Marine Recreational Information Program
License Survey Project

Interim Report: Design Options and Potential Sources of Error in Surveys of Recreational Fishing Effort

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Traditionally, marine recreational fishing effort data for the Atlantic Coast and the Gulf of Mexico have been collected through the Marine Recreational Fisheries Statistics Survey's (MRFSS) Coastal Household Telephone Survey (CHTS), a random digit dialing (RDD) survey of coastal county households. Recent efforts of the Marine Recreational Information Program (MRIP) have focused on developing more efficient and accurate approaches for collecting recreational fishing effort data. The following sections provide general overviews of different approaches for estimating recreational fishing effort, describe general sources of survey error, as well as potential sources of error specific to recreational fishing surveys, and describe benefits and limitations of methodologies that are, or could be used to collect fishing effort data and subsequently estimate recreational fishing effort. The document concludes with general descriptions of experiments and pilot studies that could be conducted to further advance the development of more accurate fishing surveys considering both errors of representation and measurement.

1. Survey Designs

CHTS+APAIS Approach

The traditional approach that has been used for several years to estimate recreational fishing effort uses the CHTS, a random digit dialing (RDD) survey of coastal county households to collect information about fishing activities that occurred during a two month recall period (wave). Since the CHTS does not survey anglers that live out-of-state or beyond coastal county boundaries, the CHTS is supplemented by adjusting the estimates using expansion factors derived from the MRFSS Access Point Angler Intercept Survey (APAIS). The CHTS is currently being conducted in all coastal states with the exception of TX and AK.

ALDS+APAIS Approach

An alternative telephone survey approach is to replace the RDD sample with sample selected from lists of known or likely saltwater anglers, such as databases of saltwater

license holders. These angler license directory surveys (ALDS), are generally more efficient than the CHTS because a larger portion of the sample is likely to have participated in fishing during the wave. As a result of undercoverage of anglers due to licensing exemptions, the APAIS is used to derive expansion factors to generate total effort estimates. ALDS are currently being conducted in NC, LA, WA, and CA.

CHTS/ALDS Dual Frame Approach

Largely due to the coverage problems inherent in the RDD and the ALDS approaches, a third approach is to select independent probability samples from ALDS and CHTS frames. The union of the CHTS and ALDS defines three subpopulations or domains: 1) anglers covered by the CHTS, but not the ALDS; 2) anglers covered by the ALDS but not the CHTS; and, 3) anglers covered by both frames. A fourth subpopulation of interest is anglers who are not covered by either the ALDS or CHTS. It is also possible to supplement the estimates from this survey with expansion factors derived from APAIS. The CHTS/ALDS dual frame approach is currently being conducted in NC, LA and WA.

ABS/ALDS Dual Frame Approach

A variation of the CHTS/ALDS dual-frame approach is to replace the RDD survey with a sample selected from an address-based sampling (ABS) frame. While no survey is without errors, the ABS frame should cover a much larger proportion of eligible anglers, as it includes all residential addresses serviced by the U.S. Postal Service. Interviews resulting from an ABS sample of addresses could be conducted by contacting the household by mail and either doing a mail questionnaire or inviting respondents to complete an online questionnaire. In addition, telephone interviews could be used for those addresses that can be matched to a telephone number. The ABS/ALDS dual frame approach will be pilot tested in NC during wave 6, 2009.

ABS-only Approach

Since the ABS has greater coverage than either the CHTS or the ALDS, this method uses a sample selected from the ABS but without supplementation by the angler registry or any adjustment factor from the APAIS. As before, the ABS sample could be conducted using a variety of modes, but mail is an essential component of any ABS design.

2. Survey Errors

The total error in a survey estimate is sometimes classified as resulting from errors in representativeness and errors in measurement. Representation errors result from differences between the units in the population we intend to make inference about and the units that are available from the survey. Roughly speaking, the representation component is related to the survey respondents not reflecting the population, even after appropriate estimation methods have been applied. Measurement errors are those that are due to imperfections in the way we conceptualize and implement the data collection process for the surveyed units. These errors are related to what and how we obtain the information from the respondents.

