A comparison of recall error in recreational fisheries surveys with one and two-month reference periods

Marine Recreational Information Program

FY-2015

Project: Recall Error in a Recreational Fishing Effort Survey - Testing the Impacts of 1-Month Waves

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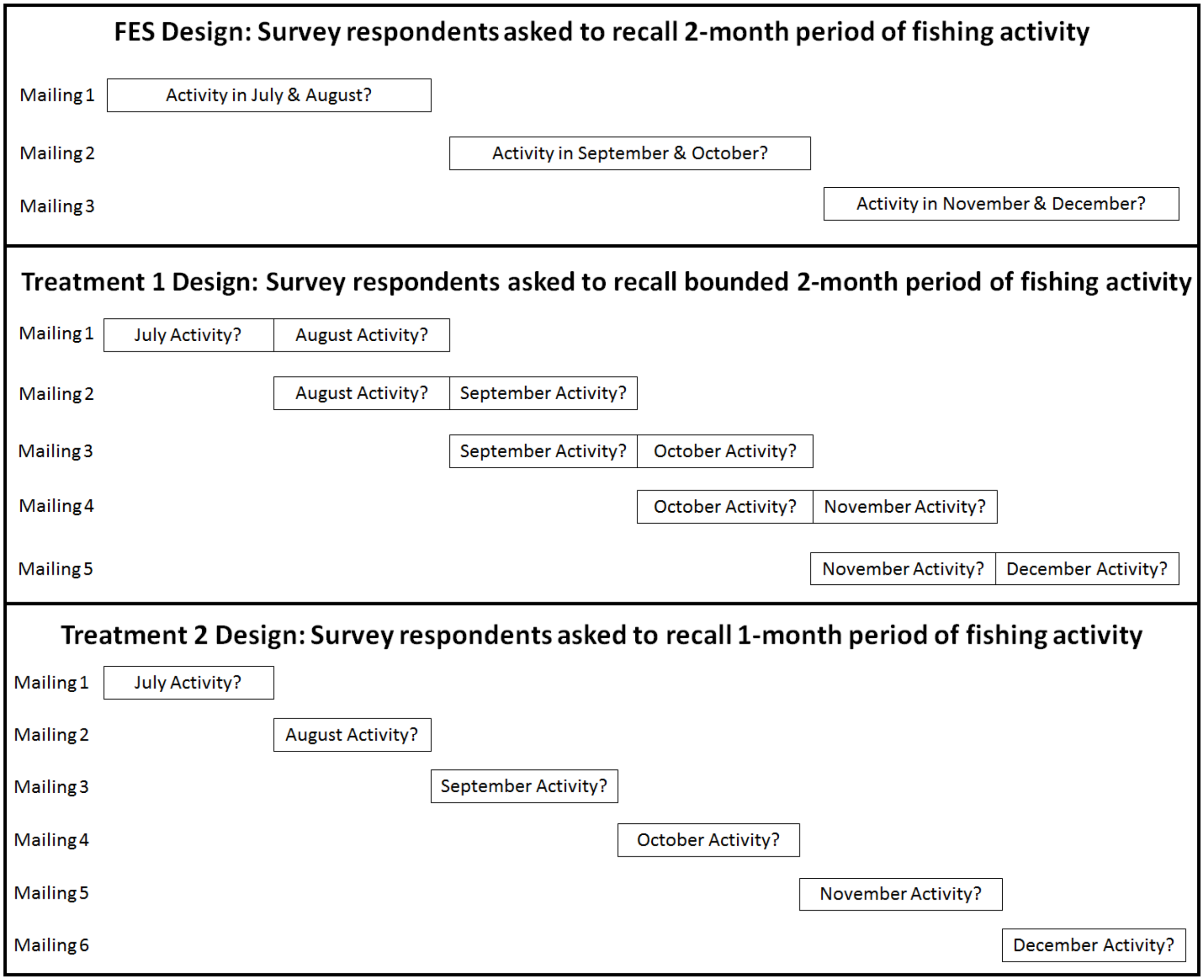
4. Acknowledgement

We thank Gallup for administering data collection for the FES and our experimental surveys as well as all of the participants that took the time to respond. We also thank Ryan Kitts-Jensen for useful feedback during the initial development of the project.

5. Executive Summary



Many fisheries monitoring programs use self-administered surveys to collect data, which are subject to recall error. Recall error occurs when respondents inaccurately remember past events due to telescoping (remembering events more recently or further back in time than they occurred) or omission error (forgetting events altogether). Previous research on the effects of variable reference periods in fisheries surveys has been inconclusive due to difficulty in disentangling method effects from recall error and in determining whether estimates from shorter recall periods are less biased, or more subject to telescoping. The National Marine Fisheries Service has developed a new household mail survey, the Fishing Effort Survey, where anglers are asked to recall cumulative fishing effort over the past two months from which estimates of saltwater fishing effort are produced. Here, we examined how the length of the reference period may affect the Fishing Effort Survey in four U.S. states by comparing effort estimates to two feasible alternatives; 1) a survey administered monthly with both a one- and two-month reference period (where respondents were asked to recall fishing effort for each of the past two months individually), and 2) a survey administered monthly with a one-month reference period. To further explore bias in the designs, we compared total effort, fishing prevalence and mean trips per household estimates derived from the two experimental surveys. We found no significant differences between the Fishing Effort Survey and experimental survey estimates. However, we found evidence that multiple reference periods in a single survey may reduce bias for one-month estimates. Increased understanding of techniques that can reduce recall bias, and of the trade-offs of shorter or longer reference periods will ultimately help fisheries survey designers more accurately weigh bias against survey costs, and improve the quality of data used to inform management decisions.

6. Background

Self-reported data collected through retrospective recall of past events is a crucial component of a variety of social, public health and economic research (e.g. Abbott and Monsen 1979; Wright and Pescosolido 2002; Bhandari and Wagner 2006), and has been widely used to estimate recreational fishing statistics in the United States and elsewhere (e.g. Hicks et al. 1999; Ditton and Hunt 2008; Sampson 2011; Rocklin et al. 2014). Such data, however, is subject to various sources of non-sampling error, including measurement error. Memory or recall error is a type of measurement error that occurs when respondents are unable to accurately remember, or recall, past events (Neter and Waksberg 1964; Eisenhower et al. 2011). Recall errors are typically classified as either telescoping error or omission error (Sudman and Bradburn 1973; Chu et al. 1992). Telescoping occurs when a respondent misplaces an event in time, usually placing the event more recently in time than it actually occurred, and omission error, also referred to as recall decay, occurs when a respondent forgets an event.

Several factors are thought to affect a respondents ability to remember and report past events, including 1) the number events reporting becomes more time consuming as the number of events increases, 2) the extent to which events are important or memorable (salience), 3) the frequency or regularity of events, and 4) the length of the reference period, or the time period for which recall of an activity is utilized by the respondent - longer reference periods potentially require recollection of events that are more distant as well as a greater number of events (Blair and Burton 1987). It is generally accepted that the greater the length of the reference period, the greater the expected bias due to recall error.

Identifying how to best minimize recall error while maximizing the quantity of information collected and optimizing a surveys budget, remains a challenge (Clarke et al. 2008). Researchers have developed several strategies to enhance memory and subsequently reduce recall error (Sudman and Bradburn 1984). These include aided recall, which stimulates recall by providing memory cues, such as pictures or calendars; requesting that respondents consult personal records, such as bank statements or receipts; landmark procedures, which relate the reference period to a landmark event, such as a major holiday, personal milestone or a natural disaster (Loftus and Marburger 1983, Gaskett et al. 2000); adjusting the duration of the reference period (Chu et al. 1989); and bounded recall, which bounds respondent memory against a prior interview (Neter and Waksberg 1964) or a previous question within a single interview (Sudman et al. 1984). Researchers frequently utilize a combination of these approaches to improve the quality of survey responses.

Prior studies have been inconsistent with respect to the effects of the length of reference periods on recreational fisheries survey measures (Gems et al. 1982; Chu et al. 1992; Tarrant et al. 1993; Connelly and Brown 1995, 2011; Connelly et al. 2000). For example, Gems et al. (1982) found that a two-month reference period resulted in lower estimates of fishing activity than a two-week reference period and attributed the difference to omission error associated with a longer reference period. In contrast, others have suggested that longer reference periods result in overestimation of fishing activity (Chu et al. 1992; Tarrant et al. 1993; Connelly and Brown 1995). Still others report no difference in reported fishing activity as a function of the duration of the reference period (Connelly and Brown 2011). An enhanced understanding of how recall affects recreational fisheries data collection programs is needed to continue improving the accuracy of recreational fisheries statistics.

