Marine Recreational Information Program, Research and Evaluation Team Review of the iAngler and iSnapper Reporting Programs

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The Marine Recreational Information Program (MRIP) has supported research to evaluate the utility and feasibility of smartphone applications (apps) for collecting recreational fishing data that could be used to estimate fishery parameters such as catch rates and catch composition, leading to estimates of species-specific fishery removals. This research has resulted in certified designs for monitoring red snapper landings in Alabama (Snapper Check) and Mississippi (Tails n' Scales), both of which mandate reporting for red snapper anglers - each data collection is intended to be a census of red snapper fishing activity, with legal consequences for failing to report. Snapper Check and Tails n' Scales utilize capture-recapture designs that have been certified as statistically valid by MRIP[1]. These two surveys utilize electronic reporting (ER) via smartphone app as the primary mode of data collection, enhancing the timeliness of the self-reported information.

The MRIP Research and Evaluation Team (RET) was tasked with evaluating results from two MRIP-supported projects, iAngler and iSnapper, that tested voluntary (non-mandatory) data collection via smartphone apps. Below, we provide brief overviews of the designs and intended use of the data collected, describe project results, identify the strengths and limitations of each design, and provide recommendations for future research efforts.

To support its evaluation, MRIP commissioned a review of ER options for recreational fishing surveys by Westat, Inc., a prominent survey research firm in Rockville, MD. The review report, "Electronic Reporting in Survey Research Applied to Estimating Fishing Effort," was authored by Dr. J. Michael Brick, an internationally recognized expert on survey methods who has served on survey review panels of the National Academies of Sciences and the American Statistical Association's Advisory Committee for the U.S. Census Bureau. The report addresses recommendations from two independent reviews of the recreational data collection programs of the National Marine Fisheries Service (NMFS): the Marine Recreational Fisheries Statistical Survey (MRFSS) review by the National Research Council (NRC 2006), and the review by the National Academies of Sciences (NAS 2017) of the subsequent improvements developed under the MRIP program. The NRC review of the Coastal Household Telephone Survey (CHTS, effort estimating component of MRFSS) recommended replacement of the survey that was being negatively impacted by the advent and popularity of cell phones, and the decrease in telephone survey response rates. The NAS review acknowledged the valid design elements of the CHTS-replacement mail survey, the Fishing Effort Survey (FES),

[1] MRIP certification materials, including descriptions of data collection designs, results from methodological testing and peer review documents can be accessed via https://www.fisheries.noaa.gov/national/recreational-fishing-data/survey-certification-marine-recreational-information-program.

and its superior response rates. But the NAS also recommended that electronic data collection should be further evaluated as an option for the Fishing Effort Survey, including smartphone apps, electronic diaries for prospective data collection, and a web option for all or just panel members." Although the Westat review focuses on the use of surveys and apps to estimate recreational fishing effort, the principles can be applied to the evaluation of any ER app, the data collected, and the intended use of those data.

Westat Review of Electronic Reporting

The Westat review focuses on the underlying data collection designs that either can or do include ER and clearly differentiates between probability and non-probability samples. Recently, there has been a growing interest in non-probability designs, specifically opt-in, volunteer sampling approaches, because the utilization of technology - websites or smartphone apps - has the potential to collect large, timely samples at minimal cost. However, the sampling theory for non-probability designs is poorly developed, and there are no standardized approaches for either sampling or estimation. Consequently, sampling and estimation designs for non-probability samples often lack the strict objectivity required for official government statistics - in the absence of standards for example, models and model assumptions can be adjusted to achieve a politically desirable outcome. Additionally, the methods used to recruit respondents are highly variable, and the diversity of participants can be extremely dynamic from one survey administration to the next. For example, expanding an outreach campaign to increase participation in an opt-in data collection will likely change the composition of the sample, resulting in inconsistent results. Finally, opt-in designs are susceptible to selection bias - a tendency for individuals to participate because they are interested in the survey topic. In short, non-probability samples have the potential to be highly biased often with no way to measure or correct the bias. With respect to fishing surveys, Westat concluded that non-probability samples in general, and samples derived from angler apps specifically, are susceptible to extreme selection bias - an over-representation of avid or more successful anglers in the sample - and are not well suited for monitoring recreational fishing activity. Population estimates derived from such samples are likely to severely overestimate the specific fishing activity of these opt-in or self-selected anglers, and it is unlikely that this bias can be resolved through statistical modeling approaches.

In contrast to non-probability designs, probability sampling approaches are based upon an accepted theoretical framework that has provided the foundation for official government statistics for decades. The acceptance and proliferation of probability-based designs is largely the result of objective sampling and estimation procedures - opportunities to influence results or purposefully introduce bias are minimal.