The three main types of representation errors are coverage errors (we sample from a population that differs from the inference population), sampling error (we survey only a sample of the units of the covered population rather than conducting a census), and nonresponse error (we obtain responses from a subset of the sampled units and incomplete data are collected for at least some of the respondents). Of these, sampling error is the best studied and most easily addressed since the sampling is under the control of the sampler. Probability sampling designs and estimation strategies enable us to control and measure sampling error. Coverage error and nonresponse error are more difficult to quantify and control, and almost all methods for dealing with these errors require some modeling assumptions.

While there are many potential sources of error in measurement, we typically refer to construct validity, measurement error, and processing error. Construct validity refers to

the error due to the inability of the survey to specify the information needed by the survey sponsor in a survey. Measurement error is the error or set of errors due to the way the data are collected in the survey, and includes a variety of sources such as the interviewer, the questionnaire, the respondent, and the interactions among these survey actors. Processing error is related to the handling of the collected data, both simple responses that may be edited or coded, to more complex data, such as physical samples that may be analyzed in laboratories and summarized in the data record.

Of all the representation and measurement errors, only sampling error is easily quantified. These errors are not independent of each other in most circumstances, making examinations of each individual error less than desirable. For example, choosing to reduce coverage error by using a frame that covers a large proportion of the population might result in higher nonresponse if the more complete frame has less information used to contact and interview the sampled units.

Despite the interactions, we have little choice but to consider the errors separately given the current state of knowledge.

3. Measurement Errors

The current designs of the CHTS and ALDS involve an interviewer-administered, telephone survey, during which one respondent (typically) reports on the fishing activities for him- or herself as well as all other anglers in the household. The respondent is queried about characteristics of anglers in the household, number of days in the past two months that anglers fished, and then details about the trips for each of the days on which the angler fished.

With the exception of some discussion of the use of panel surveys (to improve efficiency) and the internet as a mode of data capture, the NRC report on Recreational Fisheries Survey Methods did not address measurement error issues.

Previous research on measurement error suggests the following factors may impact the quality of the data in the CHTS and the ALDS:

- The pace of telephone data collection tends to result in shorter responses (to open ended questions) and less likelihood of accessing records to assist in the recall of information.

- The use of proxy reporters, while often cost-efficient, frequently comes at the cost of an increase in measurement error, most notably errors of omission (that is, failure to report the occurrence of an event). The quality of proxy reporting is directly related to the relationship between the respondent and the target person as well as whether or not the event of interest was a shared behavioral event. For example, a respondent may not know about a spouse's fishing trips, making it impossible to report about those trips.

- The longer the length of the recall period (that is, the time between the behavioral event and the date of the interview), the greater the likelihood that the event will not be reported. This has been well documented across the reporting of many different types of behaviors (e.g., purchases, unemployment spells, health care utilization) and often follows a pattern of exponential decay –that is, higher levels of reporting for events close in proximity to the date of the interview, with sharp fall off as the recall period increases.

- The use of interviewers for the collection of these data may introduce interviewer error (interviewer variance) or may reduce error (e.g., interviewer ability to probe on incomplete responses).

4. Representation Errors

We begin by reviewing the components of the designs with respect to the representation errors associated with each. The components are the CHTS, the ALDS, the ABS, and the APAIS.

CHTS

The CHTS is probably the most well understood of all the component surveys. The CHTS is a survey of households in the coastal region, regardless of whether or not residents are licensed. The coverage of the CHTS is limited in that it excludes households and anglers living in those households if they, 1) cannot be contacted by telephone (those with no telephone, those with only a cell phone in the household, and those with telephone numbers that are not in the 1+bank of telephone numbers traditionally used for RDD sampling), or 2) do not live in a coastal county (either in a non-coastal county within state or out-of-state).

