MARYLAND
DEPARTMENT OF
NATURAL RESOURCES

Larry Hogan, Governor
Boyd Rutherford, Lt. Governor
Jeannie Haddaway-Riccio, Secretary

March 30, 2021

The Honorable Larry Hogan
Governor
State House
Annapolis, Maryland 21401-1991

The Honorable Paul Pinsky
Chair, Senate Education, Health and Environmental Affairs Committee
2W Miller Senate Office Building
Annapolis, Maryland 21401-1991

The Honorable Kumar Barve
Chair, Environment and Transportation Committee
Room 251 House Office Building
Annapolis, Maryland 21401-1991

Re: Submission of Report for Recreational Striped Bass Fishery – Study on Harvest Data
Agency: Maryland Department of Natural Resources
Report Authority: SB 882, Chapter 587 from 2020 (MSAR #12764)

Dear Governor and Chairs:

As required by SB 882, Chapter 587 in 2020, the Department of Natural Resources conducted a study on methods of obtaining more accurate harvest data for the recreational striped bass fishery. Attached is a copy of the study as required.

Should you have any questions or comments regarding this report, please feel free to contact Director, Legislative and Constituent Services, James W. McKitrick, directly at 443-510-5013, or by email at jamesw.mckitrick@maryland.gov.

Sincerely,

Jeannie Haddaway-Riccio
Secretary

Attachment

cc: Sarah Albert, Department of Legislative Services Library
        James McKitrick

Recreational Striped Bass Fishery Study on Harvest Data

Conducted in Response to Senate Bill 882 (MSAR #12764)

Maryland Department of Natural Resources

December 2020

EXECUTIVE SUMMARY

This report has been completed to meet the study and reporting requirements of Senate Bill 882 (Chapter 587, 2020), Recreational Striped Bass Fishery – Study on Harvest Data.

The law directs the Maryland Department of Natural Resources (Department or DNR) to conduct a study on methods of obtaining more accurate harvest data for the recreational striped bass fishery. The study is required to:
   (1) Examine the benefits that more accurate harvest data for the recreational striped bass fishery would have on the scientific and management capabilities of the Department with respect to the entire (recreational and commercial) striped bass fishery;
   (2) Consider the types of information and level of detail that would be most beneficial for the Department to obtain for its scientific and management duties and capabilities;
   (3) Consider the advantages, disadvantages, and feasibility of implementing various methods for obtaining more accurate harvest data for the recreational striped bass fishery;
   (4) Recommend methods for obtaining more accurate harvest data for the recreational striped bass fishery, and
   (5) Recommend any enforcement measures that would need to be implemented to support any methods recommended under paragraph (4) of this subsection.

Maryland's annual recreational striped bass harvest estimate is provided by the National Marine Fisheries Service (NMFS) through a set of surveys known as the Marine Recreational Information Program (MRIP). Due to the large scale of the striped bass fishery, developing catch estimates through angler reports would be logistically difficult and prohibitively expensive. This is due to the large number of recreational anglers, their ability to enter and exit the fishery at-will throughout the year, and the fact that not all anglers are required to have licenses. Therefore, recreational harvest and release estimates are produced using scientifically-designed surveys and there is no comprehensive method for recreational anglers to electronically self-report catch. As detailed in this report, electronic angler reporting applications are not a substitute for scientifically-designed surveys for catch estimation, but they can provide critical supplemental information for management (e.g., lengths of discarded fish, angling methods, hook location). While DNR already has links to its volunteer angler surveys within the DNR mobile app and on its website, other platforms (e.g., iAngler or others) are being considered, which may be easier for anglers to use to submit information on their catch and fishing practices.

When determining the quality of the MRIP estimates, there are two components to consider: the accuracy and the precision. Accuracy of the survey results depend on adequate survey design, which aims to reduce bias and survey a representative sample of the angling population. To ensure appropriate methods are being used, MRIP was reviewed by the National Academies of Sciences, Engineering, and Medicine in 2017.[1] It was determined that improvements to MRIP, including redesigned surveys, strengthened the quality of data being collected. Additionally, all existing and new methodologies undergo a certification process, which is a separate peer review, to ensure they meet scientific rigor. All new methods approved for implementation are benchmarked, or conducted side-by-side with previous methods, and then calibrated so that the continuity of the survey is preserved. The precision, or certainty of the estimates is measured using Percent Standard Error (PSE). Low PSE values indicate high precision and PSE values less than 30% are generally considered to indicate good precision.

Benefits of More Accurate Harvest Data on Science and Management

The precision of the coastwide annual recreational striped bass harvest and release estimates is consistently around 7%, with no value exceeding 10% in the past 10 years. The precision of the Maryland annual recreational striped bass harvest estimates is consistently around 14%, with no value exceeding 23% in the past 10 years, while the precision of the annual release estimates is consistently around 16%, with no value exceeding 30% in the past 10 years. One key reason for the high quality of annual striped bass estimates is that the angler interviews produce a good representation of the Maryland striped bass fishery. This is because striped bass, which are widespread and sought after year-round, are frequently encountered by anglers and therefore reported in these surveys.

However, the PSEs of the estimates increase (indicating greater uncertainty) as estimates are broken down into smaller spatial and temporal scales, such as specific fishing areas (inland, ocean), specific times of year (two-month waves), and/or fishing modes (shore, private, and for-hire). Since the uncertainty in the estimates is higher at these smaller spatial and temporal scales, serious care must be taken when using smaller estimated components of MRIP for science and management.

