibility of key estimates.

We were able to reproduce a variety of estimates and standard errors including fishing participation from the fishing survey, hunting survey, and wildlife watching survey; freshwater, Great Lakes and saltwater fishing from the fishing survey; hunting participation from all three surveys; and residential and non-residential wildlife watching from the wildlife watching survey. The Rockville data set includes components of key estimates as well as one or more versions of derived variables (e.g., swdays and SWDAYS_old for saltwater fishing days), and it was not always clear if a variable was available or appropriate for constructing a key estimate. Some tables provided to us referred to variables that were not in the data set. This lack of a clean and well-documented data set led to some inefficiencies in processing; e.g., reconstructing a variable from component variables when in fact it was available by another name.

From the Rockville data, we could also reproduce composite estimates in several cases, but did not have sufficient information to reproduce the standard errors of the composite estimates.

Section 8: Evaluating Cost for the Comparison Surveys

Telephone and on-site visits are generally the more costly modes to collect survey data as compared to mail. One objective of this current bridging study was to evaluate if changing the overall survey strategies from a higher cost implementation methodology (CATI and CAPI modes used by Census) to a lower cost methodology (mail mode used by Rockville) would be cost-effective.

The total costs of survey implementation are closely connected to survey production which includes yields at each stage (completions and efficiency of screening) and final yield (completions for detailed surveys). In this report, we attempt to document the sample size that was initially surveyed and the completed sample size (partial and full completes) in order to obtain an estimate of cost per completed survey. Due to the different tasks assigned to Census and Rockville, the overall budget allocated for each vendor differed. Total cost and expenses are dependent on the level of effort expended across the stages considering initial sample sizes, efficiency of screeners for locating key informants, efficiency in detecting key survey target measures, final detailed completions, and all production costs. It should be noted that both organizations varied in some of their approaches to screeners and incorporation of other methods (e.g. including non-participants in detailed surveys), and that we evaluate total costs holding these methodology differences constant by using a per unit cost comparison.

Table 8.1 provides a comparison of per unit costs based on initial samples and based on completions. These estimates are derived from information provided to the evaluation team through correspondence and found in their technical reports (Edwards et al. 2017; U.S. Census Bureau 2017). Both vendors have reviewed this table and provided revisions and notes.

Table 8.1 Comparisons of initial sample worked in production, completes, total costs, and per unit costs

Census			Rockville		
Phase	**Initial Sample**	**Completes**	**Phase**	**Initial Sample**	**Completes**
			Screener pretest	4,533	1,150
			Screener returns	292,044	62,972
Pre-Screen	22,725	6,398	Wave 1A	50,078	28,226
Screener wave 1	8,030	4,882	Wave 1B	16,349	6,407
Wave 1 detail [A]	(1,248)	(1,043)	Wave 2	11,710	7,748
Screener Wave 2	1697	1232	Wave 3	34,618	22,345
Wave 2 detail	5,432	2,444	Brief preparation survey	14,542	2,377
Wave 3 detail	6,710	4,339	Annual survey AFWA logos	18,328	9,036
			Screener non-respondents	20,400	1,888
Total Cumulative To-Date Expenditures	$4,847,625		Total Expenditures	$7,829,222	
Number units	44,078	18,855	Number units	462,602	142,149
Cost per unit	$109.98	$257.10	Cost per unit	$16.92	$55.08

[A] *Census Wave 1 not included as all cases flowed from main screener interview as one interview.*
[B] *Column does not sum to total. Totals are revised via Census to not double count as number of cases in Wave 1 and Wave 2 flowed directly from screener to interview*
Reference documents:
Received from Steve Sheriff Dec 14, 2017 from Rockville (Sherm Edwards), task based cost—totaled to $7,829,222 RI Technical Report Tables 3-4, 3-5, 4-1, 4-2, 4-4 to 4-16; 4-18 to 4-33. Emails.
Census: Reimbursable Cost Report-Census, 2016; revised during report review. Email correspondence. Technical Report Tables 3.1 pg. 37, 87, 3.2.

As shown, based on initial sample sizes, Census's historical method (CATI/CAPI data collection for detailed survey) has 6.5 times more cost at the initial sample unit level than Rockville's primarily mail based detailed survey data collection. At the completion level, the historical Census methodology (CATI/CAPI detailed survey data collection) is 4.7 times more expensive at the unit level than the Rockville study (with mail based data collection for detailed

surveys). However, the higher magnitude of cost is complicated and may overstate the cost comparison as Census screener cases flowed directly from screener to full detail interviews and this reduces the denominator in this calculation. Nevertheless, the relative costs for Census's CATI and CAPI modes of interviews are in alignment with the evaluation team's expectation of costs for these modes.

Section 9: Recommendations

Context

To provide a context for the recommendations below, it is important to summarize the following points from the report. The 2016 Census and Rockville surveys used different methods to estimate participation and expenditure values for fishing, hunting and wildlife-association recreation. Predictably, each method produced different estimates for results with varying precision and bias. The discussion of individual design elements as well as the practical implementations show positive and negative aspects of both approaches. It is not possible to state that one approach is generally better than the other. The evaluation team does not recommend that one set of results misses the mark overall more than the other. This is because there is no benchmark available. While it is tempting to use the license data for comparison, those can suffer from coverage problems and other errors. Furthermore licensing rules differ across states and are different for fishing and hunting. No license is available for wildlife watching.

The evaluation team sees both strength and weaknesses in both approaches. Going forward, the evaluation team does not recommend that either approach is a preferred strategy and has the strong view that a preferred "best" strategy would incorporate internet survey strategies to help reduce cost and that a combination of strategies are needed to reduce respondent burden, improve accuracy and to be sustainable into the future.

The available knowledge on costs shows that the Census approach is not affordable long term. Thus even if there is merit in face-to-face recruitment and interviewing, as sole data collection mode, it will be unaffordable given the desired precision and the desire for state level (or even smaller area) estimates. The Rockville approach has a number of weaknesses as well,

such as questionnaires that are too long for mail surveys, avidity bias, and inability to create dynamic questionnaire designs to minimize duplicate expense reporting.

Recommendations for Short Term Next Steps

Given the above context, we start with recommendations that can be implemented in the short term (i.e., for the next data collection or even with the release of 2016 data).

(1) Given that the length of the survey is too long for current self-administered modes, the evaluation team recommends shortening the questionnaire. To this end, the evaluation teams recommends using upcoming meetings of the workgroup and other stakeholders to discuss which **estimates are absolutely necessary and at what level of geography or subgroup analysis**. For each of these, determine whether (a) that information is really needed and (b) there is **another independent source that could provide those data other than the survey**. In particular prices may be obtainable by other sources through collaborations. An example is the recent collaboration of the Bureau of Economic Analysis and FirstData (https://bea.gov/about/pdf/acm/2016/improving-regional-pce-estimates-using-credit-card-transactions-data.pdf). Based on this discussion a shorter questionnaire can be developed that is better suited for self-administered modes.

(2) The evaluation team strongly recommends avoiding a strategy of trying to shorten the existing questionnaire and instead **building the essential questionnaire from scratch** based on the informational needs identified in the discussions recommended above. Particular attention should be given to information that can be gathered from other sources. Also extensive data analysis can reveal variables highly correlated with each other so that some do not need to be collected and could be estimated in the future.

(3) The workgroup and other stakeholders should identify **which information needs to be collected jointly** to allow for bivariate or multivariate analyses. It is the evaluation team's impression that such multivariate analyses are rare, and thus lighter data collection vehicles can be used. This would allow a move **towards a modular design** where a much shorter subset of questions are asked of all sample members. Two types of modular designs can be considered: (a) Additional modules targeting specific questions desired by a state can be added at the request of individual states with funding from the states requesting them. The Behavioral Risk Factor Surveillance Survey (https://www.cdc.gov/brfss/) would be a template for such modular design, though here too the data collection mode is undergoing a modernization process. The Fair Market Rent Survey (https://www.huduser.gov/portal/datasets/fmr.html) is another example of a modular design, where additional questions are asked for subsets of the population tailored to stakeholders' interests. (b) For some estimates a smaller sample might be sufficient in general and a matrix design (planned missingness) can be considered (see Thomas et al. 2006 and Raghunathan and Grizzle 1995). The Bureau of Labor Statistics included matrix sample designs in their consideration for the re-design of the Consumer Expenditure Survey (See Gonzalez and Eltinge 2008 and Gonzalez 2012 and some critical remarks by Mathiowetz, Olson and Kennedy 2011).

(4) To reduce burden and increase response, the screener questionnaire should be very short, capturing only essential information to determine participation.

(5) If the current mode of data collection is kept, but likely also for any future survey that includes a screener component, **it is essential to conduct a nonresponse follow-up** of screener nonrespondents and use that to adjust estimates to correct for avidity bias.