The National Health Interview Survey (NHIS), which collects data on the telephone status of households in the U.S., estimates that 1.7% of adults are in households with no telephone service, and 18.4% are in households with only a cell phone (Blumberg and Luke 2009). The percentage of adults in households with a telephone but not covered in the traditional 1+bank frames typically used in RDD surveys is less well-known, but recent studies suggest the percentage might range from 5% to 20%. As a result, the CHTS RDD sample omits between 25-40% of adults within the survey area (coastal counties). Coverage of RDD surveys in general is likely to continue to decrease as cell phone penetration expands.

The coverage loss due to excluding non-coastal and out-of-state anglers varies considerably by state and wave. The coastal counties cover almost all of some states like Florida, while in other states like North Carolina only about 20% of the counties are included. In addition, fishing by out-of-state anglers is likely to vary greatly by state. It is likely that the exclusion of non-coastal and out-of-state anglers results in omitting between 10-30 percent of the eligible households/anglers. Notice that the telephone

coverage and the geographic coverage rates refer more to households than to anglers, who are the target population. This results in some distortions because the two are not equal; for example, non-coastal residents may be much less frequent saltwater anglers than coastal residents. Another way of examining CHTS coverage that addresses this issue, but has its own set of problems, is by comparing CHTS to the APAIS. We defer that approach until later.

A second source of representation error is due to nonresponse. Here we only consider unit nonresponse. The CHTS, like most RDD surveys, has encountered serious challenges in trying to achieve high response rates in recent years. The CHTS has two advantages compared to many other RDD surveys, at least with respect to response rates; 1) a large proportion of households are not eligible (if no angler is in the household then the interview is completed quickly and easily), and 2) any adult can respond (surveys that sample a random adult must complete the additional step of getting the sampled adult to the phone to complete the interview). Despite these advantages, the response rates to the CHTS are approximately 20%.

Thus, the CHTS begins with a coverage rate of approximately 60% and obtains responses from only about 20% of the covered population. Bias due to incomplete coverage and response is not simply the coverage or response rate, since the amount of bias depends on the difference between the characteristics of the covered/responding population and the not covered/not responding population. Furthermore, we cannot combine the coverage and response rates in examining bias because the differences in the mechanisms for the missing data may result in variable biases. For example, in estimating a mean, the bias of a simple expansion estimator or unadjusted estimator is a product of the missing rate and the difference in the characteristics of the missed and the captured units. The differences in characteristics by the source (coverage and response) may be very different.

The third source of representation error is due to sampling error. Sampling error is directly quantifiable from a probability sample such as the CHTS and does not result in

bias. Estimates vary around the population value, with more variation in samples with greater sampling error.

CHTS sampling errors are larger than might be first expected because the eligibility rate is so low. Roughly 10% of the households that complete the screening interview have an angler and are thus eligible to complete the interview. As a result, for estimating characteristics of anglers such as the number of trips, the sample size is only 10% of the households that respond. Furthermore, it appears from the CHTS data that the intraclass correlation (similarity in characteristics of the persons within the household) is very close to unity, so that sampling more than one person from within a household does not decrease the sampling error of the estimates. Later, we discuss whether this very high intraclass correlation is a genuine reflection of the population or an artifact of the CHTS collection procedure.

ALDS

Like the CHTS, the ALDS has potentially severe coverage limitations. The license frames cover all licensed anglers, regardless of where they live, but exclude; 1) anglers who fish but do not have a license (those who fish without obtaining a license or have an expired license, and those who are exempt from license requirements for one of a variety of reasons), and 2) anglers who do have a license but the list or frame information is either incorrect or insufficient for contacting the person (we have chosen to include the insufficient data persons as a coverage problem although they could be considered nonrespondents).