While harvest is one component of the total catch, releases are also important as some fish will succumb to release mortality (e.g. the rate of fish dying due to fishing activity) after being caught. This is particularly true for striped bass, which is a predominantly recreational fishery with most of the catch released alive. During 2019 in Maryland, approximately 4% of striped bass were harvested by the commercial sector, 9% were harvested by the recreational sector, and 86% were released by the recreational sector (commercial release data are not collected by DNR and is estimated for the Chesapeake Bay region in the Atlantic States Marine Fisheries Commission's (ASMFC) coastwide stock assessment).*Given the high percentage of fish released by the recreational sector, any method focused on improved understanding of recreational harvest must provide equal attention to recreational discards or it will not improve management of the fishery.*

Scientists and managers require information on the total removals from the fishery, or the harvest and the dead discards. While MRIP provides an estimate of live releases, this number is multiplied by the discard mortality rate to estimate how many fish die after being released. Estimates of the discard mortality rate can only be determined from external studies. These studies usually seek to understand how various factors, such as hook type, water temperature, oxygen levels and salinity, affect the survival of fish released. Current estimates of the discard mortality rate for striped bass are from the 1990s, and early 2000s. Updated discard mortality studies, which are designed to better elucidate the factors that affect survival after capture, could be useful for science and management. Striped bass discard mortality has been of particular interest, and is seen as one of the highest priorities of the ASMFC's Striped Bass Management Board (Board) since the most recent benchmark stock assessment. The Board has recently tasked the Striped Bass Technical Committee (Committee) to explore next steps in the understanding of

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[1]

nationalacademies.org/news/2017/01/new-report-finds-significant-improvements-in-methods-to-collect-data-on-recreational-fishing

coastwide discard mortality, and the Committee will present their initial recommendations to the Board at their upcoming meetings in spring 2021.

In addition to the discard mortality rate, more information on the sizes of fish discarded is also needed. Outside of headboat sampling, no information on discard lengths is collected in the MRIP survey and this is an area where supplemental information provided by recreational anglers would be most useful. While DNR already has links to its volunteer angler surveys within the DNR mobile app and on its website, other platforms (i.e., iAngler or others) are being considered, which may be easier for anglers to use to submit information on their catch.

Within Maryland, discussions on potential recreational electronic reporting projects are ongoing with our stakeholders and the members of the Sport Fish Advisory Commission (SFAC) and the Tidal and Coastal Recreational Fisheries Committee. Work will continue with these groups and final recommendations will be developed in 2021 regarding areas where recreational electronic reporting could be most useful for fisheries science and management, focusing on defining the objectives of such a project, the uses of the data collected, as well as necessary data standards for any data collected.

Types of Information and Level of Detail Most Beneficial for Science and Management

Recreational harvest and dead-release estimates are used at the coastwide level for development of the striped bass stock assessment and to develop coastwide regulations, which maintain the stock at a desired level. Estimates of striped bass recreational harvest and discards used at the annual level are very precise (PSEs <10%). These are not the only pieces of information that inform the assessment on the health of the striped bass stock. Additional data are collected by management agencies along the coast and include commercial harvest, biological characteristics of the catch (age, length, weight) as well as fishery independent indices, such as trawl, gill net, and juvenile seine surveys.

MRIP estimates of harvest and releases by state are used to develop state-specific regulations when the jurisdictions want to implement conservation equivalency (i.e., prefers to deviate from the proposed coastwide regulations). While these state level (and lower level) estimates are less precise than those used at the coastwide level, in many cases for striped bass the PSEs are still less than 30%. As the PSEs are below 30%, MRIP guidance is that these estimates still have reasonable precision.

In general, large quantities of data are collected each year on striped bass in Maryland, particularly in the Chesapeake Bay, but there is a lack of information from Maryland's portion of the Atlantic coast. This is due to the fact that very few striped bass trips are intercepted by MRIP in Maryland along the Atlantic coast, and not much biological information on the catch is submitted through the Department's volunteer angler survey. While striped bass removals on the Atlantic coast are a small component of the recreational fishery in Maryland, more information on the catch from this region could allow for more regulatory options to be considered. This is an area where volunteer data could be useful to supplement that collected by MRIP.

Managers usually focus on reducing harvest through the use of size limits, bag limits, or season length. However, for a fishery like striped bass, where the majority of fish caught are released, these typical methods that reduce harvest do nothing to reduce the number of dead discards and in some cases, have the unintended consequence of increasing the numbers of dead discards. This leaves fewer options for managers to consider when trying to reduce fishing mortality. These realities have put greater demands on the use of MRIP data, often in situations that were never envisioned when MRIP was designed. Additional data have also been needed to determine the effects of alternative regulatory strategies than those used previously. Specifically, this includes information on what fishing methods anglers are using, detailed hooking mortality estimates, and harvest estimates at scales smaller than the areas and two month waves provided by MRIP. In addition, other than headboat sampling, MRIP does not collect information on discard release lengths. Volunteer data collection is useful in these cases to supplement data collected by MRIP.

Advantages, Disadvantages, and Feasibility of Implementing Various Methods for Obtaining More

Accurate Harvest Data

This report examines four options to obtain more accurate harvest and release data. These include: census reporting (i.e., every angler reports every trip) for recreational striped bass harvest; increasing the precision of the current MRIP survey by increasing the sample sizes; designing a specialized survey for striped bass harvest; and utilizing electronic reporting by the recreational sector.

Census Reporting System: This option is infeasible due to the scope of the fishery and not having information on all anglers. While many anglers have fishing licenses, there is unlicensed effort as well as licensing requirement exemptions, including youth under the age of 16, anglers fishing under someone else's boat license, individuals fishing in free fishing areas and individuals fishing from their own private property. Even though some of these "exempted" anglers are supposed to have a free saltwater angler registration, DNR believes there to be high levels of non-compliance. In order for census reporting to be workable, new - and probably onerous - regulations would have to be implemented requiring all anglers to report their striped bass harvest and releases. Experience in other states shows that compliance would not be 100%, and enforcement of such regulations would be difficult. That means that a survey would have to be developed to validate the self-reported data and correct for underreported and misreported trips. Ultimately, this type of system would still be an estimate from a survey, similar to MRIP.