(6) When the questionnaire is shortened, consider using a **web-push methodology** (see Table 9.1) where sample members are contacted by mail but asked initially to complete the questionnaire by web. After obtaining as many responses as possible by web, nonrespondents are followed up by postal mail (or even face-to-face for a sub-sample to allow for nonresponse bias analysis). Web will allow the design of more dynamic questionnaires (e.g., dependent interviewing, automated branching, validity checks, etc.) and will reduce costs (e.g., lower printing, shipping, and data entry costs) given the sample sizes adopted in this survey. The invitations to the web survey will be sent by mail, allowing this approach to also start with a high quality address based sample frame, or the MAF with CDS updates. The sampling frame is of sufficient quality for this purpose, and the web-push methodology is used in several high stakes surveys, including the Canadian Census and going forward in the American Community Survey. For examples of the use of web-push designs see Dillman et al. (2014).

Table 9.1. Overview of web-push features and rationale

Feature	Rationale
Postal mail contacts	Allows sample frames with good coverage Lower costs than interviewer-administered contacts Can be used to build trust before asking for a response by web
Web Data Collection Mode (get as many responses by web as possible)	Allows more dynamic questionnaire design Reduced costs
Mail follow-up for nonrespondents	Works for people without internet or those unwilling to respond by web Can be passed between household members
Intensive nonresponse follow-up at the last stage of data collection that might include telephone contacts, a briefer questionnaire, CAPI interviews, etc.	Minimizes response burden for remaining nonrespondents

(7) Some of the current Rockville data make use of **compositing**, which is **too complicated for most data users**. If compositing is still used, a full matrix sampling design should be used in order to reap the full benefits of reducing respondent burden and increasing sample size.

(8) In general, the evaluation team also recommends that both Census and Rockville (and any future vendors) follow the American Association for Public Opinion Research Transparency Initiative guidelines for disclosure elements, which can be found here: http://www.aapor.org/Standards-Ethics/Transparency-Initiative/Educational-Materials.aspx. Even if Census and Rockville are not members of the transparency initiative, these guidelines provide a reasonable list of minimum disclosure elements needed for anyone using these data or reports to fully understand the data, including strengths and weaknesses. In any public release, full questionnaires including all skip patterns and interviewer instructions should be made available and easily accessible. Likewise, published reports should include CVs or otherwise indications of margins of errors on major estimates.

(9) In addition, in the interest of documentation and reproducibility, the evaluation team recommends that all data edits be automated to the extent possible and fully documented. It is our understanding that some outliers and suspected duplicate reports of expenditures have been manually edited and that these edits have not been documented. Further the decision criteria for what data will be edited seems subjective (i.e., one person making a case-by-case decision) and not well documented. In the future, the decision criteria and edit procedures should be established and documented.

(10) Finally, we want to reiterate our recommendation that all information necessary for reproducing released estimates be provided (see Section 7).

Recommendations for Longer Term Next Steps with Further Research

The evaluation team recommends working to develop future data collection opportunities (10+ years out), which could include the following elements:

(1) A **strategic collaboration with states to create a complete license frame** for hunters and anglers (e.g., all age groups). Perhaps see the Migratory Bird Harvest Information Program (https://www.fws.gov/birds/surveys-and-data/harvest-surveys/harvest-information-program.php). It might be useful to start with a set of selected states, show the functionality, and expand from there. If states contribute individually to state level estimates, then an additional incentive is created to provide good frames.

(2) Licenses could serve as (one of) the starting points for a **panel of respondents** who provide data over time. This could allow a more frequent collection of information and provide faster trend identification. A few examples of survey panels in general are:

- Nielsen Computer and Mobile Panel (http://www.nielsen.com/us/en/contact-us/panels.html)
- GFK KnowledgePanel (https://join.knpanel.com/about.html)
- TESS panel (http://www.tessexperiments.org/introduction.html)
- LISS panel (https://www.lissdata.nl/).

(3) A promising strategy could be the development of **data collection apps** that also have value to hunters, anglers, and wildlife watchers to motivate them to provide data through

the apps. A big advantage of such data collection vehicles would be the possibility to collect data from participants at the best time for recall.

(4) Watch for opportunities to **obtain needed data from other agencies,** including collaborating with Census on their investigations into using **administrative data or collaborate on the master demographic file**. A useful source for thoughts about the redesign is the most recent 2-part report from the National Academy of Science on the Future of Federal Statistics (https://www.nap.edu/catalog/24893/federal-statistics-multiple-data-sources-and-privacy-protection-next-steps). The National Academy of Science also has a series of peer-reviewed approaches to the modernization of other survey products, many of which include recommendations suitable for the needs here.

(5) A guiding principle is to use the **best mode for each type of information** that is identified as necessary.

References

American Association for Public Opinion Research. 2016. Address Based Sampling. Task Force Report. http://www.aapor.org/Education-Resources/Reports/Address-based-Sampling.aspx.

American Association for Public Opinion Research. 2016. Standard Definitions Final Dispositions of Case Codes and Outcome Rates for Surveys. http://www.aapor.org/AAPOR_Main/media/publications/Standard-Definitions20169theditionfinal.pdf.

Andrews, Rob, J. Michael Brick, and Nancy A. Mathiowetz. 2014. "Development and Testing of Recreational Fishing Effort Surveys: Testing a Mail Survey Design Final Report." Retrieved December 30, 2017 from https://www.st.nmfs.noaa.gov/Assets/recreational/pdf/2012-FES_w_review_and_comments_FINAL.pdf.

Biemer, Paul P. and Lars E. Lyberg. 2003. *Introduction to Survey Quality*. Hoboken, NJ: Wiley.

Brick, J. Michael, William R. Andrews, and Nancy A. Mathiowetz. 2012. "A Comparison of Recreational Fishing Effort Survey Designs." Retrieved November 14, 2017 from https://www.st.nmfs.noaa.gov/mdms/doc/08A_Comparison_of_Fishing_Effort_Surveys_Report_FINAL.pdf.

Chen, Qixuan, Michael R. Elliott, David Haziza, Ye Yang, Malay Ghosh, Roderick J. A. Little, Joseph Sedransk, and Mary Thompson. 2017. "Approaches to Improving Survey-Weighted Estimates." *Statistical Science.* 32(2): 227-248.

Couper, Mick P. 2005. "Technology Trends in Survey Data Collection." *Social Science Computer Review*. 23(4):486-501.

Couper, Mick P. and William L. Nicholls II. 1998. "The History and Development of Computer Assisted Survey Information Collection Methods." Pp. 1-21 in *Computer Assisted Survey Information Collection*, edited by M. P. Couper, R. P. Baker, J. Bethlehem, C. Z. F. Clark, J. Martin, W. L Nicholls II, and J. M. O'Reilly. New York: John Wiley & Sons, Inc.

Dai, Yiting, Jill DeMatteis, and Jim Green. 2018. "50 State Surveys of Hunting, Fishing, and Wildlife Associated Recreation Nonresponse Bias Analysis Report." Rockville Institute, Rockville, MA.

de Leeuw, Edith D. 2005. "To Mix or Not to Mix Data Collection Modes in Surveys." *Journal of Official Statistics*. 21(2):233-255.

Dillman, Don A., Jolene D. Smyth, and Leah Melani Christian. 2014. *Internet, Phone, Mail, and Mixed-Mode Surveys: The Tailored Design Method*. Hoboken, NJ: John Wiley & Sons, Inc.

Edwards, Sherm W., Jill M. DeMatteis, Jessica Behm, James Green, Mary Jones, Teresa Koening, Mina Muller, Hanna Popick, Daniel Sangria, and Regina Yudd. 2017. "50 State Surveys Related to Fishing, Hunting, and Wildlife-Associated Recreation Technical Report." The Rockville Institute, Rockville, MA.

English, Ned, Colm O'Muircheartaigh, Stephanie Eckman, Katie Dekker, and Michael Latterner. 2009. “Coverage Rates and Coverage Bias in Housing Unit Frames." Proceedings of the American Statistical Association, Survey Research Methods Section. 595-602. Alexandria, VA: American Statistical Association.

Fowler, Floyd J. and Thomas W. Mangione. 1990. *Standardized Survey Interviewing: Minimizing Interviewer-Related Error.* Newbury Park, CA: Sage.

Fuller, Mathew. 2018. “Nonresponse Bias Analysis of the 2016 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation.” U.S. Fish and Wildlife Service.

Gonzales, Jeffrey. 2012. “The Use of Responsive Split Questionnaires in a Panel Survey.” Ph.D. Dissertation, The Joint Program in Survey Methodology, University of Maryland, College Park, MD. Unpublished Manuscript.

Gonzales, Jeffrey, M. and John L. Eltinge. 2008. “Adaptive Matrix Sampling For the Consumer Expenditure Quarterly Interview.” U.S. Bureau of Labor Statistics, Washington DC. Retrieved March 7, 2018 from https://www.bls.gov/osmr/pdf/st080060.pdf.