The coverage rate of the ALDS is not as well-understood as the CHTS coverage rate, but recent efforts have reduced the losses in coverage due to insufficient contact information, and it appears that a coverage rate of about 60% or even higher is feasible in some states. The coverage loss due to license exemptions and/or illegal fishing activity is more variable by state but might be as high as 70% in some states and fishing modes. It is

likely that coverage of ALDS sample frames will continue to improve as the National Saltwater Angler Registry is implemented.

The final wave in which the ALDS was conducted in AL, FL and MS, resulted in overall response rates approaching 25%, and in NC and LA the rates have exceeded 30% in 2009. This is somewhat less than might be expected since the population being surveyed is one for whom fishing should be salient. A large portion of the nonresponse appears to be the result of an inability to contact the sampled individuals by telephone (telephone numbers ring busy, answering machines, no answer, etc.).

The sampling error in the ALDS is more directly related to the sample size, or more precisely, the size of the respondents to the sample. The proportion of the respondents who are eligible in the ALDS is much higher than in the CHTS. The eligibility rate for the ALDS runs between 25% and 80% (some respondents are ineligible because they may not have fished during the period even though they have a license).

ABS

The ABS is a survey selected from a list of addresses extracted from US Postal Service delivery sequence files (DSF). The ABS frame is not 100% complete; quality and coverage of the frame varies from vendor to vendor, as well as geographically. In particular, frames may not cover all households due to; 1) some households may not be on the ABS frame although this seems to be a relatively small proportion nationally (it may be a larger proportion in rural areas that are more likely to be eligible for angler surveys), and 2) the information in the frame may not be very useful for conducting telephone surveys (e.g., no telephone numbers are directly associated with the DSF although some vendors do link the address to phone numbers which an average matching rate of about 60%). The overall coverage rate of the ABS frame is expected to be over 90% in most states, although coverage in some rural areas may be as low as 75%.

Response rates of the ABS frames have not yet been examined in the context of recreational fishing surveys. Matching to telephone numbers will decrease coverage, so initial efforts to develop a fishing survey that utilizes ABS frames are focusing on mail as the data collection mode. Telephone nonresponse follow-up surveys might be used to enhance response. The response rates will be the product of a first phase – identifying anglers (eligible or likely to be eligible for the survey) – and a second phase – the mailing to obtain more detailed trip-level information from eligible anglers. A pilot test of the methodology, which will be conducted in NC during wave 6, 2009, will enable us to estimate the response rate. The pilot test will also allow us to measure how quickly we can collect fishing information using a mail survey. Traditionally, high response rates in mail surveys require multiple attempts over time. This may result in longer fielding periods than are typical for the CHTS.

The sampling error for estimating the number of eligible anglers is a function of the first phase mailing, while estimating characteristics of anglers is directly related to the sample size at the second phase (which is determined by the size of the first phase sample assuming no subsampling). The initial testing of the procedure will help determine how large a sample and whether design features such as stratification by geography are useful.

APAIS

The APAIS is an angler intercept survey that collects information about residency (state and county) and the possession of a saltwater fishing license for the state of intercept. The APAIS is not a true probability sample in the sense that all the units in the frame have a known, positive probability of selection used in the estimation phase (Kalton, 1983). In addition, the APAIS sample frame is incomplete due to the exclusion of privately-owned (private access) fishing sites and limited sampling during non-daylight hours.

Efforts are currently underway to examine the coverage of APAIS sample frames, but currently there are no reliable estimates of these rates. It is also worthwhile to note that intercept surveys are generally difficult to manage from an operational perspective,

resulting in nonsampling errors that may affect estimates. In terms of coverage, intercept interviewers often have the latitude to determine who to sample and when to sample. This transfer of control may result in errors that are closely related to coverage error.

Response rates of the APAIS are also not easily defined or estimated since the sampling unit is more under control of the interviewer than in other surveys. If the interviewer decides to not approach an angler, it may in part be because there are some cues that the angler would not be likely to respond to the survey. This distorts the idea of a response rate as a proportion of the sampled population that participated in the survey.

