Consultant Report on Red Snapper Recreational Catch Assessment Methods

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Introduction

The Red Snapper Recreational Catch Assessment Methods workshop was held in New Orleans on November 4-5, 2013 and was attended by representatives of NMFS and fisheries department representatives for the Gulf states. The goals of the workshop were to describe and evaluate on-going and planned surveys for red snapper and related species in the Gulf region, and to start the process of developing a proposal for a pilot project to improve the estimation of red snapper catch in the Gulf.

Accurate and timely estimation of red snapper catch is important because it is a popular recreational fishery for a species that is currently under a management plan with state quotas. Accurate estimation for the season's catch as well as for in-season catch is extremely valuable to allow fisheries managers to set and adjust fishing restrictions. With the current interest in regional management (in which each state manages its own quota independently), estimation of in-season catch on a more timely basis would be of clear importance.

At the same time, estimating red snapper catch is challenging, because of a short fishing season and the fact that vessels targeting red snapper leave from a small number of sites, so there is a substantial probability that the regular MRIP survey will sample few (or none) of these sites. Because of this, the regular MRIP survey as currently implemented results in a small number of intercepts of anglers targeting red snapper, and effort is thought to be poorly estimated as well.

Louisiana implemented a detailed survey over the past year targeting red snapper recreational fishing activity, and several other states are developing proposals to either test or implement surveys for this purpose, using a range of different approaches. These were presented during the workshop and summarized in a spreadsheet, so they will not be repeated here. In the remainder of this document, we describe what we view as the major approaches to improve the red snapper catch estimation as well as some thoughts on how to choose among them.

Description of Main Survey Approaches

We see the range of options for monitoring the red snapper recreational fishery as follows:

1. Expand/improve MRIP or equivalent general angling survey
2. Make use of logbooks and/or mandatory reporting combined with on-site validation
3. Require permits with contact information to delimit target population, then on-site survey for catch and off-site survey for effort
4. Complement MRIP (or equivalent) with longitudinal panel survey for effort
5. Use model-based methods that make use of catch data for the easily monitored part of the population (e.g. charter boats), together with an estimated regression model to predict total catch

These options should not be construed to be mutually exclusive, and hybrid approaches are certainly possible. For instance, the model-based prediction option would almost surely need to be complemented with a more traditional survey, such as those listed in options 1-4, to generate the final estimates. As another example, charter boat data on catch and effort can be collected through logbooks (option 2) while data on other modes can be obtained through a survey following options 1, 3 or 4.

1. Expand/Improve MRIP

While there appears to be a lot of interest in creating a targeted survey for the red snapper fishery, it is worth considering whether the current general recreational angling survey could not be adjusted so that red snapper catch estimates with sufficient precision are produced in a timely manner. This has the obvious advantages of not requiring the creation of a completely new survey, ensuring consistency over time and across species and modes, and maintaining operational efficiencies.

On the intercept survey side, the current MRIP sample allocation results in a low sample size of red snapper trips. Based on the discussions during the workshop, our impression is that the sites from which red snapper trips leave and the periods during which this happens are known. Hence, increasing the sampling effort in a targeted manner within the MRIP sample design would likely achieve the desired level in red snapper intercepts and fish measurements, with corresponding higher precision in the estimates of red snapper catch/trip and fish characteristics.

The estimation of red snapper fishing effort within the MRIP design is likely to be more challenging. The current telephone survey asks respondents to enumerate their fishing trips by mode, but does not differentiate them by target species. Hence, to the extent that red snapper angling behavior is similar to that of anglers in the relevant boat modes, the MRIP telephone survey can be used to estimate fishing effort. As for catch above, if the sample sizes obtained in the relevant modes are too small, the overall sample size can be increased in the waves corresponding to the red snapper fishing season.

However, if red snapper effort is expected to be substantially different from the overall fishing effort (e.g. red snapper anglers take a large number of trips during the season and represent a small fraction of the angling population), the estimation of red snapper effort by the current MRIP effort procedures will be unreliable, and a survey targeting red snapper effort specifically would be warranted. This could still be accomplished within the MRIP design by adding questions about red snapper trips to the current telephone survey. However, this might not be effective even after increasing the overall sample size if red snapper anglers are a small fraction of the overall population. In that case, a specialized survey targeting red snapper anglers might be necessary. This will be further discussed under option 4 below.