One factor that may contribute to inconsistent findings are the differences in survey designs that have been utilized to examine recall error in recreational fishing surveys. For example, some studies compared angler diaries to mail surveys with longer reference periods (e.g. Tarrant et al. 1993), while others used mail surveys to examine one reference period and telephone surveys for another (e.g. Connelly et al 2000). In all of these studies, the authors acknowledge that it is difficult in such designs to disentangle method effects from recall bias. Others have used the same survey methods with two different reference periods to better isolate recall bias (e.g. Connelly and Brown 2011), but acknowledge that even in using identical methodologies, it is difficult to conclude whether shorter reference periods reduce recall error, or are, instead, subject to more telescoping bias than longer reference periods.

The National Marine Fisheries Service (NMFS) of the National Oceanic and Atmospheric Administration has redesigned its marine recreational fisheries data collection program, creating the Marine Recreational Information Program (MRIP, see National Research Council 2006; National Academies of Sciences, Engineering 2017). In January 2018, MRIP transitioned to a new survey, known as the Fishing Effort Survey (FES) to collect data about recreational shore and private boat fishing trips along the U.S. Atlantic and the Gulf of Mexico coasts. The FES is a self-administered mail survey that asks household residents to report recreational saltwater fishing trips that occurred during two-month reference periods, or waves. These data are used to estimate fishing effort, or the total number of shore and private boat fishing trips, for each of six, two-month waves, as well as annual fishing effort at the end of each calendar year. The FES replaced the legacy Coastal Household Telephone Survey, a random digit dial, landline telephone survey that NMFS had used to estimate fishing effort since 1981 (Brick et al. 2012b). The FES has been identified as a more efficient and accurate approach for monitoring recreational fishing effort than the Coastal Household Telephone Survey (Andrews et al. 2014; National Academies of Sciences, Engineering 2017). MRIP continues to examine the impacts of measurement errors, however, including recall error, on estimates in an effort to understand potential biases and limitations of the FES design.

Accurate statistics are essential for quantifying the effects of recreational fishing on fish stocks and developing sound, evidence-based management strategies and policies. Continuous catch and effort monitoring, for example, is needed to assess trends, evaluate the impacts of management regulations, and project how different management scenarios might influence a fishery. Minimizing biases, including recall error, in recreational fisheries surveys is therefore a necessity for effective management; large biases reduce data quality, and the subsequent utility of the statistics produced from those data, to fisheries scientists and managers. Understanding the magnitude of biases that occur in existing survey methods, as well as exploring methods to help mitigate such biases, can help improve data quality so that managers are provided with the best possible information to use in their decision making.

This study examined recall error in the FES by evaluating the impact of bounded recall, as well as the length of the reference period on reports of recreational saltwater fishing trips. We compared FES estimates of shore and private boat fishing effort to estimates derived from two experimental designs; one in which respondents were asked to report fishing trips for a single month (i.e. a one-month reference period), and one that asked respondents to recall fishing trips for each of two separate months (i.e. reporting for the most recent month, bounded by reporting for the prior month). All design elements other than the reference period were identical between the FES and experimental treatments in an effort to minimize confounding effects. Comparing results from the experimental surveys, we explored possible mechanisms for any suspected recall biases.

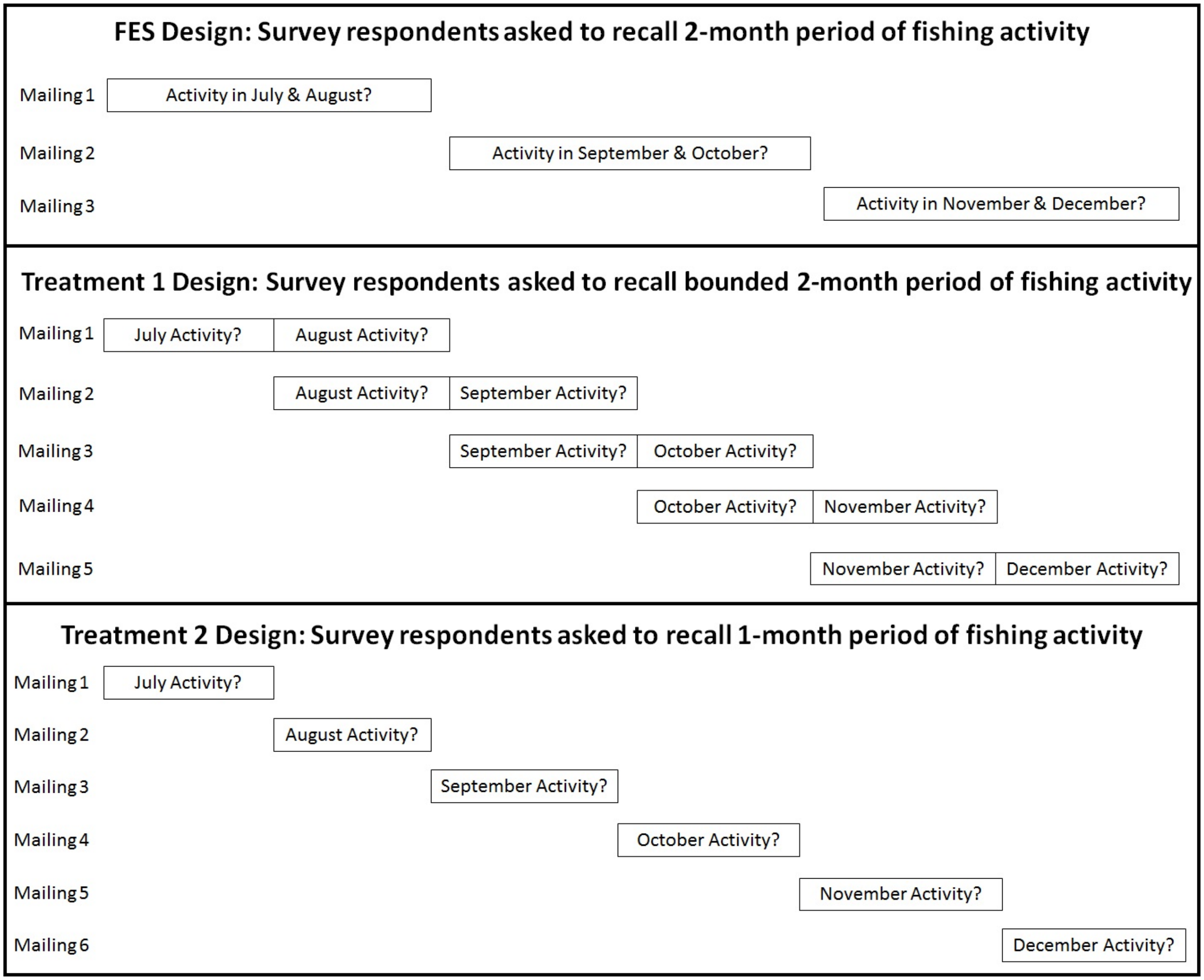
7. Methods

Experimental Design

The FES is administered at the end of two-month, mutually exclusive reference periods and asks respondents to recall the cumulative number of shore and private boat fishing trips that occurred during the reference period. From July to December 2015, two experimental questionnaires, which differed from the FES in the duration of the reference period, were administered in parallel to the FES in four states (Massachusetts, Maryland, Georgia, and Florida). One treatment (Treatment 1) asked about fishing trips for two individual months (the most recent month and the prior month). The second treatment (Treatment 2) asked about fishing trips for only the most recent month (see Appendix A for the differences between FES, Treatment 1, and Treatment 2 questionnaires). The experimental treatments were feasible modifications to the FES design that would provide greater temporal resolution and might potentially improve the accuracy of survey estimates.

With the exception of the manipulation of reference periods, the design of the FES and the experimental treatments were the same (Figure 1). The sample frame for each survey was the United States Postal Service (USPS) computerized delivery sequence file, consisting of all residential household addresses within each study state. The Massachusetts, Maryland and Georgia samples were stratified into sub-state regions, or groups of counties, defined by geographic proximity to the coast (coastal and non-coastal), while all counties in Florida were included in a single stratum due to the relatively high rate of fishing throughout the state. Within the geographic strata, we selected addresses using simple random sampling and matched them to the National Saltwater Angler Registry (Marine Recreational Information Program 2018). This partitioned the sample into two additional strata: license matched (where the households contain one or more licensed anglers) and license unmatched (where no licensed anglers were identified in the household). This stratification provided additional information to optimize sampling; previous studies (e.g. Andrews *et al.*, 2010; Brick, *et al.*, 2012; Andrews *et al.,* 2013) have demonstrated that residents of households that match to license databases respond to fishing surveys at a higher rate and are more likely to have fished during the reference wave than residents of unmatched households.