The sampling error for estimating the number of eligible anglers for the APAIS is not computed the same way as it is for the other effort surveys. Since the data are not from a true probability sample, the model used for estimating the sampling error is not under the control of the sampler and could be inappropriate for the inference stage. We have not studied any efforts currently undertaken to compute sampling errors for the APAIS samples.

The APAIS can be used to estimate the coverage of the telephone survey frames, although the concerns raised about the APAIS suggest that these coverage estimates may be of questionable accuracy. The coverage ratios are actually percentage estimates from the APAIS of anglers that are excluded under either the CHTS or ALDS. For example, the percentage of intercepted anglers that do not live in coastal counties and are not in landline telephone households are included as part of the CHTS undercoverage. The inverse of this percentage is the adjustment factor used in correcting for undercoverage in the CHTS and ALDS.

Figure 1 provides the coverage of the CHTS and ALDS by state and fishing mode for 2008. Coverage of the ALDS varies considerably by state and fishing mode, ranging from less than 30% for shore fishing in FL to approximately 80% for private boat fishing in NC and MS. ALDS coverage is greater for private boat fishing than for shore fishing in all instances.

Coverage of the CHTS also varies by state and fishing mode. Coverage ranged from less than 35% for shore fishing in NC to greater than 75% for private boat fishing in West FL and LA. As with the ALDS, the CHTS provides more complete coverage of private boat fishing than shore fishing.

5. Synthesizing Survey Errors

Based on the information available, we attempt to provide some general thoughts on the five designs mentioned earlier. We begin with the CHTS+APAIS and ALDS+APAIS approaches since they are very similar.

The *CHTS+APAIS approach* attempts to reduce the bias associated with estimated undercoverage rates of 30-50% in CHTS sample frames. The approach is to apply APAIS expansion factors (the inverse of the coverage proportions mentioned above) to CHTS effort estimates. CHTS estimates are adjusted to account for nonresponse (average nonresponse of 80%) by adjusting sample weights and assuming that non-respondents have similar fishing behaviors as respondents.

The *ALDS+ APAIS approach* uses the same methodology to account for undercoverage as the CHTS+APAIS; telephone survey effort estimates are expanded by APAIS expansion factors. The only difference is that the expansion factors are computed relative to the ALDS exclusions rather than the CHTS exclusions (i.e. intercepted anglers are asked if they have a saltwater fishing license). As with the CHTS, adjustments to the ALDS for nonresponse (70 to 80 % nonresponse rates) are made by reweighting sample data.

Because the questionnaires and data collection procedures for the ALDS and CHTS are essentially identical, both methods are equally susceptible to the sources of measurement error described above (Section 3, Measurement Error). The expansion factors derived from the APAIS also introduce the potential for measurement error. The expansion for

the CHTS is relatively straight-forward, as anglers are likely to know their state and county of residency with a high degree of confidence, and there is presumably little motivation to report this information inaccurately, although this has not been tested. The expansion for the ALDS is potentially more troublesome as possession of a fishing license may be socially desirable, which could result in overestimates of ALDS coverage (and underestimates of ALDS correction factors). In addition, the sample frame for the ALDS is compiled approximately one month prior to completion of the reference wave, creating the need to determine when APAIS respondents purchased their fishing licenses. Failure to recall when a license was purchased (month and year) introduces an additional source of measurement error.

It is virtually impossible to quantify the magnitude of the errors from these two approaches in a statistically defensible manner because of the reliance of the large adjustment factors that are applied from the APAIS. Even if the APAIS were a probability sample, there would be legitimate concerns about applying adjustment factors developed from a survey with its own set of serious coverage and measurement problems. Furthermore, the nonresponse adjustment factors used in estimating the CHTS and ALDS may also add to the errors in the estimates from these approaches. As noted in the NRC report, substantial biases are possible from these approaches.