Current MRIP estimation procedures produce estimates by two-month waves, approximately 45 days after the end of the wave. If more timely information is needed to manage the red snapper fishery, it would appear possible to produce monthly estimates, since both the intercept and the telephone MRIP components are stratified by month. It is unclear whether the interviewing and processing could be significantly shortened, so a minimum of 6-7 weeks lag is likely to remain between the target month and the release of preliminary estimates under this approach.

2. Logbooks and Mandatory Reporting

A second approach presented in the workshop's review of pilot projects was mandatory reporting of catch, both of charter captains and individual anglers, with dock-side validation checks to ensure an acceptable level of compliance. This method is made more feasible by the wider availability of technology, such as smart phones and tablets, which makes near real-time reporting possible. Several states (Texas, Mississippi and Alabama) that had experimented with this approach reported a high degree of compliance, though of course not 100%. These states reported a considerable buy-in from both captains and anglers for the notion of providing information to aid in successful management of "their" resource.

This approach has some advantages, and with appropriate design of the validation checks and angler reporting rules, could be put on firm statistical footing. Specifically, valid measures of uncertainty could be developed, and improvements in precision over those provided by the current system of independent catch and effort surveys may be possible. To do this, the reporting and validation processes can be regarded as two independent capture occasions in a capture-recapture model. Then the anglers who are encountered in the validation sample will be matched to the reporting anglers. Under certain conditions, this match rate will provide a method for estimating the number of anglers who neither reported nor were encountered in the validation sample. This, combined with the number of anglers encountered in either or both of the other capture occasions, provides an estimate of the total number of anglers. The assumptions required for this to be an asymptotically unbiased estimator are: (1) the probability of mandatory reporting is the same for all anglers (referred to as homogeneity of selection probabilities in the capture-recapture literature); (2) inclusion in the validation sample does not change the

probability of mandatory reporting (known as independence of capture occasions); and (3) the anglers in the validation sample can be accurately identified in the list of mandatory reports (known as permanence of tags). In addition, when the validation is not done on a census basis (as in this application), it must be conducted on a probability sample of anglers.

Though each of these assumptions may be violated to some extent, there are adaptations in the requirements of reporting and in the data analysis that could mitigate their effect. For example, regarding assumption (1), it seems likely that people who are fishing without the proper permits may be less likely to report than others. It may also be that in-state and out-of-state, or old and young anglers may have different reporting probabilities. The bias in the estimate of number of red snapper anglers caused by these differences, called heterogeneity bias, can be reduced by post-stratification of anglers into similar reporting rate groupings, with separate estimates made for each and then summed. The independence assumption could be mitigated by requiring that mandatory reporting be required before the anglers are approached for validation. Finally, there must be sufficient identifying information collected in both the validation and reporting sample to assure identification is accurate.

Besides estimation of counts of anglers, the number and characteristics of the fish caught must be made for the non-reporting anglers. There will likely need to be some methodology developed to handle this estimation problem, but it will be similar in spirit to the methodology used for estimating the demographic characteristics of the undercounted census population, about which there is a large literature.

The major advantage of this approach is the potential for an increase in precision, especially if the mandatory reporting could actually produce a high level of compliance. If this is successful, this precision could possibly be obtained at reduced cost, since there would be no need for the estimation of red snapper effort as mentioned in option 1 above.

The major disadvantage is its dependence on the anglers having access to devices that allow them to report their catch immediately. Not all anglers will have this technology, nor will the ones who do necessarily be willing or able to download and use the required application for their device. We do expect this disadvantage will diminish over time. In the meantime, mandatory reporting could be made by mail. However, this could violate assumption (2) above for capture-recapture sampling. Specifically, if anglers were allowed to report after they were selected in the validation sample, there may be an increase in reporting rate for intercepted anglers over non-intercepted anglers. A second disadvantage is that states that do not have mandatory reporting would need to implement it, and this may not be desirable from the point of view of anglers or regulators. Finally, this mandatory approach is a dramatic departure from the historical catch estimation methods, and one that will be obvious to the angling community. Therefore it could require an intensive and

sustained public education and outreach campaign to achieve confidence within the angling community. On the other hand, based on recent negative experiences with the red snapper catch numbers, promoting something totally new might be easier than revising what exists.

3. Permit-Based Red Snapper Fishery

If participation in the red snapper fishery could be made permit-based, it would then be possible to design a targeted survey similar to the Large Pelagic Survey (LPS) along the Atlantic Coast. A sample of site-days would be selected for red snapper angler intercepts to estimate the red snapper catch/trip and obtain fish measurements, based on a sampling frame of fishing sites and time periods that encompass the red snapper fishing activity. The effort would then be estimated based on a survey of permit holders, both charter boat owners and individual anglers, using telephone or other modes as appropriate.