Figure 1. Schematic of the FES design compared to those of the experimental surveys: the FES was administered every two months and has a two-month reference period (i.e. time frame for which survey respondents are asked to report events). Treatment 1 was administered monthly where respondents were given two reference periods, asked to differentiate between fishing trips that occurred within the past month (one-month ago) and the month prior to that (two-months ago). Treatment 2 was administered monthly with a one-month reference period.



The final sampling allocation was achieved by retaining all license matched addresses in the sample and sub-sampling unmatched addresses at a rate of approximately 30%. The assignment to experimental treatments was completed following matching and subsampling; addresses within each stratum were randomly assigned to receive one of the two experimental versions of the survey. Sampling for the FES was conducted independently from the experimental treatments. In total, 39,539 questionnaires were mailed (Table 1), including Treatment 1 (11,983 questionnaires), Treatment 2 (12,017 questionnaires), and the FES (15,539 questionnaires). See Table 1 for sample sizes by state, and Appendix B for sample sizes by stratum.

Table 1: Sample sizes and responses by state for the six month experimental period. For a more detailed breakdown of sample size and responses by individual strata (i.e. by month, state, geographic stratum [coastal/non-coastal], and license status [matched/unmatched]) see Appendix B.

	Treatment 1		**Treatment 2**		**FES**	
	Initial Sample size	**Responses**	**Initial Sample size**	**Responses**	**Initial Sample size**	**Responses**
Florida	2998	961	3002	999	1590	527
Georgia	2995	988	3005	974	4244	1402
Maryland	2994	1043	3006	1062	5564	1968
Massachusetts	2996	1142	3004	1062	4141	1554

Data Collection

Reported saltwater fishing trips were collected from occupants of each sampled address (up to a maximum of 5 household members) through a self-administered questionnaire. The data collection period began one week prior to the end of the reference month with an initial survey mailing that included a cover letter stating the purpose of the survey, a survey questionnaire, a post-paid business reply envelope, and a prepaid $2 cash incentive. One week after the initial mailing, households received an automated voice telephone reminder message and a thank you/reminder postcard. Three weeks after the initial mailing, households received a second questionnaire, a nonresponse conversion letter designed to persuade nonresponding households to participate in the survey (Olson et al. 2011), and another post-paid business reply envelope (see Table 2 for the data collection schedule for the experiment). Data were collected for approximately 13 weeks following the initial survey mailing for each reference month.

Table 2: Data collection schedule for the FES (two-month reference period), experimental Treatment 1 (T1, both one and two-month reference periods), and Treatment 2 (T2, one-month reference period). Survey questionnaires were mailed out for the FES every two months at the end of August, October, and December. Treatment 1 questionnaires were mailed out monthly

from August-December. Treatment 2 questionnaires were sent out monthly from July-December.

	Experimental Months					
	July	August	September	October	November	December
Treatment	T2	FES, T1, T2	T1, T2	FES, T1, T2	T1, T2	FES, T1, T2
1st Survey Mailing	7/27/2015	8/25/2015	9/24/2015	10/26/2015	11/24/2015	12/28/2015
Reminder Postcard	8/3/2015	9/1/2015	10/1/2015	11/2/2015	12/1/2015	1/4/2015
Reminder Phone Call	8/6/2015	9/3/2015	10/2/2015	11/4/2015	12/2/2015	1/4/2015
2nd Survey Mailing	8/17/2015	9/15/2015	10/15/2015	11/16/2015	12/15/2015	1/18/2016

Fishing Effort Estimation

Initial comparisons were of total shore and private boat fishing effort across the four experimental states for the entire six-month experimental period. However, given the large influence of Florida Florida accounted for approximately 75% of total effort for the four experimental states we decided to consider Florida separately from the three other states. We considered shore and private boat fishing separately because the activities can be very different in terms of cost and time commitments, two factors that are likely to impact memory. Both Treatment 1 and Treatment 2 estimates were based upon the month immediately preceding survey administration; for Treatment 1, this coincided with the most recent month of the two-month reference period.

Initially, we compared FES trip estimates to experimental estimates to evaluate the impact of the different reference periods on survey estimates. Specifically, we hoped to determine if estimates derived from a longer reference period were susceptible to recall decay. Next, we compared experimental estimates to each other. We expected estimates from the two treatments to be similar since both were based upon reported fishing activity during the most recent month. Differences between treatments would presumably reflect the impact of the bounded recall design asking about a behavior for multiple periods - on reporting. In addition to comparing the estimated number of trips across experimental treatments, we also compared fishing prevalence (percent of households that reported fishing) and the mean number of trips reported per fishing household. Differences in these measures could help identify a mechanism for recall errors (Table 3).

Table 3: The statistical comparisons made between the survey estimates along with the purpose of each, the expected outcomes, and potential mechanisms behind expected outcomes.

Comparison	Primary Purpose of Comparison	Expected Outcome	Potential Mechanisms
FES total effort to T1 total effort	Identify recall decay in the longer reference period (FES).	FES estimates lower than T1 estimates	Recall decay in the FES.
FES total effort to T2 total effort	Identify recall decay in the longer reference period (FES).	FES estimates lower than T2 estimates	Recall decay in the FES or telescoping in T2.
T1 total effort to T2 total effort	Examine the impact of a bounded recall design (T1) on estimates.	Comparable estimates with no systematic differences	No difference in recall because the reference periods are the same. (If T2 estimates are instead higher than T1, it would suggest telescoping in T2.)
T1 fishing prevalence to T2 fishing prevalence	Explore mechanisms of observed recall error.	Comparable estimates with no systematic differences	No difference in recall because the reference periods are the same. (Differences between treatments suggest recall error is likely due to non-fishing households erroneously reporting fishing

			activity, indicating telescoping, social desirability, or a combination of both factors.)
T1 mean trips per household to T2 mean trips per household	Explore mechanisms of observed recall error	Comparable estimates with no systematic differences	No difference in recall because the reference periods are the same. (Differences between treatments suggest recall error is likely due to fishing households over- or underestimating the number of trips they took, indicating that recall ability is impacted by the frequency/regularity of fishing activity.)

Fishing prevalence and mean trips per household were calculated for Treatment 1 and Treatment 2 using established weighted mean estimators (SAS Institute Inc. 2016). Estimates of total fishing effort $(\hat{T}_r)$ were produced for the FES, Treatment 1 and Treatment 2 using the Horvitz-Thompson total estimator, a standard method for estimating the total of a stratified sample (Horvitz and Thompson 1952):

$$\hat{T}_r = \sum_{h=1}^{H} \sum_{i=1}^{n_h} w_{hi} t_{hi}$$

where w_{hi} is the weight of address *i* in stratum *h*, and t_{hi} is the reported number of recreational fishing trips for address *a* in stratum *h*. The sample weights (w_{hi}) were calculated in a series of four steps that included 1) a base weight reflecting the sample inclusion probability, 2) an adjustment to account for unit nonresponse, 3) a post-stratification adjustment to account for incomplete coverage of the target population (e.g. Brick and Kalton 1996) using the most recent, reliable estimates of the number of residential households available from the American Community Survey (U.S. Census Bureau 2015) as population controls, and 4) an established, estimated mean square error trimming procedure (see Potter 1990) to minimize the effects of extreme weights on the sampling variance.