Considering the challenges associated with non-probability designs, the Westat review recommended that MRIP consider alternatives to non-probability sampling and noted that electronic technologies could easily be incorporated into more reliable probability-based survey designs including the current MRIP surveys used to estimate recreational catch and effort. The general conclusions from the Westat review are consistent with previous evaluations of non-probability sampling approaches conducted by the American Association for Public Opinion Research (Baker et al. 2010, Baker et al. 2013).

iAngler

iAngler is a smartphone app developed by the Snook and Gamefish Foundation (now known as the Angler Action Foundation) in 2012. Use of the app by anglers is focused in southeast Florida for reporting landings of inshore species such as common snook and red drum. iAngler is not a component of a formal, probability-based sampling program, and the program does not attempt to validate self-reported information. Rather, iAngler relies upon volunteer panels of anglers - a type of convenience sampling - who self-select or opt into the program by downloading the app and reporting catch information. Such data collections are broadly categorized as citizen science and include activities such as bird watching, water quality monitoring, identifying new planets, and reporting weather observations.

iAngler data were evaluated by a partnership between the University of Florida and the Florida Fish and Wildlife Conservation Commission for the period of 2012-2016 (Ahrens 2017). The goals of the project were to evaluate the utility of iAngler data for use in stock assessments and to develop a method to correct for bias in iAngler data.

During 2012-2013, 402 iAngler users reported a total of 3,573 saltwater fishing trips. The majority (>60%) of app users reported only a single trip during this period - most of the trips were reported by a small group of anglers - and the app experienced a 10% annual retention rate[2]. Consequently, participation was categorized as “highly variable and rapidly rotating,” and the authors conclude that, “to be useful on a larger scale, the app would have to be expanded in its scope and usage.” The authors further note that, “maintenance of what would likely need to be a large pool of users over a broad geographic range would likely require an expansive advertising campaign and incentives.”

In terms of collecting valid data, the report states that iAngler catch rates, for a small number of species within a limited geographic region, were comparable to unweighted

[2] Participation data for 2014-2016 are not presented.

MRIP catch rates. The report attributes these similarities to the ability, "of an electronic, self-reporting program to provide representative catch rate data." Survey estimates are often compared to external benchmarks to evaluate representativeness (Baker et al. 2013). However, unweighted MRIP catch data are not intended to be representative. It is the application of sample weights that ensures MRIP catch data are representative of the overall population of recreational fishing trips. Further, external factors, such as restrictive fishing regulations (e.g., one fish per trip), may limit the variability of catch rates for given species and reduce the ability to detect differences among different data collection programs. Consequently, the existing comparisons do not provide a useful measure of representativeness or bias. Furthermore, because iAngler lacks a formal sample selection process, comparisons between individual estimates are not generalizable to the data collection design as a whole. In other words, the validity of a sample cannot be determined based upon comparisons with previous samples. As noted, this is especially problematic for non-probability data collections with low participation and high turnover rates, where the composition of the sample is likely to be highly variable between data collection events. Determining the validity of iAngler data would require continuous evaluation.

In the absence of a valid sampling design, including a robust reporting validation component, data collected through fishing apps, such as iAngler, have little value for estimating population statistics, even for those measures that are not currently collected through ongoing surveys. The properties of samples and statistics derived from such designs are unknown, and estimates for any population measure are likely to be biased.

iSnapper

iSnapper is a smartphone app developed to provide more timely and robust information on red snapper landings in the Gulf of Mexico. The app was released to the for-hire sector for reporting red snapper landings in 2011, and expanded to include Texas private recreational anglers in 2015. While iSnapper was initially developed for reporting red snapper landings, the application allows anglers to report landings for all species. In addition to landings data, the application collects information about discarded catch, fishing depth, fishing location, and socioeconomic information.

Initially, iSnapper was envisioned as a stand-alone, voluntary data collection program, similar to iAngler. However, the concurrent development of capture-recapture designs in Mississippi and Alabama, which includes mandatory reporting of red snapper landings, provided an opportunity to integrate voluntary iSnapper reporting with a probability-based dockside sampling program. A key component of the study was the validation of iSnapper data, with creel sampling conducted to verify the accuracy of

reported information, measure the extent of iSnapper reporting (i.e. reporting rates) and collect information about trips that were not reported. Theoretically, this capture-recapture method - voluntary reporting combined with a probability-based dockside sampling program - is an unbiased data collection design. However, certain critical assumptions, that have yet to be tested, must be satisfied to ensure that practical design constraints do not introduce bias.

iSnapper was tested in Texas as the reporting mechanism for a capture-recapture design from 2015-2017[3] (Liu et al. 2017, Stunz et al. 2018). The app was introduced to private recreational anglers through, "an extensive outreach and advertising campaign employing TV, radio, print and social media." The dockside sampling component was based upon an ongoing creel survey administered by Texas Parks and Wildlife Department (TPWD), supplemented with convenience intercept samples targeting red snapper trips. The project report did not include a description of the TPWD creel survey design, so the RET assumed that the creel survey represents unbiased sampling of angler trips covered by the creel survey frame.