Groves, Robert M. and Emilia Peytcheva. 2008. “The Impact of Nonresponse Rates on Nonresponse Bias: A Meta-Analysis.” *Public Opinion Quarterly*. 72(2):167-189.

Heerwegh Dirk. 2009. "Mode Differences between Face-to-Face and Web Surveys: An Experimental Investigation of Data Quality and Social Desirability Effects." *International Journal of Public Opinion Research.* 21:111–121.

Heerwegh, Dirk and Geert Loosveldt. 2008. "Face-to-Face Versus Web Surveying in a High-Internet-Coverage Population." *Public Opinion Quarterly*. 72(5):836-846.

Holbrook, Allyson, L., Melanie C. Green, and Jon A. Krosnick. 2003. "Telephone Versus Face-to-Face Interviewing of National Probability Samples with Long Questionnaires: Comparisons of Respondent Satisficing and Social Desirability Response Bias." *Public Opinion Quarterly*. 67:79-125.

Isreal, Glenn and Alexa Lamm. 2012. "Item Nonresponse in a Client Survey of the General Public." *Survey Practice*. 5(2).

Kalton, Graham and Daniel Kasprzyk. 1986. “The Treatment of Missing Survey Data.” *Survey Methodology*. 12(1):1-16.

Kreuter, Frauke, Stanley Presser and Roger Tourangeau. 2008. “Social Desirability Bias in CATI, IVR and Web Surveys.” *Public Opinion Quarterly.* 72:847-865.

Lesser, Virginia, Lydia Newton, and Daniel Yang. 2012. "Comparing Item Nonresponse across Different Delivery Modes in General Population Surveys." *Survey Practice*. 5(2).

Lugtig, Peter and Annette Jackle. 2014. “Can I Just Check…? Effects of Edit Check Questions on Measurement Error and Survey Estimates.” *Journal of Official Statistics.* 30(1):45-62.

Mathiowetz, Nancy A. and Katherine A. McGonagle. 2004. "An Assessment of the Current State of Dependent Interviewing in Household Surveys." *Journal of Official Statistics.* 16(4):401-418.

Mathiowetz, Nancy, Kristen Olson, and Courtney Kennedy. 2011. "Redesign options for the Consumer Expenditure Survey." Report Prepared for the National Academy of Sciences. Retrieved March 7, 2018 from https://www.bls.gov/cex/redwrkshp_pap_abtsrbirecommend.pdf.

Messer, Benjamin, Michelle Edwards, and Don Dillman. 2012. "Determinants of Item Nonresponse to Web and Mail Respondents in Three Address-Based Mixed-Mode Surveys of the General Public" *Survey Practice*. 5(2).

Millar, Morgan and Don Dillman. 2012. "Do Mail and Internet Surveys Produce Different Item Nonresponse Rates? An Experiment Using Random Mode Assignment." *Survey Practice*. 5(2).

Nicolaas, Gerry and Sarah Tipping. 2006. "Mode Effects in Social Capital Surveys." *Survey Methodology Bulletin*. Special Edition 58:56-74.

Office of Management and Budget. 2006. Standards and Guidelines for Statistical Surveys, Federal Register, 71 FR 55522 https://www.federalregister.gov/documents/2006/09/22/06-8044/standards-and-guidelines-for-statistical-surveys. https://www.federalregister.gov/documents/2006/09/22/06-8044/standards-and-guidelines-for-statistical-surveys.

Potter, F. 1988. "Survey of Procedures to Control Extreme Sampling Weights." Proceedings of the American Statistical Association, Survey Research Methods Section. 453–458. Alexandria, VA: American Statistical Association.

Potter, F. 1990. "A Study of Procedures to Identify and Trim Extreme Sampling Weights." Proceedings of the American Statistical Association, Survey Research Methods Section. 225–230. Alexandria, VA: American Statistical Association.

Raghunathan, Trivellore E. and James E. Grizzle. 1995. "A Split Questionnaire Survey Design." *Journal of the American Statistical Association*. 90(429):54-63.

Smalley, Andrea L. 2005. "'I Just Like to Kill Things': Women, Men and the Gender of Sport Hunting in the United States, 1940-1973." *Gender & History*. 17(1):183-209.

Stedman, Richard C., and Thomas A. Heberlein. 2001. "Hunting and Rural Socialization: Contingent Effects of the Rural Setting on Hunting Participation." *Rural Sociology*. 66(4):599-617.

The National Academies of Sciences, Engineering, and Medicine. 2017. Review of the Marine Recreational Information Program. Washington, DC: The National Academies Press. doi: https://doi.org/10.17226/24640.

Thomas, Neal, Trivellore E. Raghunathan, Nathaniel Schenker, Myron J. Katzoff, and Clifford L. Johnson. 2006. "An Evaluation of Matrix Sampling Methods Using Data from the National Health and Nutrition Examination Survey." *Survey Methodology*. 32(2):217-231.

Tourangeau Roger, Frauke Kreuter, and Stephanie Eckman. 2015. "Motivated Misreporting: Shaping Answers to Reduce Survey Burden." In: Engle, Uwe (Ed.) *Survey Measurements. Techniques, Data Quality and Sources of Error.* Campus Verlag.

Tourangeau, Roger, Lance J. Rips, and Kenneth Rasinski. 2000. *The Psychology of Survey Response*. New York, NY: Cambridge University Press.

Tourangeau, Roger and Tom W. Smith. 1996. "Asking Sensitive Questions: The Impact of Data Collection Mode, Question Format, and Question Context." *Public Opinion Quarterly*. 60:275-304.

U.S. Census Bureau, 2016 National Survey of Fishing, Hunting, and Wildlife-Association Recreation, FHWAR 2016, Waves 1 and 2, CATI Interviewer Manual.

U.S. Census Bureau. 2017. "2016 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation (FHWAR) Technical Report."

U.S. Fish and Wildlife Service. 2014. "2011 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation." Retrieved February 13, 2018 from https://www.census.gov/library/publications/2014/demo/fhw-11-nat.html .

Valliant, Richard, Jill A. Dever, and Frauke Kreuter. 2013. *Practical Tools for Designing and Weighting Survey Samples.* New York: Springer.

Ward, Joe H. Jr. 1963. "Hierarchical Grouping to Optimize an Objective Function." Journal of the American Statistical Association. 58:236-244.

West, Brady T. and Annelies G. Blom. 2017. "Explaining Interviewer Effects: A Research Synthesis," *Journal of Survey Statistics and Methodology*. 5(2):175-211.

Appendix A. Four State Comparison of Estimates, Differences and Percent Change, Census to Rockville

Fishing and Hunting Participation Comparisons

Table A1. Anglers and Hunters, Days of Participation, and Trips in Maine by Type of Fishing and Hunting: 2016
(Population 16 years and older. Numbers in thousands (Table 2, Maine)

	Rockville						Census						Difference (RI All - Census)			Percent Change (RI All - Census)		
	Participants		Days		Trips		Participants		Days		Trips		Partici-pants	Days	Trips	Partici-pants	Days	Trips
	#	%	#	%	#	%	#	%	#	%	#	%	#	#	#	#	#	#
ALL FISHING	**763**	**100**	**10,818**	**100**	**7,577**	**100**	**353**	**100**	**3,646**	**100**	**3,495**	**100**	**410**	**7,172**	**4,082**	**116%**	**197%**	**117%**
All freshwater	592	78	8,774	81	5,696	75	266	75	2,952	81	2,711	78	326	5,822	2,985	123%	197%	110%
Freshwater, except Great Lakes	592	78	8,774	81	5,696	75	266	75	2,952	81	2,711	78	326	5,822	2,985	123%	197%	110%
Great Lakes	X	X	X	X	X	X	...	...	...	...	...	...	...	...	...	...		
Saltwater	276	36	2,044	19	1,882	25	161	46	890	24	784	22	115	1,154	1,098	71%	130%	140%
ALL HUNTING	**334**	**100**	**4,804**	**100**	**2,325**	**100**	**75**	**100**	**822**	**100**	**991**	**100**	**259**	**3,982**	**1,334**	**345%**	**484%**	**135%**
Big game	296	89	3,082	64	1,348	58	49	65	669	81	746	75	247	2,413	602	504%	361%	81%
Small game	105	31	898	19	560	24	32	43	189	23	177	18	73	709	383	228%	375%	216%
Migratory birds	—	—	—	—	—	—	...	...	...	...	...	...	...	...	...	...	...	...
Other animals	—	—	—	—	—	—	...	...	...	...	...	...	...	...	...	...	...	...