The variance of the fishing effort estimates were calculated using Taylor series linearization (Dienes, 1957; SAS Institute Inc., 2016). The Taylor series obtains a linear approximation of a non-linear function, and then the variance estimate of the non-linear function is estimated by the variance of the Taylor series approximation of that function (Fuller 1975; Woodruff 1971). The method calculates the estimated variance as:

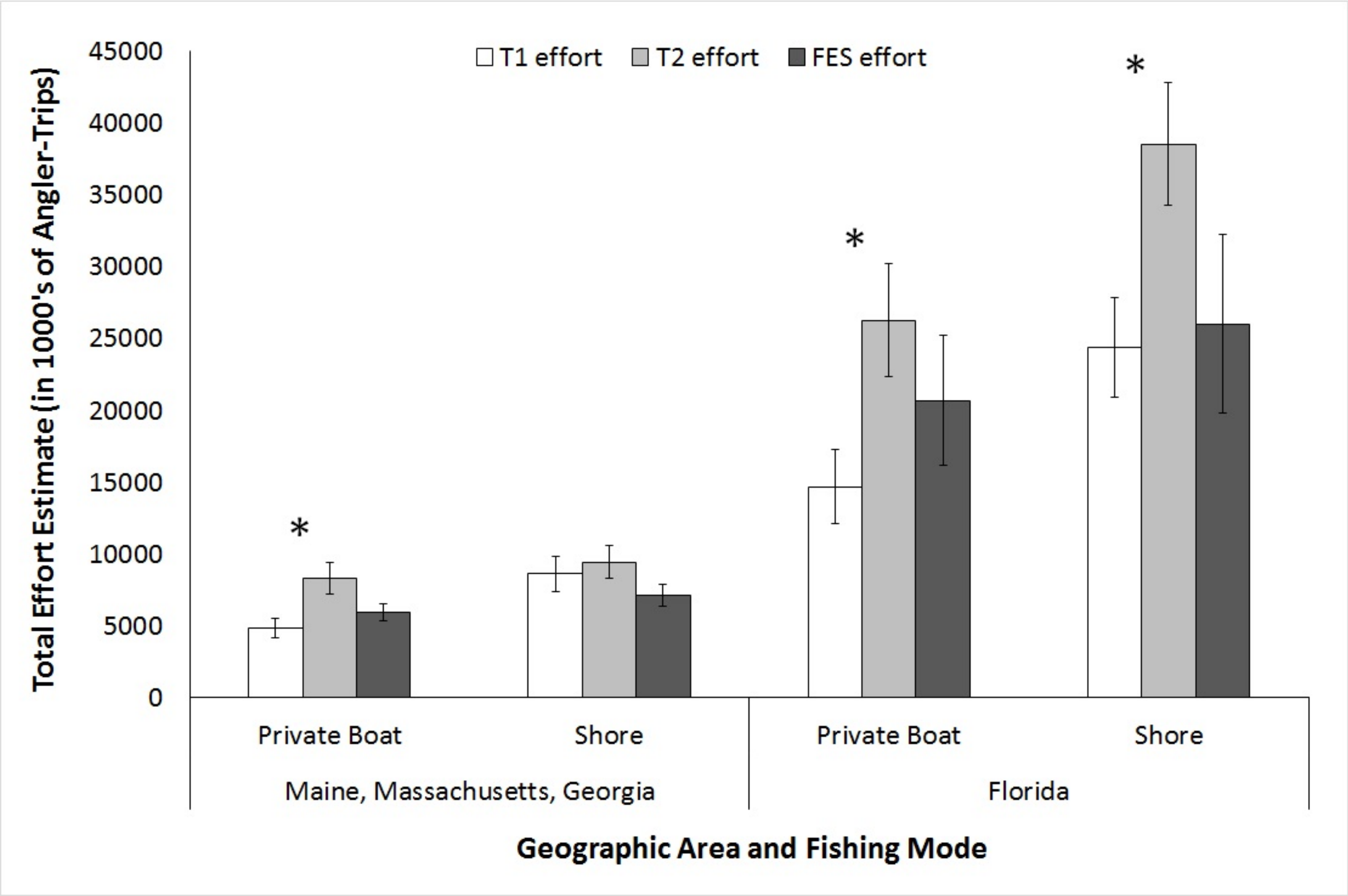
$$\hat{V}\left(\hat{\tau}_r\right) = \sum_{h=1}^{H}\left(\frac{n_h}{n_h\text{-}1}\left(\sum_{i\text{-}1}^{n_h} w^*_{hi} t_{hi} - \frac{1}{n_h}\sum_{i=1}^{n_h} w^*_{hi} t_{hi}\right)^2\right)$$

8. Results

Of the over 10,000 questionnaires mailed for each of the experimental treatments, between 647 and 665 were undeliverable and between 3,385 and 3,440 were completed and returned (see Table 2 for responses by state, and Appendix B for responses by stratum). Of the near 16,000 FES questionnaires that were mailed during the six-month experimental period, 745 were undeliverable and 5,657 were returned. Adjusted response rates across all surveys were very similar, ranging from 36.21% to 37.25%.

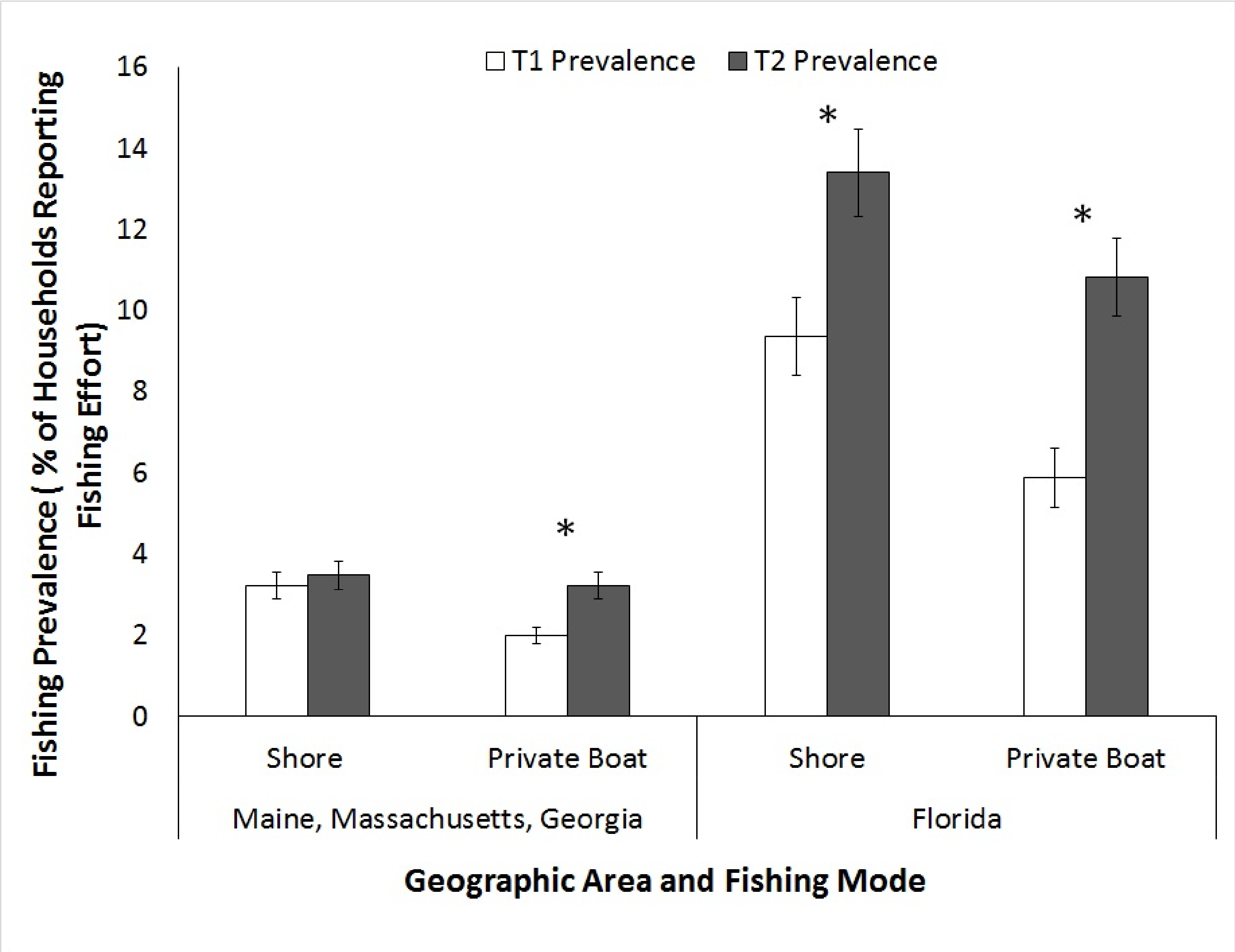
Differences in estimated fishing trips between the FES and the two experimental estimates were not statistically significant for either shore or private boat fishing. However, Treatment 2 estimates were systematically higher than FES estimates for both fishing modes (Figure 2).   In contrast, differences between FES and Treatment 1 estimates were neither significant nor systematic (Figure 2).

Figure 2. Comparison of fishing effort estimates (in 1000s of trips) from Treatment 1 (T1) and Treatment 2 (T2) to each other and to the FES by geographic area and by fishing mode. Estimates for each Treatment were calculated for each reference period (T1 uses one-month estimates derived from the most recent month in the treatments two-month period, T2 uses one-month estimates and the FES uses two-month estimates) and summed across the six month experimental period. Values are presented standard error. There were no significant differences in total fishing effort between the FES and T1 and T2 (*P*>0.05). Significant differences between T1 and T2 estimates are indicated by asterisks (*P*<0.05).