Because MRIP and others have established that the general capture-recapture design, if implemented properly, is unbiased, the RET focused on unique attributes of iSnapper and the administration of the capture-recapture design in Texas. As noted, iSnapper reporting is not mandatory. Predictably, iSnapper reporting rates are considerably lower than those observed in Mississippi and Alabama; red snapper reporting rates decreased from 4.1% in 2015 to 3.5% in 2016 and 2.5% in 2017, in spite of the outreach campaign. Reporting rates in Mississippi and Alabama are approximately 80% and 30%, respectively. Low reporting rates will not necessarily result in biased estimates. However, reporting rates are directly related to the precision of survey estimates. iSnapper testing resulted in estimates with coefficients of variation ranging from 0.35-0.57. Precision would improve with either higher reporting rates or larger sample sizes in the validation component of the capture-recapture design. Mandating reporting for recreational anglers would likely improve reporting rates, and the investigators who evaluated iSnapper suggested that mandatory reporting is a logical next step. However, this would substantially increase costs as compliance monitoring and enforcement are expensive.

More troubling than the reporting rates is the observation that "…anglers are submitting their trips after being creeled." A critical assumption of the capture-recapture design is that reporting and validation are independent – if validated anglers are more or less likely to report, then estimates will be biased. Specifically, if anglers are more likely to

[3] The design has continued beyond 2017, but the MRIP project report and subsequent RET review are limited to 2015-2017.

report when interviewed by a sampler, then estimated reporting rates are biased upwards and effort and catch estimates are biased downwards. If anglers are less likely to report when interviewed, then the direction of the biases is reversed. It is very likely that the independence assumption was violated as intercepted anglers "…were informed about iSnapper, the value of using it, and were highly encouraged to download and use it…" Estimates derived from the capture-recapture design cannot be considered unbiased unless independence between reporting and validation is ensured. Consequently, the reported iSnapper estimates, as well as subsequent estimate comparisons and conclusions, are not valid.

Conclusions and Recommendations

Generally, ER is a reporting mode, not a data collection design. Attributes of a reporting technology (e.g. mobile phone app, website) may improve the timeliness or accuracy of reported information, but in and of itself, the technology does not constitute a valid or complete design. For example, pictures captured by a mobile phone may improve the accuracy of species identification, but the application is simply a reporting mode used to convey information about a fishing trip. Regardless of the reporting mechanism, any reporting program must be based upon a valid data collection design that considers the goals of the program, use of the data (descriptive or production of population estimates), primary and secondary data elements, target population, the potential respondent universe (sample frame), response rates (reporting compliance for mandatory programs), reporting accuracy, suitability of the estimation design, and the precision of survey estimates.

The perceived benefits of ER are 1) more accurate data, 2) more timely data, and 3) a general desire of anglers to report on their fishing activity using electronic technologies. The results from the iAngler and iSnapper projects suggest that the third point - a desire by anglers to report - is, at best, overstated if not entirely inaccurate. Participation in both programs was extremely low, despite extensive outreach and communications efforts. Others have also identified lack of participation and retention of anglers as significant challenges to voluntary fishing app data collection (Papenfuss et al. 2015, Venturelli et al. 2017). The utility of angler apps should remain limited to qualitative, citizen science applications, so long as anglers are generally unwilling to adopt or sustainably use the apps.

The RET acknowledges that smartphone apps can collect timely recreational fishing data, including data elements not currently collected through ongoing catch and effort surveys such as specific fishing locations, depth fished, discard disposition, release method, and socioeconomic data. In this respect, both iAngler and iSnapper are viable

data collection modes - platforms for reporting recreational fishing information. However, in the absence of a probability-based dockside component to validate reported information, monitor the relative extent of reporting, and characterize unreported trips, data collected via opt-in fishing apps cannot provide valid population statistics. This dependence on probability sampling limits the timeliness of estimates. For iSnapper, estimates were not available until after red snapper seasons concluded, and the design could not produce reliable estimates for an abbreviated three-day federal red snapper season. While angler apps present an opportunity for anglers to report in a timely manner, this does not necessarily translate into more timely availability of valid population statistics.