Since MRIP targets all angling activities and this new survey would target a subset of them, both surveys would overlap in scope. Hence, it would be necessary to decide whether to combine the data from both surveys using dual-frame estimation methods, or to avoid overlap by removing the red snapper angling activity from MRIP and using the results of the new survey as the official red snapper estimates. In either case, coordination with the MRIP survey would be needed, to avoid multiple interviewers at the same site.

A separate survey approach as described here will be most cost-effective if the fishery is highly concentrated in time and space, since otherwise one ends up creating a "parallel MRIP" just for one species. It is critically predicated on the availability of a permit system that covers all participants in the recreational red snapper fishery, and it requires the sampling frame of permit holders to contain high quality contact information.

4. Longitudinal Effort Survey

Within the current structure of measurement of catch and effort through independent surveys, there is still potential for improved estimation. As a change to the enhanced MRIP survey in which an address or telephone frame is used for measuring effort, one innovation that could improve precision would be to retain anglers in multiple waves if they are identified as red snapper anglers. This type of survey design is known as a panel survey. It is commonly used in surveys conducted by federal statistical agencies, especially when measures of change from one time period to the next are of special interest. Though measuring change is not a major objective for the MRIP surveys, this approach would likely achieve increased efficiency because it would increase the yield of interviews of red snapper anglers per dialing (assuming that anglers who targeted red snapper in the past are more likely to do so in the future than those who did not).

Even if the effort survey is a special purpose one that uses a list of potential red snapper anglers, it might be beneficial to retain respondents from one period to the next. One reason is the yield may still be higher per dialing since bad contact information that causes unproductive calls can be reduced, since fewer new respondents are needed each wave. Another reason is that the interviews that are conducted (or questionnaires to be filled) may be shorter, since basic demographic data collection and explanations of survey purposes and instructions may be abbreviated.

The disadvantages of this approach are that new survey methods will have to be developed and tested because decisions about the structure of the panel design would be required. First, it is not even clear that panel surveys will provide substantial efficiency. To determine this, data must be collected about the consistency of angling behavior. If it is determined that efficiencies are possible, decisions must still be made about how long respondents can stay in the sample before attrition eliminates the design's efficiency advantage. There is a need for new methods to trace anglers whose contact information changes from one wave to the next (although this problem is likely to be less severe than in the future, given the increasing prevalence of cellphones as primary contact mode). Finally, new estimation procedures will be required.

5. Model-Based Methods

A different approach to estimate the red snapper catch is to take advantage of relationships between the overall red snapper catch and auxiliary variables that are easier to collect on a timely basis. As a specific example to describe this approach further, we consider the proposal discussed during the workshop of using logbook-reported charter boat red snapper catch as an auxiliary variable to predict total red snapper catch. The steps involved in such an approach are as follows:

1. fit a regression model between total catch and logbook charter boat catch using past data
2. using the regression model and available logbook charter boat data, predict total catch for the target period
3. following collection of data on total catch through a survey (any of options 1-4 above), adjust estimates
4. periodically revisit the regression model based on new data obtained over time and on performance of the regression model in prediction.

Properly applied, model-based predictions have the advantage of being able to provide relatively rapid estimates with low variability (step 2, once step 1 is completed), depending on the auxiliary variable being used. The charter-boat logbooks were suggested for this purpose, since these numbers are supposed to be reported soon after the completion of the trips, are comprehensive for an important portion of the red snapper fishery and are thought to be good predictors of overall red snapper catch. Other possible variables might be weather or ocean conditions,

catch from another fishery with larger sample sizes but otherwise similar characteristics to red snapper, or boat counts at sites with heavy red snapper activity (these are some hypothetical examples; actual proposals should come from people more familiar with these fisheries).

As should be clear from these steps, using a model-based approach for producing official estimates is a far from trivial task, because unlike survey estimates, these alternative estimates are now subject to model misspecification errors. These errors can be due to the choice of which variables to use and to the specification of the regression model. In addition, even if the variables are well-chosen and model is well-specified, these relationships can change over time and hence need to be periodically monitored, as specified in step 4.