Comparisons between the experimental treatments demonstrated that Treatment 2 trip estimates were systematically higher than Treatment 1 estimates for both fishing modes (Figure 2). Differences between treatments were significant *(P*<0.05) in Florida for both shore and private boat fishing and in the remaining states for private boat fishing. Differences in trip estimates result from differences in fishing prevalence between the two treatments; a higher percentage of households reported fishing when the overall reference period was limited to a single month (Figure 3). Differences in fishing prevalence between Treatments 1 and 2 were significant for both shore and private boat fishing in Florida, as well as for private boat fishing in the other states. In contrast, differences between treatments in mean trips per household were relatively minor and not significant (Figure 4).

Figure 3. Comparison of fishing prevalence (the percentage of households reporting fishing) in Treatments 1 (T1, using most recent of the two-months within the treatment) and 2 (T2, one-month reference period) by geographic area and fishing mode. Values are presented standard error. Significant differences between T1 and T2 metrics are indicated by asterisks *(P*<0.05).


T1 Prevalence
T2 Prevalence
Fishing Prevalence (% of Households Reporting Fishing Effort)
16
14
12
10
8
6
4
2
0
*
*
*
Shore
Private Boat
Shore
Private Boat
Maine, Massachusetts, Georgia
Florida
Geographic Area and Fishing Mode

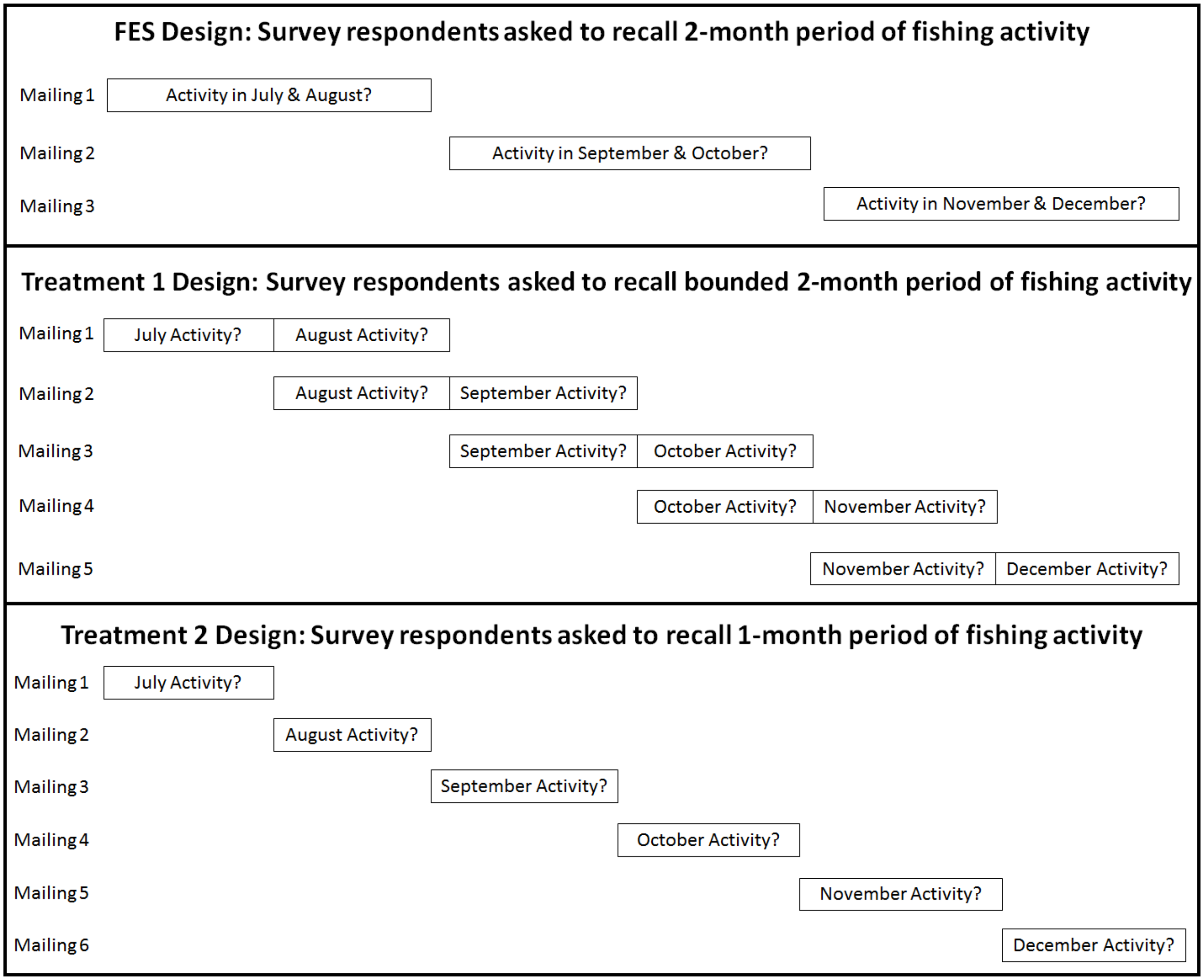
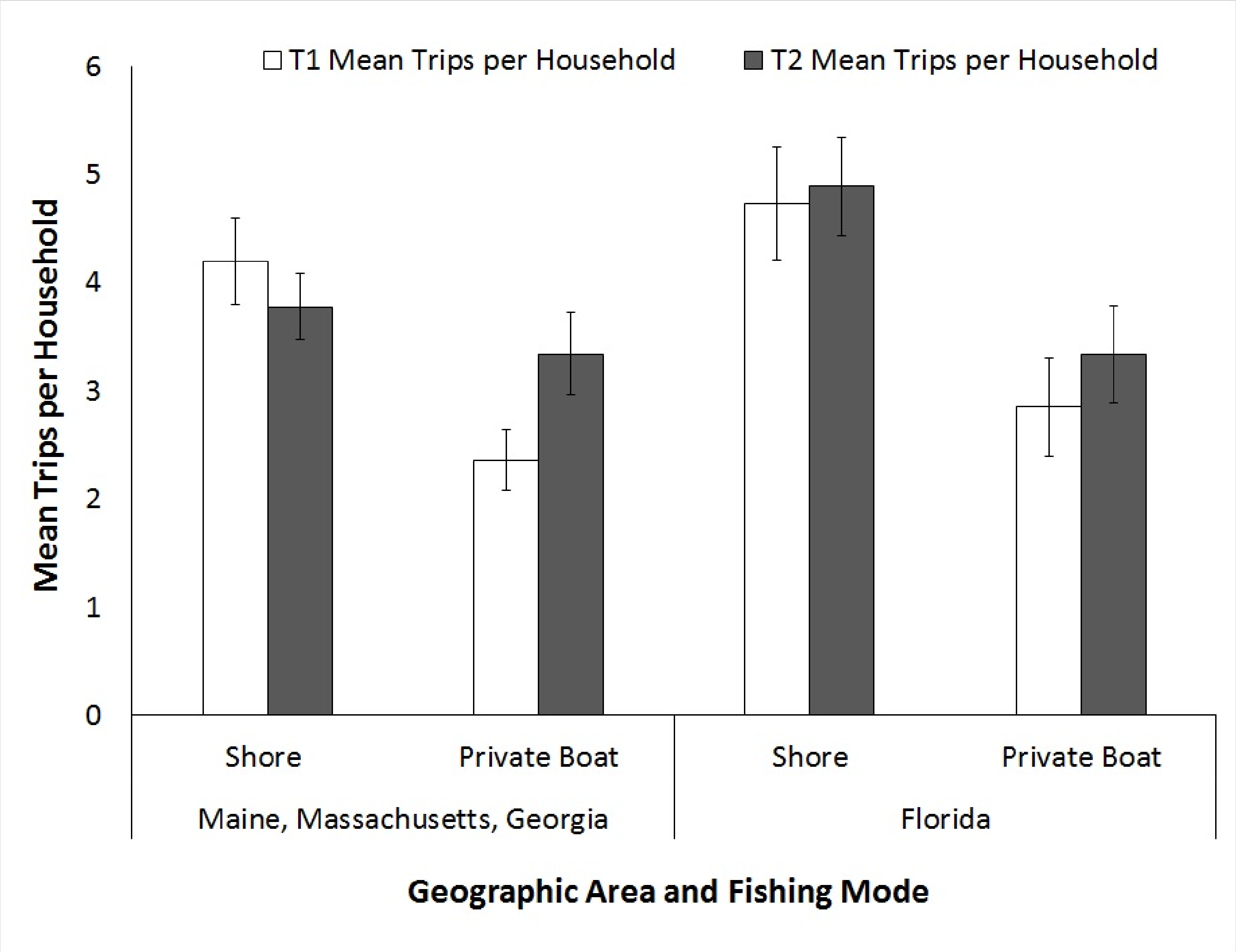


Figure 4. Comparison of mean fishing trips per household in Treatments 1 (T1, using the most recent month within the treatment) and Treatment 2 (T2, one-month reference period) by geographic area and fishing mode. Values are presented standard error. There were no significant differences in mean trips per household between T1 and T2 (*P*>0.05).