**Census estimates were based on a sample size 10-29. No estimate if sample size too small (less than 10) to report reliably. X means not applicable.*
Small Game, Migratory Birds, Other animals information not reported for Census, or both Census and Rockville.
Rockville reference: RI_State Tables Batch 3, Dec 15, 2017; received 12-15-2017.
*Census reference: Final **Maine** Tables rev with pop counts.*

Table A2. Anglers and Hunters, Days of Participation, and Trips in Minnesota by Type of Fishing and Hunting: 2016
(Population 16 years and older. Numbers in thousands (Table 2, Minnesota)

	Rockville						Census						Difference (RI All - Census)			Percent Change (RI All - Census)		
	Participants		Days		Trips		Participants		Days		Trips		Partici-pants	Days	Trips	Partici-pants	Days	Trips
	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%
ALL FISHING	**1,871**	**100**	**25,882**	**100**	**15,737**	**100**	**1,087**	**100**	**13,360**	**100**	**11,132**	**100**	**784**	**12,522**	**4,605**	**72%**	**94%**	**41%**
All freshwater	1,871	100	25,882	100	15,737	100	1,070	99	13,525	101	11,132	100	801	12,357	4605	75%	91%	41%
Freshwater, except Great Lakes	1,776	95	24,422	94	15,217	97	1,070	99	13,178	99	11,001	99	706	11,244	4,216	66%	85%	38%
Great Lakes	—	—	—	—	—	—	...	...	...	...	...	...	...	...	...	...	...	...
Saltwater	X	X	X	X	X	X	...	...	...	...	...	...	...	...	...	...	...	...
ALL HUNTING	**833**	**100**	**10,522**	**100**	**6,423**	**100**	**501**	**100**	**5,979**	**100**	**10,743**	**100**	**332**	**4,543**	**-4,320**	**66%**	**76%**	**-40%**
Big game	645	77	7,008	67	3,241	50	314	63	2,134	36	4,392	41	331	4,874	-1,151	105%	228%	-26%
Small game	376	45	3,260	31	2,154	34	265	53	3,860	65	3,257	30	111	-600	-1,103	42%	-16%	-34%
Migratory birds	*104	*12	*879	*8	*719	*11	...	...	...	...	...	...	...	...	...	...	...	...
Other animals	—	—	—	—	—	—	...	...	...	...	...	...	...	...	...	...	...	...

**Census estimates were based on a sample size 10-29. No estimate if sample size too small (less than 10) to report reliably.*
Small Game, Migratory Birds, Other animals information not reported for Census, or both Census and Rockville.
Rockville reference: RI_State Tables Batch 3, Dec 15, 2017; received 12-15-2017.
*Census reference: Final **Minnesota** Tables rev with pop counts.*

Table A3. Anglers and Hunters, Days of Participation, and Trips in Oklahoma by Type of Fishing and Hunting: 2016
(Population 16 years and older. Numbers in thousands (Table 2, Oklahoma)

	Rockville						Census						Difference (RI All - Census)			Percent Change (RI All - Census)		
	Participants		Days		Trips		Participants		Days		Trips		Partici-pants	Days	Trips	Partici-pants	Days	Trips
	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%
ALL FISHING	**1,386**	**100**	**24,254**	**100**	**19,744**	**100**	**894**	**100**	**9,464**	**100**	**7,824**	**100**	**492**	**14,790**	**11,920**	**55%**	**156%**	**152%**
All freshwater	1,386	100	24,254	100	19,744	100	894	100	9,464	100	7,824	100	492	14,790	11,920	55%	156%	152%
Freshwater, except Great Lakes	1,386	100	24,254	100	19,744	100	894	100	9,464	100	7,824	100	492	14,790	11,920	55%	156%	152%
Great Lakes	X	X	X	X	X	X	...	...	...	...	...	...	...	...	...	...	...	...
Saltwater	X	X	X	X	X	X	...	...	...	...	...	...	...	...	...	...	...	...
ALL HUNTING	**614**	**100**	**9,659**	**100**	**8,800**	**100**	**157**	**100**	**4,527**	**100**	**3,595**	**100**	**457**	**5,132**	**5,205**	**291%**	**113%**	**145%**
Big game	416	68	4,856	50	3,560	40	142	91	3,890	86	2,609	73	274	966	951	193%	25%	36%
Small game	216	35	1,944	20	1,661	19	...	...	...	...	...	...	...	...	...	...	...	...
Migratory birds	277	45	2,740	28	2,505	28	...	...	...	...	...	...	...	...	...	...	...	...
Other animals	107	17	1,268	13	1,075	12	...	...	...	...	...	...	...	...	...	...	...	...

**Census estimates were based on a sample size 10-29. No estimate if sample size too small (less than 10) to report reliably. X not applicable.*
Small Game, Migratory Birds, Other animals information not reported for Census, or both Census and Rockville.
Rockville reference: RI_State Tables Batch 3, Dec 15, 2017; received 12-15-2017.
*Census reference: Final **Oklahoma** Tables rev with pop counts.*

Table A4. Anglers and Hunters, Days of Participation, and Trips in Virginia by Type of Fishing and Hunting: 2016
(Population 16 years and older. Numbers in thousands (Table 2, Virginia)

	Rockville						Census						Difference (RI All - Census)			Percent Change (RI All - Census)		
	Participants		Days		Trips		Participants		Days		Trips		Partici-pants	Days	Trips	Partici-pants	Days	Trips
	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%
ALL FISHING	**1,787**	**100**	**31,662**	**100**	**23,552**	**100**	**802**	**100**	**8,302**	**100**	**6,591**	**100**	**985**	**23,360**	**16,961**	**123%**	**281%**	**257%**
All freshwater	1,303	73	26,469	84	20,094	85	646	81	6,982	84	5,160	78	657	19,487	14,934	102%	279%	289%
Freshwater, except Great Lakes	1,303	73	26,469	84	20,094	85	646	81	6,980	84	5,160	78	657	19,489	14,934	102%	279%	289%
Great Lakes	X	X	X	X	X	X	...	...	...	...	...	...	...	...	...	...	...	...
Saltwater	625	35	5,193	16	3,458	15	269	34	1,645	20	1,431	22	356	3,548	2,027	132%	216%	142%
ALL HUNTING	**625**	**100**	**12,786**	**100**	**11,198**	**100**	**251**	**100**	**3,615**	**100**	**4,007**	**100**	**374**	**9,171**	**7,191**	**149%**	**254%**	**179%**
Big game	582	93	10,675	83	7,296	65	225	90	3,017	83	3,265	81	357	7,658	4,031	159%	254%	123%
Small game	222	36	4,136	32	3,470	31	63	25	401	11	257	6	159	3,735	3,213	252%	931%	1250%
Migratory birds	—	—	—	—	—	—	...	...	...	...	...	...	...	...	...	...	...	...
Other animals	—	—	—	—	—	—	40	16	504	14	382	10	...	...	...	...	...	...

**Census estimates were based on a sample size 10-29. No estimate if sample size too small (less than 10) to report reliably. X not applicable.*
Small Game, Migratory Birds, Other animals information not reported for Census, or both Census and Rockville.
Rockville reference: RI_State Tables Batch 3, Dec 15, 2017; received 12-15-2017.
*Census reference: Final **Virginia** Tables rev with pop counts.*

Hunting Expenditure Comparisons

Table A5: Comparison of Hunting Trip and Equipment Expenditures in Maine by Type of Hunting: 2016 (reference state Table 18, Maine)

	Rockville				Census				Difference (RI All - Census)				Percent Change (RI All - Census)		
	Amount	Ave per Hunter	Ave per Spender	Number of Spenders	Amount	Ave per Hunter	Ave per Spender	Number of Spenders	Amount	Ave per Hunter	Ave per Spender	Number of Spenders	Amount	Ave per Hunter	Ave per Spender
	(thous $)	($)[1]	($)[1]	(thous)	(thous $)	($)[1]	($)[1]	(thous)	(thous $)	($)[1]	($)[1]	(thous)	(thous $)	($)[1]	($)[1]
ALL HUNTING	**289,741**	**1,347**	**1,525**	**190**	**75,768**	**300**	**978**	**77**	**213,973**	**1,047**	**547**	**113**	**282%**	**349%**	**56%**
Food and lodging	57,830	269	438	132	3,410	46	100	34	54,420	223	338	98	1596%	485%	338%
Transportation	28,639	133	214	134	3,610	48	66	55	25,029	85	148	79	693%	177%	224%
Other trip costs	9,441	44	205	*46	...	...	...	...	...	...	...	...	...	...	...
Equipment	193,831	901	1,175	165	68,456	202	1,066	64	125,375	699	109	101	183%	346%	10%
BIG GAME	174,472	985	1,187	147	**11,980**	**160**	**257**	**47**	**162,492**	**825**	930	100	1356%	516%	362%
Food and lodging	24,845	140	267	93	2,687	36	99	27	22,158	104	168	66	825%	289%	170%
Transportation	11,790	67	120	98	2,505	34	66	38	9,285	33	54	60	371%	97%	82%
Other trip costs	4,549	26	147	31	...	...	...	...	...	...	...	...	...	...	...
Equipment	133,289	752	1,307	102	6,496	86	186	35	126,793	666	1,121	67	1952%	774%	603%
SMALL GAME	**57,942**	***590**	***733**	***79**	**...**	**...**	**...**	**...**	**...**	**...**	**...**	**...**	...	...	...
Food and lodging	24,670	*251	*374	*66	...	...	...	...	...	...	...	...	...	...	...
Transportation	11,593	*118	*161	*72	...	...	...	...	...	...	...	...	...	...	...
Other trip costs[2]	3,965	*40	*147	*27	...	...	...	...	...	...	...	...	...	...	...
Equipment	17,714	*180	*322	*55	...	...	...	...	...	...	...	...	...	...	...