Increasing the Precision of MRIP: MRIP uses two surveys to estimate recreational catch: the Fishing Effort Survey (FES) and the Access Point Angler Intercept Survey (APAIS).

FES is a mail survey sent to households along the coast. It uses the state saltwater angler registries, which identify people who fish, to optimize the sampling. The results of this survey are only as good as the license frame supporting it. Improving compliance with the free saltwater angler registry within the state would help to identify more fishing households across the state.

APAIS is a dockside intercept survey that is used to calculate catch rates. One way to improve the precision of the estimates from this survey is to increase the number of angler interviews by increasing the number of sampling assignments. While increasing the sample size may benefit striped bass estimates for specific times of year or fishing modes, it will not greatly improve striped bass estimates because striped bass are already intercepted frequently in the survey. Additional sampling, however, may benefit the estimates of other species.

While increasing sample sizes would help to improve the precision of the estimates, they would still conform to MRIP's survey design with estimates provided at the two-month wave level and with inland catch estimates, including catch from both the Chesapeake Bay and coastal bays.

Specialized Survey for Striped Bass Catch: Specialized surveys have been developed in consultation with MRIP in specific cases where the usual MRIP sampling is not able to estimate harvest and releases very precisely, or in time for management actions. These specific cases include rare event species not often encountered in normal MRIP surveys, species with short seasons or pulse fisheries, or in-season quota monitoring. None of these conditions apply to striped bass in Maryland, which are widespread and available year-round. Additionally, the final estimates would still be the result of a survey, just as the MRIP estimates are the result of a survey, with no guarantee that the resulting survey estimates will be any more precise than what is currently provided by MRIP.

Utilize Electronic Reporting: Electronic reporting on its own will not provide harvest estimates though it can be used to gather information from anglers on their fishing trips. DNR currently asks for data online from striped bass anglers through the volunteer angler survey and is exploring other reporting methods, which may be easier for anglers to use (e.g.. apps such as iAngler or other platforms). The current volunteer angler survey is particularly important in striped bass management to DNR as it is the only information available on the lengths of fish discarded by anglers. These electronic volunteer reporting options, while important for biological data collection, cannot be used to calculate the total numbers of fish harvested or released. Volunteer, or opt-in programs, are susceptible to bias as those who participate in them are often avid anglers or those more familiar with technology. Therefore they will not likely provide

data representative of the angling population as a whole. However, they can provide critical supplemental information for management. Programs that are able to provide estimates of total harvest and releases through electronic reporting have mandatory reporting, with legal penalties for non-reporting, as well as probabilistic surveys, which correct the reported data for underreporting or misreporting.

Recommended Methods

Given that striped bass are well represented in the MRIP data and any new surveys would likely not produce better estimates of harvest and releases for scientific or management use, the recommendation is to continue using the MRIP survey for estimates of harvest and releases, continue working with the National Oceanic and Atmospheric Administration (NOAA) and other states along the Atlantic coast to improve MRIP, and to supplement information collected by MRIP with volunteer data.

Volunteer data on striped bass catch is critical to DNR's understanding of recreational discard length frequencies and could be used to fill in the data gaps that currently exist for the Atlantic coast striped bass fishery. Increasing participation from all anglers in the current volunteer angler survey would be useful for science and management, and help to ensure that the data is representative of fishing across the state.

Studies on discard rates and updated discard mortality rates would also be useful to science and management. Discards are a very large component of the striped bass fishery along the coast and managers have limited options to control mortality from this sector. Studies on discard rates would help to validate the self-reported data provided by anglers in dockside interviews to MRIP. Updated discard mortality studies that quantify the effect of various fishing methods and environmental factors would provide more information to managers so they can focus on management actions that have the best chances to lower discard mortality in the fishery. Discard mortality studies are underway in Massachusetts and DNR has provided a letter of support for grant proposals to study discard mortality in Chesapeake Bay submitted by academic institutions in Maryland. Additionally, the ASMFC Striped Bass Management Board will be presented with initial recommendations on how best to further our understanding of discard mortality in striped bass along the coast at their upcoming meetings in spring 2021, and further coastwide studies may be proposed.

Lastly, having more comprehensive for-hire data will improve management of this part of the recreational sector. For example, in spring 2020, DNR expanded the pilot FACTS e-reporting system to charter boat operators, allowing them to submit their logbooks electronically in a much more timely manner than the weekly paper reports currently required for charter boat decal holders.

Additional recommendations may come from stakeholders through the SFAC and the newly created Tidal and Coastal Recreational Fisheries Committee (a subcommittee of the SFAC). DNR will seek direct input from these groups relating to recommendations in this report, with specific focus on voluntary electronic reporting platforms (i.e.,iAngler or other platforms) and reporting standards in the recreational sector.

Enforcement Measures Needed to Support Recommended Methods

Improving compliance with Maryland's free saltwater angler registry would help optimize the effort survey used by MRIP to estimate the number of angler trips taken in Maryland. This could be accomplished through an education campaign with the angling public on who needs to get a free registration and why it is important.

Additionally, the charter logbook data could be improved if there was increased compliance with reporting requirements. While the pilot FACTS e-reporting system has increased the completeness and timeliness of for-hire data collection, increasing the reporting rate will improve the completeness of the data as long as captains are submitting all of the required data.