Especially for a fishery with many stakeholders, using a model-based method leaves one open to the risk of some stakeholders disagreeing with the estimates and pointing at the model as a cause for the estimates being incorrect. In contrast, when a survey is properly implemented, which includes the use of a comprehensive sampling frame and randomization of the sampling units, the resulting estimates are not subject to model misspecification error and are approximately unbiased. They can be quite variable if sample sizes are small, however, and they might also only be available after a lengthy delay if they require a separate telephone survey to estimate effort. But because properly created survey estimates are more defensible, even if the model-based estimates are used to monitor the fishery on a continual basis, we recommend performing step 3 to create the final official estimates at the end of the season or whenever a sufficiently large survey sample size is available. In fact, the model-based estimates can be used to improve the precision of the design-based estimates, by constructing so-called "model-assisted" estimators. Speaking somewhat loosely, model-assisted estimators take the model-based estimates as a starting point and then estimate the difference between the model-based estimators and the true population numbers in a design-based way. If the model-based estimates are indeed reasonably close to the true population numbers, then this approach can result in significant gains in precision compared to pure design-based estimators, while retaining the approximate unbiasedness and robustness. In this sense, we view the model-based prediction approach as a complement to a survey approach, rather than as a replacement.

Evaluation of Possible Approaches

The decision on which of these options to pursue as one (or several) pilot programs hinges on a discussion of the following questions:

- Are a permit-based system and/or mandatory reporting for the red snapper fishery feasible, both politically and practically?
  From the experiences reported during the workshop, it would appear that this might not be a major hurdle. Nevertheless, a change of this magnitude

would definitely need to be carefully evaluated, possibly through a pilot study or as part of another survey (e.g. add a question to MRIP telephone survey).

- How reliable would logbook-reported catch estimates for red snapper be?
  In addition to the practical feasibility of using logbooks, a key consideration will be the compliance level. The precision of the capture recapture estimator increases with compliance. Its bias decreases as the compliance becomes more uniform across anglers (due to the homogeneity assumption of the capture recapture model). So even before a pilot study is undertaken, an analysis of the data from programs that have implemented this approach could provide some information on these features, so that the statistical competitiveness of this approach could be assessed. If it appears promising, it will undoubtedly require a pilot study designed to meet the requirements of the capture methodology as nearly as possible. This approach would also require careful design of the new reporting and estimation programs.
- How concentrated is the red snapper fishery in terms of participants, departure sites and season?
  As previously mentioned, this impacts the feasibility and cost of developing a red snapper specific survey. Assuming prior knowledge of the fishery, which certainly seems available at the state level, it would be useful to perform an in-depth analysis, possibly including a simulation component, to estimate the cost of such a survey. A simulation would make it possible to look at scenarios in which the fishing activity is more or less concentrated, and the resulting sampling efficiencies and cost to reach target sample sizes. Data on the past fishing season in Louisiana might be helpful in this analysis as well, but results will need to be generalized to other Gulf states.
- How important are in-season estimates?
  If in-season estimates are needed to manage the fishery, then it is likely that more timely estimates than currently provided will be needed, which might require model-based predictions. At the workshop, it appeared that at least some states valued stability and predictability more than being able to make fishing regulation changes "on the fly." So a more complete evaluation of this would be needed in order to decide on the usefulness of starting to look at model-based methods more carefully. This would include talking to the relevant stakeholders in the states.
- What is the desired level of precision, and what is the desired spatio-temporal scale?
  More intensive sampling leads to higher levels of precision, but also increases the cost. A discussion of this issue, based on the expected uses of the data and the desired resolution (e.g. in-season monitoring vs annual estimates, catch by mode vs. overall catch) is highly recommended, so that future surveys being considered remain realistic in scope and cost.
- Availability of staff with relevant expertise to develop, evaluate and adapt prediction models and/or advanced survey estimation methods?
  This is likely to be most critical for the capture-recapture estimation in option 2 and the model-based approach in option 5, but applies to some

extent in any new survey approaches being considered. Are there suitable individuals who can take charge of the model development, as well as remain involved in the future to ensure the models do not become "stale" over time?

- How important is it that all (or most) states use the same methodology for estimating the red snapper catch?

  During the workshop, the topic of having the states individually monitor their red snapper fishery was brought up a number of times. If this is implemented in the future, then it would indeed be realistic that red snapper survey and estimation procedures vary by state as well, so that they can be customized to the data needs and available resources in each state. However, there are certainly advantages to having these procedures remain closer to homogeneous for the region, facilitating data sharing and aggregation and making it possible to fully leverage the available statistical expertise.