The next two strategies are dual frame approaches using the ALDS as one frame, and either the CHTS or the ABS as the second frame. The general ideas are the same for these two approaches, but there are important differences that require separate discussion.

The *CHTS/ALDS dual frame approach* is used to both reduce undercoverage and to improve the efficiency of sampling (the ALDS is more efficient in terms of targeting eligible anglers as noted earlier). Based upon information collected during the APAIS, the dual-frame methodology provides a better coverage rate than either the CHTS or ALDS alone (Figure 1). Dual-frame coverage rates range from 65% to nearly 100%. As with the CHTS and ALDS, the dual-frame methodology provides more complete coverage of private boat fishing than shore fishing.

A key issue in any dual frame survey is that members of the overlapping population (those covered by both the CHTS and the ALDS) have two chances of being sampled and must be weighted appropriately to avoid selection/estimation biases. Some components of the overlap are relatively straight-forward to determine during data collection (for example, county of residence), while others may be complex (for example, telephone status/license status).

While the CHTS/ALDS dual frame approach results in substantial improvements in coverage rates, determining the overlap between the two sample frames is likely to add some error to the estimation design. Current procedures rely on survey responses to questions about possession of a fishing license to identify overlapping frame units (questions designed to determine the overlap are similar to the APAIS questions used to expand ALDS estimates). Respondents' willingness and/or ability to answer these questions accurately cannot currently be assessed. The representational issues associated with nonresponse are also complicated by having two different frames that may result in differential nonresponse patterns and nonresponse bias.

The *ABS/ALDS dual frame approach* is used primarily to improve the efficiency of sampling, since the ABS is relatively complete. In this regard, the ALDS is especially important for surveying domains that are not very common since only a small proportion (likely less than 10%) of the ABS general population may be eligible for the survey.

Problems associated with determining the overlap in frame membership are expected to be reduced in this approach relative to the CHTS/ALDS method. Membership in the overlapping population is determined by whether or not ABS sample addresses are on ALDS sample frames. While this is not something that will be simple to deal with, it greatly relieves the problems associated with collecting the vast majority of data on overlap membership in the survey itself, provided that address information included in ALDS sample frames is relatively complete and accurate.

We expect that the primary representational issue with this approach will be associated with nonresponse. Some of the obvious nonresponse problems can be handled by careful choice of data collection mechanisms (for example, treating both frames as much alike as possible). The magnitude of potential representational errors should be more evident after an initial test of the ABS/ALDS dual frame methodology, which will be conducted in NC during wave 6, 2009. Careful examination of the response patterns and the effect of the frame on the responses will be an important diagnostic.

The *ABS-only approach* should be considered only if the ABS/ALDS dual frame strategy proves to be more complex than expected. The ABS has nearly complete coverage, and it avoids the complications of determining overlap membership in a dual frame setting. However, the ABS is not very efficient, especially for surveying rare domains, such as fishing populations. Thus, the sampling error for the ABS-only approach would be much greater than for the ABS/ALDS dual frame approach if other errors in the two approaches are approximately equal.

The primary representational issue in the ABS-only approach will be due to nonresponse. The ABS-only approach has the advantage that the frame will not be a direct source of nonresponse as is possible in the ABS/ALDS dual frame approach. However, as discussed above, we believe this type of error can be handled if care is taken in the design of the data collection protocols. The ABS sample in the test will help answer some of the questions about nonresponse error. We currently believe that the ABS is an alternative design that could be considered if the dual frame ABS/ALDS is more problematic than we currently assume, or if the ALDS frame in some states does not exist or is of very poor quality.