Background

In order to effectively manage fisheries, managers need information on how many fish are harvested and released each year. For a species like striped bass, which is a predominantly recreational fishery, managers rely on estimates of recreational harvest and releases from surveys. On the Atlantic coast, these estimates come from the federal MRIP. Harvest and release numbers are estimates, and inherently have some amount of error associated with them. The MRIP was designed as a coastwide annual survey and while estimates are provided at smaller spatial and temporal scales, these estimates are more uncertain than the coastwide annual estimates. While some estimates of harvest and release at these smaller scales are still reasonably precise for most frequently encountered species in the surveys, for other, rarely observed species or pulse fisheries, the estimates become too imprecise for management use when examined at these smaller scales. For this reason, careful consideration of the adequacy of these smaller scale data for management decisions is required.

In order to fully understand what options may be available to improve recreational striped bass harvest estimates, it is important to first understand why recreational fisheries are estimated using surveys.

General Methods for Estimating Recreational Harvest and Releases

Recreational catch is hard to determine due to the large number of private recreational anglers, their ability to enter and exit the fishery at will throughout the year, and their access to the water from a variety of public and private access points. Additionally, many anglers are exempted from needing a fishing license (e.g., individuals fishing on someone else's vessel or fishing on private property) and they are not usually required to report their catch. Due to the large number of recreational anglers and the transient nature of their participation, estimating recreational catch is most often done using surveys.

In most recreational fisheries surveys, two pieces of information are needed to estimate the total numbers of fish harvested and/or released: total effort and the number of fish harvested or released per unit effort. Effort is usually calculated as the number of boat trips or angler trips. Methods to estimate effort vary depending on the scale of the area to be sampled, but include aerial or video surveys as well as mail and telephone surveys. Harvest or releases per trip are usually estimated through angler intercept surveys where anglers are met at the dock and asked about their fishing trip. By multiplying the total effort (i.e., number of angler trips) by the catch rate (i.e., harvest or releases per angler trip), an estimate of the number of fish harvested or released can be calculated. While some fisheries are managed solely based on harvest, many, including striped bass, now look at total removals. Total removals sums the number of fish harvested with the number of released fish that die as a result of being caught. To estimate the number of fish that die after being released, one needs to multiply the estimated number of fish released alive by the discard mortality rate. Discard mortality rates are estimated by discrete studies separate from the recreational catch estimates and usually involve holding fish in tanks or pens following capture to see how many die after a set amount of time (e.g., 72 hours).

Surveys aim to collect data that are representative of the angling population as a whole. For this reason, care is taken to ensure that bias is not introduced. One way to do this is to use random sampling to make sure the sample is representative of the population of interest. Sampling can also be stratified (i.e., by area or fishing mode) and weighted (i.e., sites that are popular and have more fishing trips in general and throughout different times of the day are given more weight in sample site selection) so that all important factors are accounted for.

Available Recreational Harvest and Release Estimates

Estimates of recreational harvest and releases of over 20 species of fish found in Maryland's tidal waters, including striped bass, are provided by NMFS through a set of surveys known as the MRIP. MRIP grew out of the Marine Recreational Fisheries Statistics Survey (MRFSS). MRFSS was established in 1979,

and provided its first recreational fishing estimates in 1981. MRFSS relied on a random-digit dial telephone survey of coastal counties to estimate effort and an angler intercept survey to estimate catch rates, allowing for the estimation of total catch (harvest and releases). In 2004, the National Research Council was asked to conduct an independent review of MRFSS as well as recreational data collection across the United States. They released their review in 2006, and provided a number of recommendations for the redesign of MRFSS to provide improved recreational fishing estimates. Following the review, NMFS began the transition from MRFSS to MRIP and over the years changes have been made to all aspects of the surveys to address the review recommendations. The main changes include:

- The launch of the National Saltwater Angler Registry in 2010. Rather than continue to rely on the random-digit phone survey that was very inefficient, the angler registry was created to produce a list of known saltwater anglers. Implementation of the registry resulted in changes to Maryland's recreational licensing, requiring a saltwater fishing license for all tidal waters of the state and requiring those 16 and older to have a free registration when fishing under certain circumstances (e.g., under someone else's boat license, from tidal free fishing areas, or from your own private property);
- The re-design of the MRIP estimation procedures with new weighted estimation procedures in use since 2012;
- The redesign of the APAIS, which determines the catch rate per fishing trip. Implementation began in 2013. Additionally, all states on the Atlantic coast took over conduct of the APAIS in 2016 with state conduct coordinated along the Atlantic coast by the Atlantic Coastal Cooperative Statistics Program (ACCSP) at the direction of MRIP; and
- The redesign of the effort survey, which determines the number of private angler trips. This resulted in the transition from the Coastal Household Telephone Survey, the random-digit dial survey of coastal counties, to the Fishing Effort Survey (FES), a mail-based survey. While both surveys were conducted concurrently from 2015-2017, full transition to the FES on the Atlantic coast began in 2018.

Following implementation of the changes recommended by the first review, the MRIP was reviewed again by the National Academies of Sciences, Engineering, and Medicine in 2017.[2] While the review contained suggestions for continued improvements and explorations, they found that significant progress had been made in improving recreational fishing estimation.

Certification of Surveys

All surveys used in the MRIP process must be certified to ensure they meet scientific rigor. One of the recommendations from the 2006 National Research Council's review was the implementation of a process to evaluate and review new and existing methods used for data collection. This certification process was formalized by NMFS in Procedural Directive 04-114-02. According to the directive, any new proposed method must meet MRIP's data standards and best practices, and has to be tested and documented before MRIP staff are contacted regarding potential certification. Given the time commitments of MRIP staff and the review panels, only a certain number of reviews can be conducted each year. Once a project is in the queue for certification, documents describing the methods and pilot test results are submitted to the peer review panel who provide their comments on the adequacy of the survey design and analysis methods. This process is often iterative with projects responding to and incorporating the reviewers' recommendations before undergoing additional review. Surveys are certified after they are recommended by the review panel and by the MRIP Program Management Team, and then approved by the MRIP Executive Steering Committee and NMFS leadership.