Considering the lack of participation in angler apps and the challenges associated with effectively implementing the capture-recapture design, the RET recommends that MRIP focus efforts to expand ER for private recreational anglers (shore and private boat anglers) on more proven, cost-effective opportunities. The Westat review identified two probability-based survey approaches that could readily include online or mobile reporting: cross sectional designs, such as that currently used by the MRIP Fishing Effort Survey (FES), and prospective data collection methodologies, such as panel designs, in which panelists are randomly selected and asked to participate in the survey for multiple reporting periods. Incorporating an ER mode into either of these designs could improve reporting accuracy at reduced costs, while maintaining the validity of the data collection design.

MRIP implemented the FES in 2015 and established the design as the official methodology for estimating recreational fishing effort for private boat and shore fishing for Hawaii and the Atlantic and Gulf of Mexico subregions in 2018. The design has been extensively tested and peer reviewed, and in 2017 the National Academies of Sciences (NAS) concluded that, “the methodologies associated with the current Fishing Effort Survey, including the addressed-based sampling mail survey design, are major improvements over the original Coastal Household Telephone Survey...” As recommended by the NAS, MRIP has developed an online reporting option for the FES that is being tested in a web push design that encourages response to the online questionnaire before providing a paper, mail questionnaire. This is a relatively simple, cost-effective adaptation to the FES design that may provide more accurate data at a reduced cost. Initial testing of the web push design will be completed in 2019.

Like the Westat review, the NAS review also recommended that MRIP consider prospective data collection designs, such as panel designs and electronic diaries. Panel designs could improve respondent recall, encourage more respondents to report electronically, and reduce data collection costs relative to cross-sectional designs,

although these benefits are largely hypothetical and have not been tested. In addition, panel designs are generally more effective than cross-sectional designs for estimating measures of change, such as changes in employment status over time. However, MRIP generally estimates fishing activity for discrete time periods (e.g. year/two-month reference wave) rather than changes in fishing activity over time, so repeated cross-sectional designs may be more efficient. Additionally, panel designs have a unique set of challenges of their own, including attrition (e.g., failure to respond after agreeing to participate) and panel conditioning, where participation in a panel results in a substantive change in the measured behavior. For example, panelists might fish more because they are participating in a fishing panel. Both attrition and conditioning can result in biased estimates. Finally, a transition from the FES to an alternative effort survey design would be costly and disruptive, similar to what was experienced when MRIP transitioned from the CHTS to the FES. Considering the positive aspects of the FES design, including the potential to incorporate online reporting, an extensive evaluation of alternative methods for estimating general shore and private boat fishing effort is not recommended. The RET recommends that MRIP limit consideration of panel designs to specific research questions for which panel designs are uniquely suited.

The RET provides the following additional recommendations regarding ER:

- ER should be evaluated for use as a data collection mode in any valid design for marine recreational fishing data collection programs. Potential applications for ER include: 1) as a reporting mode for offsite effort surveys, as described above, 2) as an alternative to paper data collection forms in onsite catch surveys, and 3) electronic logbooks for for-hire data collections or other census programs. Specific benefits of ER are likely to include reduced costs and improved reporting accuracy.
- Non-probability data collection programs, including those using ER, should not be considered for use in producing total population estimates in marine recreational fisheries. Further evaluation of ER in non-probability data collections should be limited to observational/qualitative studies that will not provide population-level estimates for any parameter or statistic. This recommendation is consistent with previous recommendations resulting from an MRIP workshop that evaluated the appropriate uses of opt-in angler data (Summary of February 2, 2012 Workshop).
- Further development of capture-recapture designs should focus on increasing reporting rates and ensuring independence between reporting and validation. As noted in the iSnapper report, mandatory reporting may be a necessary step to increase participation to levels that would support cost-effective, reasonably

precise estimates. Applications of the capture-recapture design that cannot ensure that critical assumptions are satisfied should not be considered valid designs.

- Given the number of federal, regional, state, and academic data collection programs for marine recreational fisheries, consideration should be given to cumulative angler reporting burden whenever new programs are being proposed or developed. Increasing angler reporting burden through new programs and associated reporting requirements may adversely affect response rates and data quality across all programs. While specialized programs provide an opportunity for more detailed data collection, it is unclear what number of such programs would be sustainable in the long term.
- Considering the perceived popularity of angler apps, future communications about ER should focus on:
    - Limited participation in existing angler app programs;
    - The challenges associated with developing and implementing valid probability designs that incorporate ER;
    - The deficiencies of non-probability sampling which make it inappropriate for use in producing population estimates; and
    - Potential observational studies that could use non-probability ER data along with the significant limitations of such studies

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