9. Discussion/Conclusions/Recommendations

FES estimates of total fishing effort were not significantly different from experimental estimates derived from a one-month recall period (either Treatment 1 or Treatment 2). However, FES estimates were systematically lower than experimental estimates when the recall period was limited to a single month (Treatment 2). This could mean that FES respondents are forgetting or omitting trips from the longer, two-month recall period, resulting in moderate underestimates of fishing effort. Were this true, we would also expect FES estimates to be lower than estimates derived from the most recent month of a two-month reference period (Treatment 1). Differences between FES and Treatment 1 estimates were neither significant nor systematic, suggesting that differences between FES and Treatment 2 estimates are not the result of omission error in the FES.

An alternative explanation for the differences between FES estimates and those based upon a single month (Treatment 2) is that respondents, when asked to report for a single month, telescope trips from prior months into the reference period. This explanation is consistent with the observed differences between Treatment 2 and Treatment 1 estimates, both of which are based upon reported fishing trips during the most recent month and have the same recall period. The distinction between Treatment 1 and Treatment 2 is that Treatment 1 utilized a bounded design, asking first about fishing activity during the more distant month before asking about the recent month.

Differences between Treatment 1 and Treatment 2 trip estimates were the result of differences in fishing prevalence rather than differences in the number of trips reported per household more households reported fishing when the reference period was limited to a single month, but those households that did report fishing reported a similar number of trips, regardless of treatment. This result may reflect social desirability bias (Chu et al. 1989), or the desire by respondents to complete the requested task of reporting some level of fishing effort (Sudman and Bradburn 1974). In other words, respondents may think they are being helpful by providing a positive response to questions about fishing effort. Anglers who actually did fish are able to satisfy this desire without having to telescope trips into the reference period. The longer FES reference period may help satisfy this desire and partially mitigate the impacts of telescoping error by increasing the probability that a respondent actually did fish during the reference period.

Similarly, asking about fishing trips for two separate months, as in Treatment 1, may minimize telescoping error for the most recent month by providing bounds against which responses are based. Neter and Waksberg (1964), who utilized a panel approach to improve recall and minimize telescoping error, initially described the potential benefits of bounded recall. In their design, the initial interview provides a recall bound for subsequent interviews. Sudman et al. (1984) modified the design to apply bounded interviewing in a single contact by asking about behaviors for multiple periods first an earlier period, then a more recent period. Sudman and others (Loftus et al. 1990) found that this approach reduced telescoping in the more recent reference period, resulting in lower, more accurate estimates. Our results suggest that bounded recall (as in Treatment 1) minimizes telescoping for the most recent reference month by providing an additional opportunity for respondents to report a socially desirable behavior.

Based upon the results from this study, we cannot attribute differences in estimates between the FES and experimental estimates to recall error in the FES design. In fact, limiting the recall period to a single month appeared to increase recall error resulting in overestimates of fishing effort. These results were consistent across geographic regions and fishing modes. If shorter, one-month estimates are desired, however, our results suggest that a bounded two-month design may be optimal for reducing recall error by using data from the second, most recent month of the reference period. These findings highlight the need for careful consideration in changes to survey designs, as subtle questionnaire differences can have substantial impacts on survey results. In weighing the trade-offs of survey design changes, consideration must also be given to precision, the subsequent sampling requirements needed to support different levels of resolution, and the impact of increased sampling on survey costs.

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11. Appendix

"Appendix A Questionnaire Differences", page 1

APPENDIX A: Difference between Treatment 1, Treatment 2, and FES Questionnaires. The questionnaires consisted of 16 questions for up to five people living in the household. The surveys differed only in Questions 15 and 16, which were about recalling shore and private boat fishing activity. Below are questions 15 and 16 for each of the three surveys used in this study.

FES Questionnaire (Q's 15 and 16)	Treatment 1 Questionnaire (Q's 15 and 16)	Treatment 2 Questionnaire (Q's 15 and 16)
Please think only about recreational saltwater fishing in <Merged State>. **15** How many days did you go recreational saltwater fishing from the shore in <Merged State>? The shore includes docks, bridges, causeways, beaches, banks, or any other shore-based place or area. ☐ No shore recreational saltwater fishing in last 12 months → ***Go to question 16*** ☐☐ Number of days in July and August of 2015 ☐☐ Total number of days in last 12 months **16** How many days did you go recreational saltwater fishing from a private or rental boat that returned to shore in <Merged State>? Do not include charter boats or commercial boats that have a captain or crew who help locate and catch fish. ☐ No private boat recreational saltwater fishing in last 12 months → ***Go to Household Member 2*** ☐☐ Number of days in July and August of 2015 ☐☐ Total number of days in last 12 months **If you have more household members, continue to household member 2.**	**Please think only about recreational saltwater fishing in <Merged State>.** **15 How many days did you go recreational saltwater fishing from the SHORE in <Merged State>?** *The shore includes docks, bridges, causeways, beaches, banks, or any other shore-based place or area. Do not include freshwater fishing.* ☐ Did not recreational saltwater fish from shore in last 12 months → ***Go to question 16*** ☐☐ Number of days shore fishing in Jun. of 2015 ☐☐ Number of days shore fishing in Jul. of 2015 ☐☐☐ Total number of days shore fishing in last 12 months, including Jun. and Jul. **16 How many days did you go recreational saltwater fishing from a private or rental BOAT that returned to shore in <Merged State>?** *Do not include freshwater trips or trips where a paid captain or crew helped locate and catch fish.* ☐ Did not recreational saltwater fish from private boat in last 12 months. ☐☐ Number of days boat fishing in Jun. of 2015 ☐☐ Number of days boat fishing in Jul. of 2015 ☐☐☐ Total number of days boat fishing in last 12 months, including Jun. and Jul. **If you have more people in your household, continue to Household Member 2.**	**Please think only about recreational saltwater fishing in <Merged State>.** **15 How many days did you go recreational saltwater fishing from the SHORE in <Merged State>?** *The shore includes docks, bridges, causeways, beaches, banks, or any other shore-based place or area. Do not include freshwater fishing.* ☐ Did not recreational saltwater fish from shore in last 12 months → ***Go to question 16*** ☐☐ Number of days shore fishing in Jul. of 2015 ☐☐☐ Total number of days shore fishing in last 12 months, including Jul. **16 How many days did you go recreational saltwater fishing from a private or rental BOAT that returned to shore in <Merged State>?** *Do not include freshwater trips or trips where a paid captain or crew helped locate and catch fish.* ☐ Did not recreational saltwater fish from private boat in last 12 months. ☐☐ Number of days boat fishing in Jul. of 2015 ☐☐☐ Total number of days boat fishing in last 12 months, including Jul. **If you have more people in your household, continue to Household Member 2.**

"Appendix B Frame and Sample Sizes per Stratum", page 1

Appendix B: Sample sizes and response rates per stratum, as well as the estimated number of total households in each stratum