**Census estimates were based on a sample size 10-29. No estimate if sample size too small (less than 10) to report reliably.*
Small Game, Migratory Birds, Other animals information not reported for Census, or both Census and Rockville.
*Percent change: (x-y)/y*100*
Rockville reference: State_ME_MN_OK_VA_sample participants only, December 3, 2017: ***Maine*** *Table 18.*
Census reference: Census _Results_pop.zip, September 20, 2017, Final ***Maine*** *Tables rev with pop counts*

Table A6. Comparison of Hunting Trip and Equipment Expenditures in Minnesota by Type of Hunting: 2016 (reference state Table 18, Minnesota)

	Rockville				Census				Difference (RI All - Census)				Percent Change (RI All - Census)		
	Amount	Ave per Hunter	Ave per Spender	Number of Spenders	Amount	Ave per Hunter	Ave per Spender	Number of Spenders	Amount	Ave per Hunter	Ave per Spender	Number of Spenders	Amount	Ave per Hunter	Ave per Spender
	(thous $)	($)[1]	($)[1]	(thous)	(thous $)	($)[1]	($)[1]	(thous)	(thous $)	($)[1]	($)[1]	(thous)	(thous $)	($)[1]	($)[1]
ALL HUNTING	**1,221,963**	**1,498**	**1,591**	**768**	**480,319**	**952**	**937**	**513**	**741,644**	**546**	**654**	**255**	**154%**	**57%**	**70%**
Food and lodging	146,589	180	219	669	82,817	165	175	472	63,772	15	44	197	77%	9%	25%
Transportation	127,658	157	191	668	77,850	155	183	425	49,808	2	8	243	64%	1%	4%
Other trip costs	73,310	90	243	302	21,143	42	108	196	52,167	48	135	106	247%	114%	125%
Equipment	874,406	1,072	1,457	600	298,509	589	757	394	575,897	483	700	206	193%	82%	92%
BIG GAME	**691,145**	**1,100**	**1,150**	**601**	**168,721**	**330**	**518**	**326**	**522,424**	**770**	**632**	**275**	**310%**	**233%**	**122%**
Food and lodging	84,040	134	168	501	40,522	81	142	285	43,518	53	26	216	107%	65%	18%
Transportation	81,638	130	160	511	25,909	52	119	219	55,729	78	41	292	215%	150%	34%
Other trip costs	36,062	57	201	179	17,915	36	137	130	18,147	21	64	49	101%	58%	47%
Equipment	489,405	779	1,383	354	84,375	162	367	230	405,030	617	1,016	124	480%	381%	277%
SMALL GAME	**257,862**	**719**	**743**	**347**	**77,056**	**260**	**306**	**252**	**180,806**	**459**	**437**	**95**	**235%**	**177%**	**143%**
Food and lodging	56,693	158	190	299	26,438	89	109	242	30,255	69	81	57	114%	78%	74%
Transportation	40,657	113	136	299	28,406	96	121	236	12,251	17	15	63	43%	18%	12%
Other trip costs[2]	*35,112	98	218	161	...	...	...	...	...	...	...	...	...	...	...
Equipment	125,400	350	594	211	...	...	...	...	...	...	...	...	...	...	...

**Census estimates were based on a sample size 10-29. No estimate if sample size too small (less than 10) to report reliably.*

Small Game, Migratory Birds, Other animals information not reported for Census, or both Census and Rockville if not reported.

*Percent change: (x-y)/y*100*

Rockville reference: State_ME_MN_OK_VA_sample participants only, December 3, 2017: ***Minnesota*** *Table 18.*

Census reference: Census _Results_pop.zip, September 20, 2017, Final ***Minnesota*** *Tables rev with pop counts*

Table A7. Comparison of Hunting Trip and Equipment Expenditures in Oklahoma by Type of Hunting: 2016 (reference state Table 18, Oklahoma)

	Rockville				Census				Difference (RI All - Census)				Percent Change (RI All - Census)		
	Amount	Ave per Hunter	Ave per Spender	Number of Spenders	Amount	Ave per Hunter	Ave per Spender	Number of Spenders	Amount	Ave per Hunter	Ave per Spender	Number of Spenders	Amount	Ave per Hunter	Ave per Spender
	(thous $)	($)[1]	($)[1]	(thous)	(thous $)	($)[1]	($)[1]	(thous)	(thous $)	($)[1]	($)[1]	(thous)	(thous $)	($)[1]	($)[1]
ALL HUNTING	**908,075**	**1,480**	**1,585**	**573**	**201,947**	**1,253**	**1,330**	**152**	**706,128**	**227**	**255**	**421**	**350%**	**18%**	**19%**
Food and lodging	139,855	228	282	496	34,757	222	327	106	105,098	6	-45	390	302%	3%	-14%
Transportation	122,044	199	277	441	36,027	230	306	118	86,017	-31	-29	323	239%	-13%	-9%
Other trip costs	87,818	143	336	261	4,297	27	60	72	83,521	116	276	189	1944%	430%	460%
Equipment	558,358	910	1,088	513	126,865	774	981	129	431,493	136	107	384	340%	18%	11%
BIG GAME	294,761	708	750	393	**145,960**	**896**	**1,040**	**140**	**148,801**	**-188**	**-290**	**253**	**102%**	**-21%**	**-28%**
Food and lodging	62,155	149	192	324	28,083	179	310	91	34,072	-30	-118	233	121%	-17%	-38%
Transportation	44,466	107	158	282	29,565	189	271	109	14,901	-82	-113	173	50%	-43%	-42%
Other trip costs	25,484	61	250	*102	...	...	...	...	...	...	...	...	...	...	...
Equipment	162,656	391	623	261	85,069	507	741	115	77,587	-116	-118	146	91%	-23%	-16%

**Census estimates were based on a sample size 10-29. No estimate if sample size too small (less than 10) to report reliably.*
Small Game, Migratory Birds, Other animals information not reported for Census, or both Census and Rockville if not reported.
*Percent change: (x-y)/y*100*
Rockville reference: State_ME_MN_OK_VA_sample participants only, December 3, 2017: ***Oklahoma*** *Table 18.*
Census reference: Census _Results_pop.zip, September 20, 2017, Final ***Oklahoma*** *Tables rev with pop counts*

Table A8. Comparison of Hunting Trip and Equipment Expenditures in Virginia by Type of Hunting: 2016 (reference state Table 18, Virginia)

	Rockville				Census				Difference (RI All - Census)				Percent Change (RI All - Census)		
	Amount	Ave per Hunter	Ave per Spender	Number of Spenders	Amount	Ave per Hunter	Ave per Spender	Number of Spenders	Amount	Ave per Hunter	Ave per Spender	Number of Spenders	Amount	Ave per Hunter	Ave per Spender
	(thous $)	($)[1]	($)[1]	(thous)	(thous $)	($)[1]	($)[1]	(thous)	(thous $)	($)[1]	($)[1]	(thous)	(thous $)	($)[1]	($)[1]
ALL HUNTING	**1,248,281**	**1,998**	**2,175**	**574**	**400,305**	**1,474**	**1,399**	**286**	**847,976**	**524**	**776**	**288**	**212%**	**36%**	**55%**
Food and lodging	130,408	209	308	423	44,339	177	221	200	86,069	32	87	223	194%	18%	39%
Transportation	77,142	123	168	459	42,998	170	222	194	34,144	-47	-54	265	79%	-28%	-24%
Other trip costs	69,220	111	246	281	20,234	81	431	47	48,986	30	-185	234	242%	37%	-43%
Equipment	971,511	1,555	2,063	471	292,734	1,047	1,432	204	678,777	508	631	267	232%	49%	44%
BIG GAME	**940,955**	**1,618**	**1,775**	**530**	**309,275**	**1,127**	**1,229**	**252**	**631,680**	**491**	**546**	**278**	**204%**	**44%**	**44%**
Food and lodging	88,531	152	233	380	34,883	139	193	181	53,648	13	40	199	154%	9%	21%
Transportation	51,638	89	121	426	27,931	110	164	170	23,707	-21	-43	256	85%	-19%	-26%
Other trip costs	50,928	88	197	259	9,954	40	290	34	40,974	48	-93	225	412%	120%	-32%
Equipment	749,858	1,289	2,300	326	236,507	838	1,438	164	513,351	451	862	162	217%	54%	60%
SMALL GAME	**165,188**	**744**	**860**	**192**	**36,750**	**354**	**652**	**56**	**128,438**	**390**	**208**	**136**	**349%**	**110%**	**32%**
Food and lodging	29,380	132	179	164	5,061	49	96	52	24,319	83	83	112	481%	169%	86%
Transportation	17,919	81	124	144	12,404	120	264	47	5,515	-39	-140	97	44%	-33%	-53%
Other trip costs[2]	14,332	65	110	130	...	...	...	...	...	...	...	...	...	...	...
Equipment	—	—	—	—	...	...	...	...	...	...	...	...	...	...	...