While the new APAIS was designed in 2008-2010, and tested in 2010, the APAIS was not certified until 2012. Various methods were tested when redesigning the private fishing effort survey between

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[2]

nationalacademies.org/news/2017/01/new-report-finds-significant-improvements-in-methods-to-collect-data-on-recreational-fishing

2008-2013. The final FES design was certified in 2015. The For Hire Telephone Survey (FHTS), used to estimate the for-hire effort, is scheduled to undergo certification in 2020.

Certification, however, is separate from implementation or use of the data in stock assessments and management. As stated on MRIP's website on survey design certification, prior to deciding whether to implement a new survey, "the cost and practicality of changing methods must be evaluated, and the fit of the new estimates against science and management needs must be explored." Additionally, new surveys must be benchmarked, where both the new and old survey methods are conducted side-by-side, and then calibrated before use in stock assessments and management.

Calibrations

One unique feature of the MRIP is the need to conduct calibration of the data each time changes in methodology are made. These calibrations are necessary so that the time series of data needed for stock assessments and management are consistent through time and measured on the same scale (i.e., changes in scale track real changes in catch and are not different due to differences in estimation methods used through time).

While the MRFSS to MRIP calibration and APAIS calibration did not change the time series of estimates much in Maryland, the recent calibration to incorporate the changes from the FES has greatly changed the effort estimates for all states along the Atlantic coast. The mail survey found that there was much greater effort from the shore and private boat modes than previously estimated using the phone survey. This greatly increased the estimates of fish harvested and released with the scale of the differences varying across species and regions depending on the amount of shore and private boat effort. The effort calibration was completed in 2018, and these updated data have been incorporated into new stock assessments and updated management plans in the years since, resulting in changes in management for a number of species along the coast.

Evaluating the Accuracy of MRIP Estimates

MRIP measures the precision of their estimates using PSE. An example of an estimate with associated precision follows.

Precision can be envisioned as a distance that "flanks" the estimate, creating a range of values.
[PRECISION] [HARVEST] [PRECISION]
[--]

The most common measure of precision is PSE.

As an example, consider a harvest estimate of 50,000 fish with a PSE of 20%.

The precision of the estimate (the PSE) is equal to 20% of the harvest estimate or 10,000 fish.
[10,000] [50,000] [10,000]

Therefore, our best understanding of the true number of fish harvested is between 40,000 and 60,000 fish.

There is no official recommended value of PSE for fishery management. However, Dr. John Weidenmann of Rutgers University was contracted by the Atlantic Coastal Cooperative Statistics Program to study the effect of recreational harvest uncertainty (PSE) on fishery management. The executive summary of his report "Evaluation of the Effects of Uncertainty in Recreational Harvest Estimates on Fisheries Assessment and Management" states:

"Estimates of harvest in many recreational fisheries are often associated with a high degree of uncertainty. Accurate estimates of harvest in recreational fisheries are important for the effective assessment and management of species of recreational importance. For this study, a simulation model was developed to evaluate the effects of uncertainty in recreational harvest estimates on the assessment and management processes, and how these effects depend on the relative size of the recreational harvest for a stock. The model was run for three different species life histories ("fast", "medium", and "slow"), three sizes of the recreational fishery (with landings comprising 30, 60 and 90% of the total, on average), and even levels of uncertainty in recreational landings estimates (PSEs of 0.2, 0.3, 0.4, 0.5, 0.6, 0.7, and 1.0). Results of this work suggest that PSEs above 0.6 produce unreliable estimates of population status, such that inclusion of catch estimates with this level of uncertainty in an assessment may result in a biased estimate from the assessment, which may impact the management process for a stock. In general, model estimates are more reliable (unbiased) for PSEs at or below between 0.4 and 0.6, with the specific upper limit dependent on the scenario being explored. Finally, the selection of a particular threshold PSE based on this study requires having clear objectives and specified levels of risk to effectively interpret the broad range of performance measures calculated."

In the report summary above, percentages are reflected as decimals, so stated another way, the study examined PSE levels ranging from 20 to 100%, and determined that PSEs above a range of 40 to 60% resulted in too much uncertainty in stock assessment model results and stock status determination.

Similar guidance is provided on the NMFS website that provides recreational harvest estimates:

"Estimates should be viewed with increasing caution as PSEs increase beyond 30%. Large PSEs – those above 50% – indicate high variability around the estimate and therefore low precision. Estimates with large PSEs should be viewed cautiously."

MRIP data are most precise at higher levels of data aggregation (i.e., annual and/or coastwide levels). The PSEs get larger, and hence harvest estimates more uncertain, at smaller temporal or spatial scales (i.e., individual waves (two month periods), fishing modes (private boat, shore, or for-hire modes), or individual states/areas (inland or offshore).

Current Efforts to Improve MRIP

NMFS has been working cooperatively with the states and regional partners to improve MRIP and to address regional data needs through regional implementation plans. On the Atlantic coast, the regional implementation team is headed by the ACCSP. ACCSP is a program under theASMFC, which in addition to being a data warehouse for fisheries data along the coast also coordinates the Atlantic coast state conduct of the MRIP surveys, specifically the APAIS and FHTS. The 2017-2022 ACCSP Atlantic Coast MRIP Implementation Plan's top four priorities for the region are: to improve precision (PSE) of MRIP catch estimates; to develop a plan for comprehensive for-hire data collection and monitoring; to improve recreational fishery discard and release data; and to develop projects that conduct biological sampling for recreational fisheries separate from MRIP APAIS.