Survey	Month	State	Geographic stratum (coastal or non-coastal)	License Status (Matched or Unmatched)	Sample Size	Complete Surveys	Estimated Number of Housholds in the Stratum
Treatment 1	July	Florida	Coastal	Matched	108	41	699510
Treatment 1	July	Florida	Coastal	Unmatched	392	116	6512564
Treatment 1	July	Georgia	Coastal	Matched	157	68	45540
Treatment 1	July	Georgia	Coastal	Unmatched	160	45	261939
Treatment 1	July	Georgia	Non-Coastal	Matched	48	19	147656
Treatment 1	July	Georgia	Non-Coastal	Unmatched	134	43	3094723
Treatment 1	July	Maryland	Coastal	Matched	34	14	70723
Treatment 1	July	Maryland	Coastal	Unmatched	329	98	1848157
Treatment 1	July	Maryland	Non-Coastal	Matched	33	10	8172.96046
Treatment 1	July	Maryland	Non-Coastal	Unmatched	103	43	235552
Treatment 1	July	Massachusetts	Coastal	Matched	115	54	44695
Treatment 1	July	Massachusetts	Coastal	Unmatched	331	118	1870372
Treatment 1	July	Massachusetts	Non-Coastal	Matched	20	13	16355
Treatment 1	July	Massachusetts	Non-Coastal	Unmatched	33	13	605543
Treatment 2	July	Florida	Coastal	Matched	108	42	699510
Treatment 2	July	Florida	Coastal	Unmatched	392	135	6512564
Treatment 2	July	Georgia	Coastal	Matched	158	61	43604
Treatment 2	July	Georgia	Coastal	Unmatched	161	44	261939
Treatment 2	July	Georgia	Non-Coastal	Matched	48	15	147656
Treatment 2	July	Georgia	Non-Coastal	Unmatched	134	45	3094723
Treatment 2	July	Maryland	Coastal	Matched	34	11	70723
Treatment 2	July	Maryland	Coastal	Unmatched	329	121	1848157
Treatment 2	July	Maryland	Non-Coastal	Matched	34	27	8172.96046
Treatment 2	July	Maryland	Non-Coastal	Unmatched	104	41	235552
Treatment 2	July	Massachusetts	Coastal	Matched	115	50	44695
Treatment 2	July	Massachusetts	Coastal	Unmatched	332	109	1870372
Treatment 2	July	Massachusetts	Non-Coastal	Matched	21	3	16355
Treatment 2	July	Massachusetts	Non-Coastal	Unmatched	33	12	605543
Treatment 1	August	Florida	Coastal	Matched	90	35	603521
Treatment 1	August	Florida	Coastal	Unmatched	410	135	6608553
Treatment 1	August	Georgia	Coastal	Matched	157	62	37507
Treatment 1	August	Georgia	Coastal	Unmatched	160	56	268036
Treatment 1	August	Georgia	Non-Coastal	Matched	48	22	137828
Treatment 1	August	Georgia	Non-Coastal	Unmatched	134	38	3104551
Treatment 1	August	Maryland	Coastal	Matched	26	9	91796
Treatment 1	August	Maryland	Coastal	Unmatched	355	136	1827084
Treatment 1	August	Maryland	Non-Coastal	Matched	8	5	6463.845554
Treatment 1	August	Maryland	Non-Coastal	Unmatched	110	46	237261
Treatment 1	August	Massachusetts	Coastal	Matched	94	48	76538
Treatment 1	August	Massachusetts	Coastal	Unmatched	358	126	1838529
Treatment 1	August	Massachusetts	Non-Coastal	Matched	10	6	13417
Treatment 1	August	Massachusetts	Non-Coastal	Unmatched	38	15	608481
Treatment 2	August	Florida	Coastal	Matched	90	36	603521
Treatment 2	August	Florida	Coastal	Unmatched	410	129	6608553
Treatment 2	August	Georgia	Coastal	Matched	158	65	37507
Treatment 2	August	Georgia	Coastal	Unmatched	161	54	268036
Treatment 2	August	Georgia	Non-Coastal	Matched	48	18	137828
Treatment 2	August	Georgia	Non-Coastal	Unmatched	134	43	3104551
Treatment 2	August	Maryland	Coastal	Matched	26	9	91796
Treatment 2	August	Maryland	Coastal	Unmatched	356	110	1827084

"Appendix B Frame and Sample Sizes per Stratum", page 2

Survey	Month	State	Geographic stratum (coastal or non-coastal)	License Status (Matched or Unmatched)	Sample Size	Complete Surveys	Estimated Number of Housholds in the Stratum
Treatment 2	August	Maryland	Non-Coastal	Matched	9	7	6463.845554
Treatment 2	August	Maryland	Non-Coastal	Unmatched	110	49	237261
Treatment 2	August	Massachusetts	Coastal	Matched	94	44	76538
Treatment 2	August	Massachusetts	Coastal	Unmatched	358	121	1838529
Treatment 2	August	Massachusetts	Non-Coastal	Matched	10	4	13417
Treatment 2	August	Massachusetts	Non-Coastal	Unmatched	38	14	608481
FES	July/August	Florida	Coastal	Matched	74	24	647686
FES	July/August	Florida	Coastal	Unmatched	309	96	6564388
FES	July/August	Georgia	Coastal	Matched	359	155	47275
FES	July/August	Georgia	Coastal	Unmatched	366	110	268962
FES	July/August	Georgia	Non-Coastal	Matched	109	43	141962
FES	July/August	Georgia	Non-Coastal	Unmatched	305	96	3089723
FES	July/August	Maryland	Coastal	Matched	60	22	86113
FES	July/August	Maryland	Coastal	Unmatched	879	326	1832767
FES	July/August	Maryland	Non-Coastal	Matched	20	8	7592.679128
FES	July/August	Maryland	Non-Coastal	Unmatched	272	100	236132
FES	July/August	Massachusetts	Coastal	Matched	158	86	67843
FES	July/August	Massachusetts	Coastal	Unmatched	699	264	1847224
FES	July/August	Massachusetts	Non-Coastal	Matched	25	15	16754
FES	July/August	Massachusetts	Non-Coastal	Unmatched	66	20	605144
Treatment 1	September	Florida	Coastal	Matched	101	46	680637
Treatment 1	September	Florida	Coastal	Unmatched	398	123	6531437
Treatment 1	September	Georgia	Coastal	Matched	157	66	39333
Treatment 1	September	Georgia	Coastal	Unmatched	160	49	266210
Treatment 1	September	Georgia	Non-Coastal	Matched	48	22	122817
Treatment 1	September	Georgia	Non-Coastal	Unmatched	134	41	3119562
Treatment 1	September	Maryland	Coastal	Matched	29	9	102387
Treatment 1	September	Maryland	Coastal	Unmatched	352	118	1816493
Treatment 1	September	Maryland	Non-Coastal	Matched	10	5	7592.679128
Treatment 1	September	Maryland	Non-Coastal	Unmatched	108	40	236132
Treatment 1	September	Massachusetts	Coastal	Matched	91	40	74142
Treatment 1	September	Massachusetts	Coastal	Unmatched	361	125	1840925
Treatment 1	September	Massachusetts	Non-Coastal	Matched	15	8	20797
Treatment 1	September	Massachusetts	Non-Coastal	Unmatched	32	9	601101
Treatment 2	September	Florida	Coastal	Matched	102	31	680637
Treatment 2	September	Florida	Coastal	Unmatched	399	129	6531437
Treatment 2	September	Georgia	Coastal	Matched	158	64	39333
Treatment 2	September	Georgia	Coastal	Unmatched	161	52	266210
Treatment 2	September	Georgia	Non-Coastal	Matched	48	14	122817
Treatment 2	September	Georgia	Non-Coastal	Unmatched	134	39	3119562
Treatment 2	September	Maryland	Coastal	Matched	29	11	102387
Treatment 2	September	Maryland	Coastal	Unmatched	353	117	1816493
Treatment 2	September	Maryland	Non-Coastal	Matched	10	2	7592.679128
Treatment 2	September	Maryland	Non-Coastal	Unmatched	109	38	236132
Treatment 2	September	Massachusetts	Coastal	Matched	91	32	74142
Treatment 2	September	Massachusetts	Coastal	Unmatched	361	112	1840925
Treatment 2	September	Massachusetts	Non-Coastal	Matched	16	9	20797
Treatment 2	September	Massachusetts	Non-Coastal	Unmatched	33	12	601101
Treatment 1	October	Florida	Coastal	Matched	96	34	648276
Treatment 1	October	Florida	Coastal	Unmatched	404	109	6563798
Treatment 1	October	Georgia	Coastal	Matched	140	40	38814
Treatment 1	October	Georgia	Coastal	Unmatched	177	65	266729