**Census estimates were based on a sample size 10-29. No estimate if sample size too small (less than 10) to report reliably.*
Small Game, Migratory Birds, Other animals information not reported for Census, or both Census and Rockville if not reported.
*Percent change: (x-y)/y*100*
Rockville reference: State_ME_MN_OK_VA_sample participants only, December 3, 2017: ***Virginia*** *Table 18.*
Census reference: Census _Results_pop.zip, September 20, 2017, Final ***Virginia*** *Tables rev with pop counts*

Appendix B. Statistics, Comparison between Census and Rockville for Selected Estimates, Standard Errors, CV, Ratio, t-statistic

Table B1. Statistics, Comparison Census and Rockville Selected Estimates, Anglers and Fishing (reference Table D-1)

	Census					Rockville						
Anglers, days, and expenditures	Estimate	Standard error	Lower 95 percent	Upper 95 percent	CV	Estimate	Standard error	Lower 95 percent	Upper 95 percent	CV	Census / RI	Census - Rockville t-statistic
ANGLERS (thousands)												
Total	35,754	1,642	32,536	38,972	4.6	55,551	2,205	51,197	59,906	4	1.15	-7.20*
Freshwater	30,137	1,527	27,145	33,129	5.1	46,586	2,039	42,560	50,612	4.4	1.16	-6.46*
Freshwater, except Great Lakes	29,490	1,512	26,526	32,454	5.1	45,684	2,050	41,635	49,734	4.5	1.13	-6.36*
Great Lakes	1,824	399	1,043	2,605	21.9	3,218	528	2,176	4,261	16.4	1.34	-2.11*
Saltwater	8,320	840	6,673	9,967	10.1	17,903	1,756	14,435	21,371	9.8	1.03	-4.92*
DAYS OF FISHING (thousands)												
Total	459,341	55,699	350,170	568,512	12.1	900,763	44,829	826,596	974,929	5	2.42	-6.17*
Freshwater	383,192	48,551	288,032	478,352	12.7	756,695	45,506	681,409	831,981	6	2.12	-5.61*
Freshwater, except Great Lakes	372,660	47,465	279,628	465,692	12.7	701,234	38,715	637,183	765,285	5.5	2.31	-5.36*
Great Lakes	13,440	4,419	4,779	22,101	32.9	37,751	7,004	26,164	49,338	18.6	1.77	-2.94*
Saltwater	75,392	13,840	48,265	102,519	18.4	187,306	24,240	147,203	227,409	12.9	1.43	-4.01*
Average Days per Angler												
Total	12.8	1.2	10.5	15.2	9.4	16.2	0.77	14.9	17.5	4.8	1.96	-2.38*
Freshwater	12.7	1.2	10.3	15.2	9.4	16.2	0.88	14.8	17.7	5.4	1.74	-2.35*
Freshwater, except Great Lakes	12.6	1.2	10.2	15.1	9.5	15.4	0.77	14.1	16.6	5	1.90	-1.96*
Great Lakes	7.4	1.7	4	10.8	23	11.7	1.70	8.9	14.5	14.5	1.59	-1.79
Saltwater	9.1	1.2	6.7	11.4	13.2	10.5	0.82	9.1	11.8	7.8	1.69	-0.96
FISHING EXPENDITURES (thousand dollars)												
Total	$46,115,118	$7,250,349	$31,904,435	$60,325,801	15.7	$119,724,748	$12,539,830	$98,978,441	$140,471,055	10.5	1.50	-5.08*
Freshwater	$27,520,133	$4,372,391	$18,950,247	$36,090,019	15.9	$72,694,171	$6,622,209	$61,738,170	$83,650,172	9.1	1.75	-5.69*
Freshwater, except Great Lakes	$25,144,248	$4,001,416	$17,301,472	$32,987,024	15.9	$66,104,829	$6,293,623	$55,692,452	$76,517,206	9.5	1.67	-5.49*
Great Lakes	$2,246,114	$676,207	$920,748	$3,571,480	30.1	$6,426,975	$1,272,221	$4,322,170	$8,531,780	19.8	1.52	-2.90*
Saltwater	$11,176,149	$2,150,195	$6,961,767	$15,390,531	19.2	$31,484,640	$7,240,485	$19,505,743	$43,463,538	23	0.83	-2.69*
Average Expenditure per Angler (dollars)												
Total	$1,290	$167	$963	$1,617	12.9	$2,231	$212	$1,880	$2,582	9.5	1.36	-3.49*
Freshwater	$913	$117	$683	$1,143	12.8	$1,649	$149	$1,402	$1,896	9	1.42	-3.89*
Freshwater, except Great Lakes	$853	$110	$638	$1,067	12.9	$1,526	$145	$1,286	$1,766	9.5	1.36	-3.70*
Great Lakes	$1,232	$265	$713	$1,751	21.5	$2,069	$424	$1,367	$2,770	20.5	1.05	-1.67
Saltwater	$1,343	$190	$971	$1,716	14.1	$1,862	$331	$1,315	$2,409	17.8	0.79	-1.36
Number not significant												4
Minimum					4.6					4.0	0.79	
Maximum					32.9					23.0	2.42	
Mean					17.21					13.8	1.36	

*p<.05, significantly different

Table B2. Statistics, Comparison Census and Rockville Selected Estimates, Hunters, Days, Expenditures (reference Table D-2)

	Census					Rockville						
Hunters, days, and expenditures	Estimate	Standard error	Lower 95 percent	Upper 95 percent	CV	Estimate	Standard error	Lower 95 percent	Upper 95 percent	CV	Census /RI	Census - Rockville t-statistic
HUNTERS (thousands)												
Total	11,453	949	9,594	13,312	8.3	26,323	1,208	24,324	28,322	4.6	1.80	-9.68*
Big game	9,208	854	7,533	10,883	9.3	20,840	918	19,322	22,358	4.4	2.11	-9.28*
Small game	3,505	533	2,460	4,550	15.2	10,622	611	9,612	11,632	5.8	2.62	-8.78*
Migratory bird	2,353	438	1,495	3,211	18.6	5,557	527	4,686	6,429	9.5	1.96	-4.68*
Other animals	1,315	328	672	1,958	24.9	5,197	515	4,345	6,048	9.9	2.52	-6.36*
DAYS OF HUNTING (thousands)												
Total	184,021	30,185	124,859	243,183	16.4	553,949	28,833	506,247	601,651	5.2	3.15	-8.86*
Big game	132,665	23,352	86,896	178,434	17.6	372,018	20,034	338,874	405,162	5.4	3.26	-7.78*
Small game	38,306	9,659	19,375	57,237	25.2	134,790	11,404	115,924	153,656	8.5	2.96	-6.46*
Migratory bird	15,621	3,923	7,932	23,310	25.1	66,185	10,345	49,069	83,301	15.6	1.61	-4.57*
Other animals	13,275	5,176	3,130	23,420	39.0	76,618	10,664	58,975	94,261	13.9	2.81	-5.34*
Average Days per Hunter												
Total	16.1	2	12.2	19.9	12.4	21.1	1.04	19.4	22.8	4.9	2.53	-2.22*
Big game	14.4	1.9	10.8	18.1	13.2	17.9	0.82	16.5	19.2	4.6	2.87	-1.69
Small game	10.9	2	7	14.8	18.3	12.7	0.90	11.2	14.2	7.1	2.58	-0.82
Migratory bird	6.6	1.2	4.3	9	18.2	11.9	1.64	9.2	14.7	13.8	1.32	-2.61*
Other animals	10.1	2.8	4.6	15.6	27.7	15.0	1.82	12.0	18.0	12.1	2.29	-1.47
HUNTING EXPENDITURES (thousand dollars)												
Total	$26,190,488	$5,906,739	$14,613,279	$37,767,697	22.6	$96,638,022	$6,553,725	$85,795,323	$107,480,721	6.8	3.32	-7.98*
Big game	$14,878,550	$3,435,793	$8,144,396	$21,612,704	23.1	$43,944,776	$4,016,489	$37,299,765	$50,589,788	9.1	2.54	-5.50*
Small game	$1,653,408	$442,980	$785,168	$2,521,648	26.8	$7,888,536	$815,617	$6,539,153	$9,237,920	10.3	2.60	-6.72*
Migratory bird	$2,253,939	$663,959	$952,579	$3,555,299	29.5	$6,909,453	$1,754,739	$4,006,356	$9,812,550	25.4	1.16	-2.48*
Other animals	$755,073	$276,753	$212,637	$1,297,509	36.7	$1,867,277	$284,984	$1,395,791	$2,338,764	15.3	2.40	-2.80*
Average Expenditure per Hunter (dollars)												
Total	$2,287	$406	$1,490	$3,083	17.8	$3,790	$245	$3,384	$4,195	6.5	2.74	-3.17*
Big game	$1,616	$289	$1,050	$2,182	17.9	$2,339	$188	$2,028	$2,650	8	2.24	-2.10*
Small game	$472	$92	$292	$652	19.5	$852	$77	$724	$980	9	2.17	-3.17*
Migratory bird	$958	$202	$561	$1,355	21.1	$1,484	$375	$863	$2,105	25.3	0.83	-1.23
Other animals	$574	$150	$280	$869	26.1	$483	$64	$377	$590	13.3	1.96	0.56
Number not significant												5
Minimum					8.3					4.4	0.83	
Maximum					39.0					25.4	3.32	
Mean					21.2					10.2	2.20	