To address the first priority of improving the precision of the MRIP estimates, $900,000 in additional funding is being provided by NMFS to the Atlantic coast (via ACCSP) as part of the Modern Fish Act. This funding is being used to increase APAIS sampling levels for 2021-2024 with the goal of increasing the precision of recreational catch estimates along the coast. With this additional funding, Maryland will be funded to conduct 291 additional APAIS sampling assignments over base level starting in 2021.

The second priority, to develop a comprehensive for-hire data collection and monitoring program, is currently being worked on by the ACCSP's Recreational Technical Committee. While some for-hire

logbook data, along with the information collected by the FHTS, is used along the coast for for-hire effort estimates by MRIP, the goal of this program is to develop methods that can be used to greater utilize both the catch and effort data from the for-hire sector's logbooks in MRIP's estimation procedures. The Recreational Technical Committee is outlining minimum data standards and elements as well as developing data validation procedures. Once the proposed plan is completed by the committee, it will be submitted to MRIP for potential certification and implementation along the coast.

The last two priorities along the Atlantic coast focus on improving information on recreational fisheries releases as well as collecting biological data on recreational fisheries separate from MRIP. One such project underway to address this task is the design of a mobile app by the South Atlantic Fisheries Management Council (SAFMC), the ACCSP, and the state of North Carolina to collect information from anglers on their fishing trips as well as the lengths of fish kept and discarded. The goal of this project is to develop a customizable app that could be shared with partners along the coast, hopefully eliminating the need to develop new mobile apps for every project. It would also have the advantage of consistent data standards for all states and standardize the collection of volunteer data along the coast. The ACCSP Recreational Technical Committee will begin drafting coastwide data standards for voluntary opt-in reporting in 2021 in order to fulfill the request they received from the SAFMC on this topic.

Previous reviews of the MRIP have also suggested more outreach efforts to the public. To this end, MRIP has established a Communications and Education Team, which aims to communicate with their partners and stakeholders to increase understanding of MRIP and its role in fisheries science and management, including appropriate uses and limitations of the recreational fishing estimates. The group also aims to inform their partners and stakeholders about ongoing improvements to MRIP. A member of this team attended a recent meeting of Maryland's Tidal and Coastal Recreational Fisheries Committee to give a brief overview of MRIP as the group is interested in exploring ways to improve recreational fishing estimates in the state. Following this presentation, the group has continued discussions on how to improve recreational fishing estimates, and DNR has made staff available to answer additional questions on the MRIP and the data it currently provides.

**Recreational Striped Bass Fishery – Study on Harvest Data**

Given the background on the recreational harvest and release data currently available to DNR for science and management, this report will now examine each component listed in the bill.

(1)   Examination of the benefits that more accurate harvest data for the recreational striped bass fishery would have on the scientific and management capabilities of the Department with respect to the entire striped bass fishery.

In response to this question, DNR's assumption is that "the entire striped bass fishery" is interpreted to mean the commercial and recreational sectors of the Maryland striped bass harvest. The "recreational striped bass fishery" is interpreted to mean recreational fishers, which includes charter boat activities.

Accurate harvest data is key to successful management of any fishery. Accurate harvest data also improves the quality of stock assessments. The benefit of more accurate recreational striped bass harvest information in Maryland can only be understood in terms of the current information available to the Department, its accuracy and the use of that information. As mentioned above, MRIP does not suggest caution when using their estimates until the PSEs exceed 30%. Since the striped bass stock was declared recovered in 1995, the precision of the coastwide annual recreational striped bass harvest estimates is consistently around 7%, with no value exceeding 10% in the past 10 years. Maryland estimates of recreational striped bass harvest precision has been around 14% since the moratorium (1985-1989), with no value exceeding 23% in the past 10 years (Figure 1). Therefore, the annual values provided by the MRIP are considered excellent estimates of the striped bass recreational harvest for both scientific and management purposes.

Figure 1. Precision of Annual Maryland Striped Bass Recreational Harvest Estimates by Year
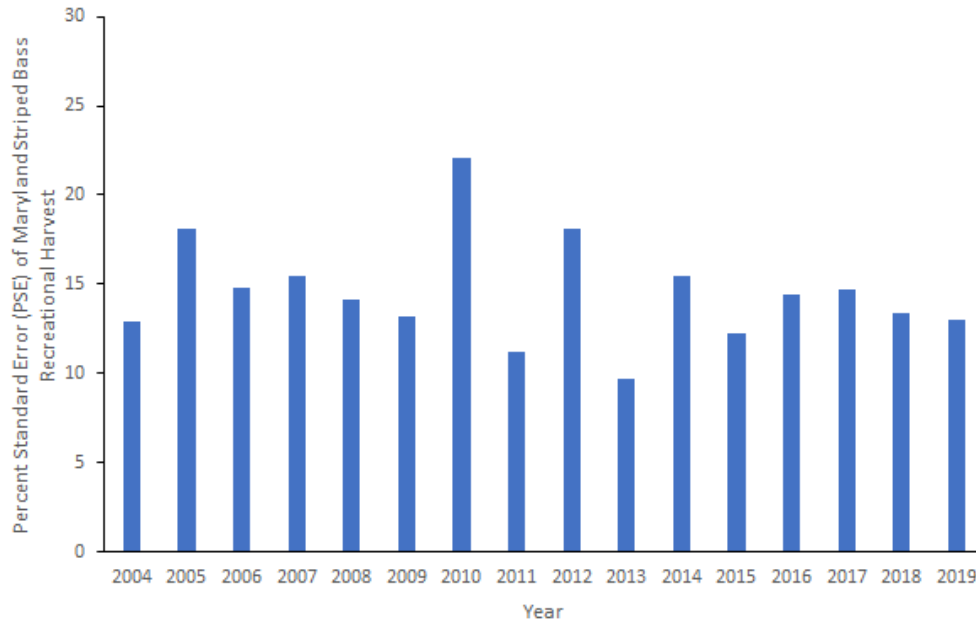