6. Conclusions and Follow-up Studies

Current efforts to sample recreational anglers from RDD frames (CHTS) or lists of licensed anglers (ALDS) are susceptible to potentially large errors of representation. Coverage loss due to the geographic limitations of sample frames (e.g. the CHTS is

limited to coastal counties), the increasing incidence of cell-phone only households, exemptions to licensing requirements, and incomplete or inaccurate contact information may be as high as 70% in some cases. In addition, response rates for these surveys have generally failed to exceed 30% in recent waves. Efforts to compensate for representational errors by APAIS expansion of telephone survey estimates introduce the potential for additional sources of error. As a result, we are not confident that the errors associated with either of these approaches can be controlled satisfactorily in a program of continuous monitoring.

Dual frame methodologies offer promise as an alternative to traditional methodologies for estimating recreational fishing effort. The CHTS/ALDS dual frame approach provides substantial improvements in coverage rates over either the CHTS or the ALDS and is likely an improvement over the CHTS/ALDS + APAIS designs. However, considerable testing is required to more fully understand both the representational and measurement errors associated with this approach. Specifically, experimentation is needed to assess anglers' ability to associate with the appropriate sample frame, and errors associated with nonresponse must be evaluated.

A second type of dual frame approach would integrate angler lists with addressed-based samples generated from a comprehensive directory of addresses serviced by the U.S. Postal Service. This methodology is likely to have the highest coverage rate of any of the methodologies, as the ABS frame is expected to be greater than 90% complete, and address is a required data element in most state saltwater licensing programs (for example, NC requires that anglers provide a driver's license when purchasing a fishing license). In addition, the overlap between sample frames can be determined by matching addresses rather than relying upon survey responses, effectively eliminating a potential source of measurement error. We believe this dual frame approach has the potential to deal with many representational issues in a ways that are defensible. As discussed, this approach will be pilot tested in NC during wave 6, 2009. The pilot study will help quantify response rates that can be achieved using a mail survey to collect fishing effort, determine sample sizes needed to estimate fishing participation and effort, verify the

timeliness with which data can be collected and processed, and evaluate how effectively overlapping sample frame units can be identified through address matching. If the dual frame mail survey proves to be successful, the methodology may also help quantify biases resulting from representational and measurement errors in existing data collection approaches.

Finalizing the design for an accurate and efficient survey of fishing effort will require additional experimentation and testing. The direction of future pilot studies will largely be determined by the results of the study to test the dual frame mail survey. Follow-up studies should consider the following:

- Methods for improving response rates,
- Nonresponse follow-up studies to improve response rates and quantify nonresponse error,
- Assessment of alternate survey reference periods (for example, 1-month waves),
- Assessment of question wording and question order,
- Assessment of alternate reporting modes (e.g. web),
- Effects of measurement errors on dual-frame estimates.

It is very conceivable that the project team will develop and implement one or more pilot studies to address these issues within the coming year.

			CHTS Coverage	ALDS Coverage	Dual-Frame Coverage
			Sum	Sum	Sum
Subregion	State	Mode			
South Atlantic	EFL	Shore	0.5236	0.2559	0.6668
		Private Boat	0.6589	0.7038	0.9619
	NC	Shore	0.3212	0.4911	0.7157
		Private Boat	0.6092	0.7800	0.9084
Gulf of Mexico	AL	Shore	0.4357	0.5472	0.8209
		Private Boat	0.6680	0.6938	0.9504
	WFL	Shore	0.5683	0.2541	0.7178
		Private Boat	0.7535	0.7177	0.9927
	LA	Shore	0.5744	0.5723	0.8707
		Private Boat	0.7738	0.7480	0.9719
	MS	Shore	0.5753	0.6923	0.9389
		Private Boat	0.6703	0.8030	0.9649

Figure 1. Coverage of CHTS, ALDS, and Dual-Frame Sample Frames. Coverage is estimated as the proportion of anglers interviewed in the MRFSS APAIS who indicated that they reside in a coastal county (CHTS), possess a saltwater fishing license (ALDS), or live in a coastal county OR possess a saltwater fishing license (dual-frame).