*p<.05, significantly different

Table B3. Statistics, Comparison Census and Rockville Selected Estimates, Fishing and Hunting Expenditures (reference Table D-3)

	Census					Rockville						
Expenditures	Estimate	Standard error	Lower 95 percent	Upper 95 percent	CV	Estimate	Standard error	Lower 95 percent	Upper 95 percent	CV	Census / RI	Census - Rockville t-statistic
FISHING/HUNT EXPENDITURES												
Total	$81,035,416	$12,629,137	$56,282,308	$105,788,524	15.6	$354,243,058	$24,641,357	$313,475,587	$395,010,529	7	2.23	9.87*
Trip-related	$30,926,023	$4,834,276	$21,450,842	$40,401,204	15.6	$80,472,402	$6,867,492	$69,110,598	$91,834,206	8.5	1.84	5.90*
Food/ lodging	$10,962,927	$1,729,380	$7,573,343	$14,352,511	15.8	$30,494,897	$2,414,189	$26,500,783	$34,489,011	7.9	2.00	6.58*
Transportation	$8,233,085	$1,300,552	$5,684,003	$10,782,167	15.8	$19,708,184	$1,433,815	$17,336,034	$22,080,334	7.3	2.16	5.93*
Other trip costs	$11,730,011	$1,866,935	$8,070,818	$15,389,204	15.9	$30,269,321	$3,525,985	$24,435,815	$36,102,827	11.6	1.37	4.65*
Equipment	$42,315,716	$6,508,669	$29,558,724	$55,072,708	15.4	$247,556,839	$19,836,288	$214,739,033	$280,374,646	8	1.93	9.83*
Fishing	$7,445,695	$1,206,066	$5,081,806	$9,809,584	16.2	$21,149,938	$3,816,762	$14,835,361	$27,464,515	18	0.90	3.42*
Hunting	$7,996,132	$1,441,940	$5,169,929	$10,822,335	18	$25,505,865	$1,592,706	$22,870,839	$28,140,890	6.2	2.90	8.15*
Auxiliary	$6,082,746	$1,104,636	$3,917,660	$8,247,832	18.2	$28,075,939	$3,765,711	$21,845,822	$34,306,055	13.4	1.36	5.60*
Special	$20,791,143	$4,667,568	$11,642,710	$29,939,576	22.4	$172,825,099	$17,161,007	$144,433,363	$201,216,834	9.9	2.26	8.55*
Other	$7,628,245	$1,194,474	$5,287,077	$9,969,413	15.7	$33,409,338	$4,336,390	$26,235,071	$40,583,604	13	1.21	5.73*
Books, Mag.subs	$383,617	$78,322	$230,105	$537,129	20.4	$1,040,139	$83,465	$902,052	$1,178,227	8	2.55	5.74*
Mem.dues/contrib.	$574,450	$124,997	$329,457	$819,443	21.8	$2,378,052	$193,504	$2,057,912	$2,698,192	8.1	2.69	7.83*
Land lease./ownsh.	$5,257,433	$1,375,744	$2,560,974	$7,953,892	26.2	$24,706,599	$4,058,530	$17,992,034	$31,421,165	16.4	1.60	4.54*
Lic., stamps, etc.	$1,412,745	$228,612	$964,665	$1,860,825	16.2	$3,271,597	$194,896	$2,949,154	$3,594,039	6	2.70	6.19*
FISHING EXPENDITURES												
Total	$46,115,118	$7,250,349	$31,904,435	$60,325,801	15.7	$119,724,748	$12,539,830	$98,978,441	$140,471,055	10.5	1.50	5.08*
Trip-related	$21,729,778	$3,425,620	$15,015,563	$28,443,993	15.8	$56,563,327	$6,807,100	$45,301,437	$67,825,217	12	1.32	4.57*
Food/ lodging	$7,848,993	$1,250,570	$5,397,876	$10,300,110	15.9	$22,290,476	$2,359,135	$18,387,445	$26,193,507	10.6	1.50	5.41*
Transportation	$5,048,606	$806,013	$3,468,821	$6,628,391	16	$12,942,755	$1,360,521	$10,691,864	$15,193,646	10.5	1.52	4.99*
Other trip costs	$8,832,179	$1,411,463	$6,065,712	$11,598,646	16	$21,330,096	$3,470,477	$15,588,424	$27,071,768	16.3	0.98	3.34*
Equipment	$21,077,638	$3,340,072	$14,531,098	$27,624,178	15.8	$54,056,701	$7,184,528	$42,170,382	$65,943,021	13.3	1.19	4.16*
Fishing	$7,430,662	$1,204,627	$5,069,594	$9,791,730	16.2	$21,149,938	$3,816,762	$14,835,361	$27,464,515	18	0.90	3.43*
Auxiliary	$3,163,575	$682,643	$1,825,595	$4,501,555	21.6	$4,650,896	$940,183	$3,095,426	$6,206,367	20.2	1.07	1.28
Special	$10,483,401	$2,802,497	$4,990,508	$15,976,294	26.7	$28,255,867	$5,904,779	$18,486,807	$38,024,928	20.9	1.28	2.72*
Other	$3,307,702	$537,685	$2,253,840	$4,361,564	16.3	$9,104,719	$2,762,159	$4,534,913	$13,674,526	30.3	0.54	2.06*
Books, Mag.subs	$147,465	$34,737	$79,380	$215,550	23.6	$309,439	$52,195	$223,086	$395,792	16.9	1.40	2.58*
Mem.dues/contrib.	$214,485	$62,810	$91,377	$337,593	29.3	$402,876	$66,516	$292,829	$512,923	16.5	1.78	2.06*
Land leas./ownsh.	$2,358,811	$863,974	$665,423	$4,052,199	36.6	$7,195,521	$2,756,844	$2,634,508	$11,756,534	38.3	0.96	1.67
Lic., stamps, etc.	$586,941	$98,127	$394,613	$779,269	16.7	$1,196,884	$97,409	$1,035,728	$1,358,040	8.1	2.06	4.41*

(Table continued next page)

Table B3. (CONTINUED) Statistics, Comparison Census and Rockville Selected Estimates, Fishing and Hunting Expenditures (reference Table D-3)