The Importance of Discards

Harvest (or fish taken home) is just one component of the removals used for management. For striped bass, a large component of the total catch is released (Figure 2). Over the past 10 years, MRIP estimates an average of 27.4 million striped bass are released alive each year by recreational anglers along the Atlantic coast and an average of 7.7 million striped bass are released alive each year by recreational anglers in Maryland. These average numbers of live releases are approximately seven times larger than the number of fish, on average, estimated to have been harvested over the same time period. Any method focused on improved understanding of recreational harvest must provide equal attention to recreational discards or it will not improve management of the fishery.

Since the striped bass stock was declared recovered in 1995, the precision of the coastwide annual recreational striped bass live release estimates is consistently around 7%, with no value exceeding 10% in the past 10 years. The precision of Maryland annual recreational striped bass live releases since the moratorium is consistently around 16%, with no value exceeding 30% in the past 10 years (Figure 3). Therefore, the annual values provided by the MRIP are considered excellent estimates of the striped bass recreational releases for both scientific and management purposes.

While MRIP estimates the number of live releases, what is important for management is actually the number of total removals, or harvest plus dead discards. To calculate the number of dead discards, the total number of live releases is multiplied by the discard mortality rate, or the percentage of fish we expect to die after being caught and released. For striped bass, an average coastwide discard mortality rate of 9% is used to estimate the number of fish that die due to being released in both Chesapeake Bay and coastal areas. Discard mortality rates, however, are variable due to factors such as water temperature, air temperature, salinity, fishing gear and tackle used (i.e., circle hooks, treble hooks, artificial lures, etc.), fish length, and hooking location (e.g., deep hooked vs. lip hooked). While studies have been conducted on discard mortality in striped bass, not many have been done since the 1990s and early 2000s. This is an area where a well-designed study to update the discard mortality estimates and better elucidate the factors impacting discard mortality rates along the coast could be useful.

Since the most recent benchmark assessment, the ASMFC Striped Bass Management Board has had many discussions on the topic of discard mortality and methods to reduce it. Recent regulatory changes coastwide, due to be implemented by January 1, 2021, aim to reduce discard mortality by requiring anglers to use circle hooks when fishing for striped bass with bait. The Striped Bass Technical Committee is also exploring the effect of varying discard mortality rates in the assessment and discussing potential discard mortality studies that could be useful to managers. These studies could potentially be coordinated coastwide in order to evaluate factors known to affect discard mortality, specifically those that vary along the range of striped bass (i.e., salinity, water temperature, etc.). While these discussions are ongoing, Massachusetts has already started a study in 2020 on discard mortality rates in striped bass using acoustic tags.

Figure 2. Distribution of Maryland 2019 Striped Bass Catch by Fishing Sector (percentages do not equal 100% due to rounding).
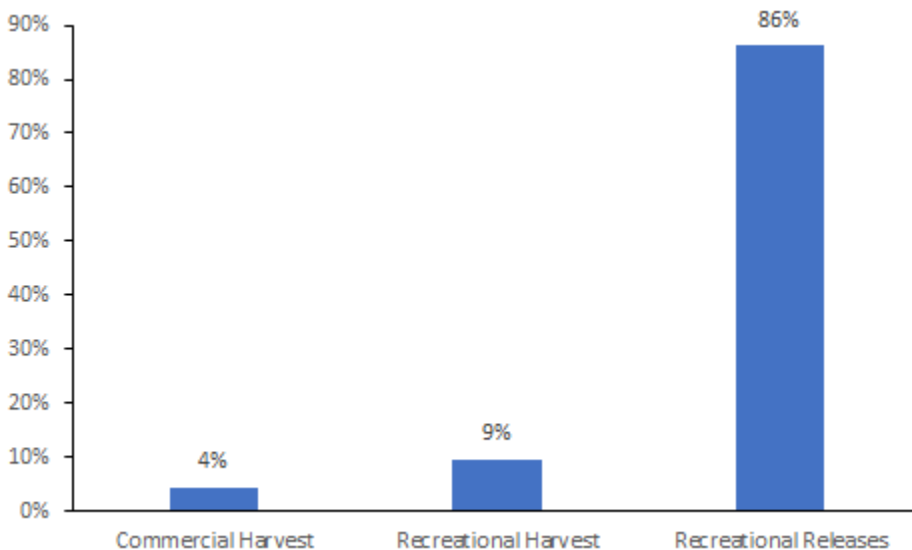
Figure 3. Precision of Annual Maryland Striped Bass Recreational Discard Estimates by Year
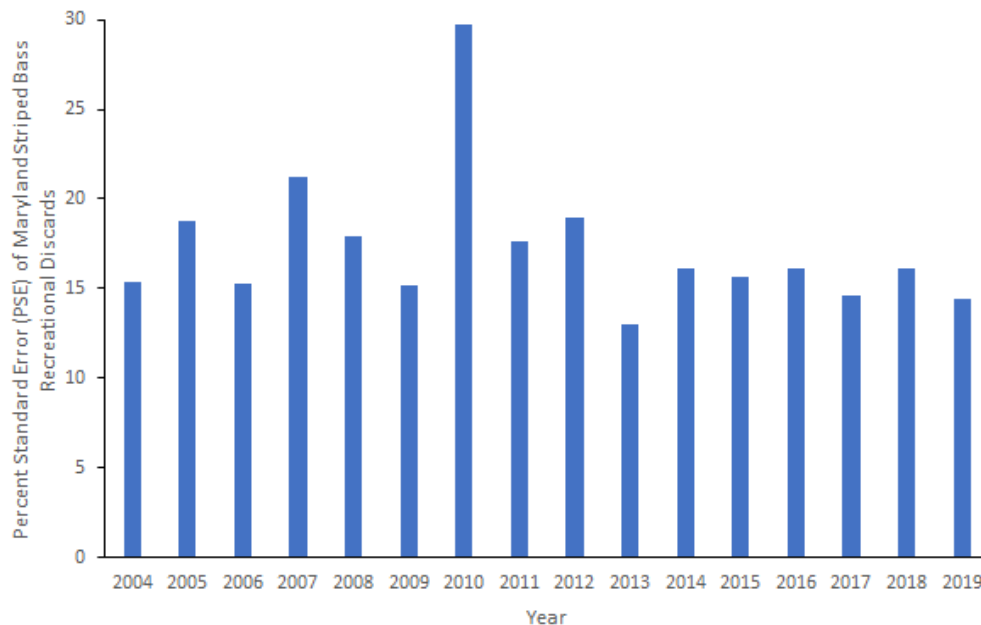
The Precision of MRIP Estimates at Different Scales