"Appendix B Frame and Sample Sizes per Stratum", page 3

Survey	Month	State	Geographic stratum (coastal or non-coastal)	License Status (Matched or Unmatched)	Sample Size	Complete Surveys	Estimated Number of Housholds in the Stratum
Treatment 1	October	Georgia	Non-Coastal	Matched	64	26	116218
Treatment 1	October	Georgia	Non-Coastal	Unmatched	117	25	3126161
Treatment 1	October	Maryland	Coastal	Matched	21	9	90872
Treatment 1	October	Maryland	Coastal	Unmatched	360	108	1828008
Treatment 1	October	Maryland	Non-Coastal	Matched	10	7	8927.655678
Treatment 1	October	Maryland	Non-Coastal	Unmatched	108	39	234797
Treatment 1	October	Massachusetts	Coastal	Matched	76	38	74315
Treatment 1	October	Massachusetts	Coastal	Unmatched	376	133	1840752
Treatment 1	October	Massachusetts	Non-Coastal	Matched	11	2	19729
Treatment 1	October	Massachusetts	Non-Coastal	Unmatched	36	14	602169
Treatment 2	October	Florida	Coastal	Matched	96	33	648276
Treatment 2	October	Florida	Coastal	Unmatched	404	134	6563798
Treatment 2	October	Georgia	Coastal	Matched	141	49	38814
Treatment 2	October	Georgia	Coastal	Unmatched	178	46	266729
Treatment 2	October	Georgia	Non-Coastal	Matched	65	20	116218
Treatment 2	October	Georgia	Non-Coastal	Unmatched	118	30	3126161
Treatment 2	October	Maryland	Coastal	Matched	22	10	90872
Treatment 2	October	Maryland	Coastal	Unmatched	360	118	1828008
Treatment 2	October	Maryland	Non-Coastal	Matched	10	4	8927.655678
Treatment 2	October	Maryland	Non-Coastal	Unmatched	109	40	234797
Treatment 2	October	Massachusetts	Coastal	Matched	76	37	74315
Treatment 2	October	Massachusetts	Coastal	Unmatched	376	123	1840752
Treatment 2	October	Massachusetts	Non-Coastal	Matched	12	5	19729
Treatment 2	October	Massachusetts	Non-Coastal	Unmatched	37	13	602169
FES	September/October	Florida	Coastal	Matched	92	34	725942
FES	September/October	Florida	Coastal	Unmatched	336	112	6486132
FES	September/October	Georgia	Coastal	Matched	214	85	42708
FES	September/October	Georgia	Coastal	Unmatched	226	71	262835
FES	September/October	Georgia	Non-Coastal	Matched	94	29	121331
FES	September/October	Georgia	Non-Coastal	Unmatched	158	39	3121048
FES	September/October	Maryland	Coastal	Matched	67	31	108769
FES	September/October	Maryland	Coastal	Unmatched	926	289	1810111
FES	September/October	Maryland	Non-Coastal	Matched	33	20	14731
FES	September/October	Maryland	Non-Coastal	Unmatched	276	103	228994
FES	September/October	Massachusetts	Coastal	Matched	138	58	67227
FES	September/October	Massachusetts	Coastal	Unmatched	772	280	1846442
FES	September/October	Massachusetts	Non-Coastal	Matched	27	7	23117
FES	September/October	Massachusetts	Non-Coastal	Unmatched	69	19	600180
Treatment 1	November	Florida	Coastal	Matched	89	29	604383
Treatment 1	November	Florida	Coastal	Unmatched	410	116	6607691
Treatment 1	November	Georgia	Coastal	Matched	146	57	31139
Treatment 1	November	Georgia	Coastal	Unmatched	172	42	204749
Treatment 1	November	Georgia	Non-Coastal	Matched	63	18	115953
Treatment 1	November	Georgia	Non-Coastal	Unmatched	119	32	3196081
Treatment 1	November	Maryland	Coastal	Matched	25	13	105665
Treatment 1	November	Maryland	Coastal	Unmatched	356	110	1813215
Treatment 1	November	Maryland	Non-Coastal	Matched	12	6	10713
Treatment 1	November	Maryland	Non-Coastal	Unmatched	106	43	233012
Treatment 1	November	Massachusetts	Coastal	Matched	77	37	75292
Treatment 1	November	Massachusetts	Coastal	Unmatched	375	118	1839775
Treatment 1	November	Massachusetts	Non-Coastal	Matched	9	2	15440
Treatment 1	November	Massachusetts	Non-Coastal	Unmatched	39	13	606458

"Appendix B Frame and Sample Sizes per Stratum", page 4

Survey	Month	State	Geographic stratum (coastal or non-coastal)	License Status (Matched or Unmatched)	Sample Size	Complete Surveys	Estimated Number of Housholds in the Stratum
Treatment 2	November	Florida	Coastal	Matched	90	35	604383
Treatment 2	November	Florida	Coastal	Unmatched	411	124	6607691
Treatment 2	November	Georgia	Coastal	Matched	146	54	31139
Treatment 2	November	Georgia	Coastal	Unmatched	172	45	204749
Treatment 2	November	Georgia	Non-Coastal	Matched	63	22	115953
Treatment 2	November	Georgia	Non-Coastal	Unmatched	119	25	3196081
Treatment 2	November	Maryland	Coastal	Matched	25	13	105665
Treatment 2	November	Maryland	Coastal	Unmatched	357	112	1813215
Treatment 2	November	Maryland	Non-Coastal	Matched	12	8	10713
Treatment 2	November	Maryland	Non-Coastal	Unmatched	107	38	233012
Treatment 2	November	Massachusetts	Coastal	Matched	77	33	75292
Treatment 2	November	Massachusetts	Coastal	Unmatched	375	114	1839775
Treatment 2	November	Massachusetts	Non-Coastal	Matched	9	5	15440
Treatment 2	November	Massachusetts	Non-Coastal	Unmatched	39	17	606458
Treatment 1	December	Florida	Coastal	Matched	92	30	628325
Treatment 1	December	Florida	Coastal	Unmatched	408	147	6583749
Treatment 1	December	Georgia	Coastal	Matched	120	46	33030
Treatment 1	December	Georgia	Coastal	Unmatched	198	51	202858
Treatment 1	December	Georgia	Non-Coastal	Matched	43	16	118533
Treatment 1	December	Georgia	Non-Coastal	Unmatched	139	39	3193501
Treatment 1	December	Maryland	Coastal	Matched	15	11	68610
Treatment 1	December	Maryland	Coastal	Unmatched	366	112	1850270
Treatment 1	December	Maryland	Non-Coastal	Matched	17	9	16187
Treatment 1	December	Maryland	Non-Coastal	Unmatched	101	43	227538
Treatment 1	December	Massachusetts	Coastal	Matched	84	44	84902
Treatment 1	December	Massachusetts	Coastal	Unmatched	367	143	1830165
Treatment 1	December	Massachusetts	Non-Coastal	Matched	11	8	17955
Treatment 1	December	Massachusetts	Non-Coastal	Unmatched	37	15	603943
Treatment 2	December	Florida	Coastal	Matched	92	42	628325
Treatment 2	December	Florida	Coastal	Unmatched	408	129	6583749
Treatment 2	December	Georgia	Coastal	Matched	120	45	33030
Treatment 2	December	Georgia	Coastal	Unmatched	198	70	202858
Treatment 2	December	Georgia	Non-Coastal	Matched	43	15	118533
Treatment 2	December	Georgia	Non-Coastal	Unmatched	139	39	3193501
Treatment 2	December	Maryland	Coastal	Matched	16	3	68610
Treatment 2	December	Maryland	Coastal	Unmatched	366	124	1850270
Treatment 2	December	Maryland	Non-Coastal	Matched	18	13	16187
Treatment 2	December	Maryland	Non-Coastal	Unmatched	101	36	227538
Treatment 2	December	Massachusetts	Coastal	Matched	85	45	84902
Treatment 2	December	Massachusetts	Coastal	Unmatched	368	130	1830165
Treatment 2	December	Massachusetts	Non-Coastal	Matched	11	5	17955
Treatment 2	December	Massachusetts	Non-Coastal	Unmatched	37	13	603943
FES	November/December	Florida	Coastal	Matched	157	75	694039
FES	November/December	Florida	Coastal	Unmatched	622	186	6518035
FES	November/December	Georgia	Coastal	Matched	564	215	32190
FES	November/December	Georgia	Coastal	Unmatched	970	264	203263
FES	November/December	Georgia	Non-Coastal	Matched	235	94	132273
FES	November/December	Georgia	Non-Coastal	Unmatched	644	201	3180195
FES	November/December	Maryland	Coastal	Matched	116	58	80165
FES	November/December	Maryland	Coastal	Unmatched	2196	735	1840010
FES	November/December	Maryland	Non-Coastal	Matched	36	22	12231
FES	November/December	Maryland	Non-Coastal	Unmatched	683	254	230199

"Appendix B Frame and Sample Sizes per Stratum", page 5

Survey	Month	State	Geographic stratum (coastal or non-coastal)	License Status (Matched or Unmatched)	Sample Size	Complete Surveys	Estimated Number of Housholds in the Stratum
FES	November/December	Massachusetts	Coastal	Matched	395	198	76860
FES	November/December	Massachusetts	Coastal	Unmatched	1941	712	1838207
FES	November/December	Massachusetts	Non-Coastal	Matched	25	12	17995
FES	November/December	Massachusetts	Non-Coastal	Unmatched	221	81	603903