	Census					Rockville						
Expenditures	Estimate	Standard error	Lower 95 percent	Upper 95 percent	CV	Estimate	Standard error	Lower 95 percent	Upper 95 percent	CV	Census / RI	Census - Rockville t-statistic
HUNTING EXPENDITURES												
Total	$26,190,488	$5,906,739	$14,613,279	$37,767,697	22.6	$96,638,022	$6,553,725	$85,795,323	$107,480,721	6.8	3.32	7.98*
Trip-related	$9,196,245	$2,085,668	$5,108,336	$13,284,154	22.7	$23,909,075	$1,957,576	$20,670,397	$27,147,752	8.2	2.77	5.14*
Food/ lodging	$3,113,934	$705,383	$1,731,384	$4,496,484	22.7	$8,204,421	$662,161	$7,108,919	$9,299,922	8.1	2.80	5.26*
Transportation	$3,184,479	$721,807	$1,769,737	$4,599,221	22.7	$6,765,429	$530,797	$5,887,261	$7,643,597	7.8	2.91	4.00*
Other trip costs	$2,897,832	$757,540	$1,413,054	$4,382,610	26.1	$8,939,225	$1,064,622	$7,177,879	$10,700,571	11.9	2.19	4.62*
Equipment	$12,755,917	$2,823,776	$7,221,317	$18,290,517	22.1	$50,206,047	$3,944,455	$43,680,211	$56,731,884	7.9	2.80	7.72*
Hunting	$7,383,871	$1,704,057	$4,043,920	$10,723,822	23.1	$25,505,865	$1,592,706	$22,870,839	$28,140,890	6.2	3.73	7.77*
Auxiliary	$2,018,696	$504,598	$1,029,684	$3,007,708	25.0	$6,328,674	$535,555	$5,442,634	$7,214,714	8.5	2.94	5.86*
Special	$3,353,350	$1,855,829	-$284,074	$6,990,774	55.3	$18,371,508	$2,950,269	$13,490,486	$23,252,530	16.1	3.43	4.31*
Other	$4,072,894	$894,057	$2,320,543	$5,825,245	22.0	$20,509,949	$3,004,384	$15,539,398	$25,480,500	14.6	1.51	5.24*
Books, Mag.subs	$166,451	$52,920	$62,727	$270,175	31.8	$285,736	$34,804	$228,155	$343,316	12.2	2.61	1.88
Mem.dues/contrib.	$182,016	$53,315	$77,518	$286,514	29.3	$638,422	$85,289	$497,318	$779,527	13.4	2.19	4.54*
Land leas./ownsh.	$2,898,622	$901,530	$1,131,622	$4,665,622	31.1	$17,511,078	$2,931,447	$12,661,197	$22,360,960	16.7	1.86	4.76*
Lic., stamps, etc.	$825,805	$178,731	$475,492	$1,176,118	21.6	$2,074,713	$172,513	$1,789,302	$2,360,124	8.3	2.60	5.03*
Number not significant												3
Minimum					15.4					6.0	0.54	
Maximum					55.3					38.3	3.73	
Mean					21.62					12.52	1.99	

*p<.05, significantly different

Table B4. Statistics, Comparison Census and Rockville Selected Estimates, Wildlife Watching Participants, Days, Expenditures (reference Table D-4)

	Census					Rockville						
	Estimate	Standard error	Lower 95 percent	Upper 95 percent	CV	Estimate	Standard error	Lower 95 percent	Upper 95 percent	CV	Census/ RI	Census - Rockville t-statistic
WILDLIFE WATCHING PARTICIPANTS (thousands)												
Total	86,042	3,136	79,896	92,188	3.6	176,413	3,194	170,107	182,720	1.8	2.00	-20.19*
Nonresidential	23,720	1,928	19,942	27,498	8.1	76,955	2,601	71,818	82,093	3.4	2.38	-16.44*
Observe wildlife	19,583	1,767	16,119	23,047	9	73,027	2,572	67,947	78,106	3.5	2.57	-17.13*
Photograph wildlife	13,721	1,498	10,786	16,656	10.9	45,925	2,406	41,174	50,677	5.2	2.10	-11.36*
Feed wildlife	4,869	908	3,088	6,650	18.6	26,620	1,676	23,310	29,930	6.3	2.95	-11.41*
Residential	81,128	3,089	75,073	87,183	3.8	171,186	3,234	164,800	177,572	1.9	2.00	-20.14*
Observe wildlife	43,829	2,504	38,922	48,736	5.7	117,876	3,407	111,148	124,605	2.9	1.97	-17.51*
Photograph wildlife	30,473	2,153	26,254	34,692	7.1	77,380	2,424	72,592	82,167	3.1	2.29	-14.47*
Feed wildlife	59,083	2,799	53,596	64,570	4.7	120,276	3,172	114,012	126,540	2.6	1.81	-14.47*
Visit public parks	11,359	1,369	8,675	14,043	12.1	53,846	2,417	49,073	58,619	4.5	2.69	-15.30*
Maintain natural areas/plantings	11,024	1,350	8,378	13,670	12.2	38,183	2,347	33,547	42,818	6.1	2.00	-10.03*
DAYS PARTIC. NONRESIDENTIAL (thousands)												
Total	386,045	48,861	290,278	481,812	12.7	2,528,329	240,001	2,131,264	2,925,394	9.5	1.34	-8.75*
Observe wildlife	308,769	42,708	225,061	392,477	13.8	1,882,451	225,859	1,508,783	2,256,119	12	1.15	-6.85*
Photograph wildlife	151,559	24,670	103,205	199,913	16.3	892,074	137,620	664,390	1,119,757	15.4	1.06	-5.30*
Feed wildlife	70,846	19,156	33,300	108,392	27	993,042	146,804	750,164	1,235,920	14.8	1.82	-6.23*
Ave. Days of Partic.in Nonresidential Activities	16.3	1.48	13.4	19.2	9.1	33.1	2.90	28.3	37.9	8.8	1.03	-5.16*
Observe wildlife	15.8	1.56	12.7	18.8	9.9	26.6	2.99	21.7	31.6	11.2	0.88	-3.20*
Photograph wildlife	11	1.29	8.5	13.6	11.7	19.8	2.74	15.3	24.4	13.8	0.85	-2.91*
Feed wildlife	14.6	2.81	9	20.1	19.2	39.0	4.93	30.9	47.2	12.6	1.52	-4.30*

(Table continued next page)

Table B4. (CONTINUED) Statistics, Comparison Census and Rockville Selected Estimates, Wildlife Watching Participants, Days, Expenditures (reference Table D-4)

	Census					Rockville						
	Estimate	Standard error	Lower 95 percent	Upper 95 percent	CV	Estimate	Standard error	Lower 95 percent	Upper 95 percent	CV	Census /RI	Census - Rockville t-statistic
EXPENDITURES (thousands)												
Total	$75,867,134	$11,486,095	$53,354,388	$98,379,880	15.1	$377,704,863	$52,470,901	$290,895,278	$464,514,449	13.9	1.09	-5.62*
Trip-related	$11,587,870	$2,019,178	$7,630,280	$15,545,460	17.4	$97,975,682	$7,935,566	$84,846,821	$111,104,543	8.1	2.15	-10.55*
Food and lodging	$6,068,131	$1,088,656	$3,934,366	$8,201,896	17.9	$52,725,789	$4,409,329	$45,430,850	$60,020,728	8.4	2.13	-10.27*
Transportation	$4,228,568	$739,070	$2,779,990	$5,677,146	17.5	$32,057,103	$3,026,024	$27,050,750	$37,063,456	9.4	1.86	-8.93*
Other trip costs	$1,291,171	$268,236	$765,429	$1,816,913	20.8	$13,192,790	$1,665,189	$10,437,847	$15,947,733	12.6	1.65	-7.06*
Equipment and Other, Total	$64,279,264	$9,810,357	$45,050,965	$83,507,563	15.3	$279,729,181	$48,782,674	$199,021,519	$360,436,843	17.4	0.88	-4.33*
Equipment, Total	$55,083,300	$8,375,081	$38,668,142	$71,498,458	15.2	$216,817,196	$40,506,894	$149,801,257	$283,833,134	18.7	0.81	-3.91*
Wildlife watching equipment, total	$12,105,745	$1,860,579	$8,459,011	$15,752,479	15.4	$44,847,014	$2,123,413	$41,333,970	$48,360,059	4.7	3.28	-11.59*
Auxiliary equipment, total	$1,043,932	$233,961	$585,368	$1,502,496	22.4	$11,468,944	$1,528,456	$8,940,215	$13,997,672	13.3	1.68	-6.74*
Special equipment, total	$41,933,623	$12,895,894	$16,657,672	$67,209,574	30.8	$160,501,238	$39,541,966	$95,081,709	$225,920,767	24.6	1.25	-2.85*
Total Other	$9,195,965	$1,536,597	$6,184,236	$12,207,694	16.7	$62,911,985	$20,788,016	$28,519,608	$97,304,362	33	0.51	-2.58*
Magazines	$236,696	$45,410	$147,692	$325,700	19.2	$1,532,223	$184,940	$1,226,253	$1,838,194	12.1	1.59	-6.81*
Land Leasing/ Ownership	$4,196,305	$1,922,344	$428,510	$7,964,100	45.8	$3,478,965	$301,089	$2,980,834	$3,977,096	8.7	5.26	0.37
Membership dues/contributions	$3,817,276	$774,133	$2,299,975	$5,334,577	20.3	$52,087,564	$20,341,929	$18,433,207	$85,741,920	39.1	0.52	-2.37*
Plantings	$945,688	$204,922	$544,040	$1,347,336	21.7	$5,813,233	$704,171	$4,648,229	$6,978,238	12.1	1.79	-6.64*
Number not significant												1
Minimum					3.6					1.8	0.51	
Maximum					45.8					39.1	5.26	
Mean					15.5					11.04	1.79	

*p<.05, significantly different