It should be noted that while the annual harvest and release estimates from MRIP have low PSE values (indicating higher certainty) on a coastwide and statewide level, the PSE values of recreational data from MRIP do increase (indicating higher uncertainty) as data are disaggregated into smaller components (Table 1). For example, in 2019, the Atlantic coast annual harvest and release estimates had PSEs of 9.7% and 6.4%, respectively. Looking at just Maryland's 2019 estimates, the PSEs increase to 13% and 14.4% for harvest and releases, respectively. Estimates can be further partitioned into inland waters which includes the Chesapeake Bay and its tributaries, as well as the coastal bays on the Atlantic coast. The PSEs do not increase much as most of the harvest and releases are estimated as being from inland, rather than ocean, waters. This inland estimate for Maryland can be partitioned into even smaller components, such as into two-month waves or specific fishing modes. Maryland's inland Wave 2 estimate (March and April) has a high PSE of 46.6% for harvest and 64.3% for releases. These PSEs are much smaller in Wave 4 (July and August) at 24.3% and 24.8% for harvest and releases. Wave 4 estimates are much more certain than those from Wave 2 due to the amount of data contributing to the estimate. Not as many people fish in March and April so not many trips are intercepted during those months. In comparison, July and August are the busiest months and many anglers are intercepted. PSEs increase again once we break down the wave data further into specific fishing modes (private/rental boat and shore modes). As can be seen in the table, PSEs increase and uncertainty increases as the data is broken down into smaller and smaller components, and care must be taken when using smaller estimated components of MRIP for science and management.

Table 1. Estimated precision of MRIP data at various levels of aggregation using 2019 estimates.

Time Scale	Geographical State/Area	Fishing Mode	Fishing Area	Harvest Estimate	PSE	Live Release Estimate	PSE
Annual	Atlantic Coast	All Modes Combined	All Areas Combined	2,199,994	9.7	29,582,415	6.4
Annual	Maryland	All Modes Combined	All Areas Combined	765,170	13.0	6,998,203	14.4
Annual	Maryland	All Modes Combined	Inland	764,137	13.0	6,981,154	14.5
Wave 2 (March-April)	Maryland	All Modes Combined	Inland	11,984	46.6	79,521	64.3
Wave 4 (July-August)	Maryland	All Modes Combined	Inland	338,414	24.3	3,161,394	24.8
Wave 4 (July-August)	Maryland	Private/Rental Boat	Inland	242,360	30.7	2,566,230	28.5
Wave 4 (July-August)	Maryland	Shore	Inland	14,097	61.3	449,268	60.6

Annual estimates of recreational total removals (harvest and dead discards) for striped bass are used by ASMFC at the coastwide level for development of the coastwide stock assessment, as well as to develop coastwide regulatory measures to maintain an acceptable fishing mortality rate. This means that the currently accepted stock assessment model is using the most precise data available to inform managers of stock status. At the state level, recreational total removals are used to develop state-specific regulatory measures under conservation equivalency (i.e., when the state would like to implement management measures different from those proposed by ASMFC). Data used at the state level is less precise given the smaller spatial scale of the estimates, and depending on the regulations being proposed, may include the use of data at even smaller levels, such as wave or mode.

While annual harvest and release estimates of striped bass are considered to have very good precision, harvest and release estimates of other coastal species are not as precise and the Department is working to enhance the precision of these estimates.

(2)   Consideration of the types of information and level of detail most beneficial for the Department to obtain for its scientific and management duties and capabilities.

(a) Types of information currently used to develop management for all striped bass fisheries

The annual Maryland commercial allocation and recreational measures are the result of a combined scientific and management process conducted through the ASMFC using information from Maine to North Carolina. A striped bass stock assessment is conducted approximately every two to three years. This mathematical model is used to estimate the health of the stock, specifically by estimating the fishing mortality rate and spawning stock biomass. The estimated values are compared to the fishing mortality rate and spawning stock biomass reference points, levels of which keep the stock within desirable

conditions. When the assessment is run, scientists and managers consider where the fishing mortality rate and spawning stock biomass are relative to their reference points, and determine what management actions, if any, need to be taken. Managers also annually review juvenile indices to determine if management action is needed between assessments and commercial landings to ensure commercial fisheries remain within their quotas.

The information required for the striped bass stock assessment is a combination of harvest, other removals from the fishery (discards, catch-and-release mortality, natural mortality) and age structure of the population. Estimates from tagging studies or other studies are used to estimate the natural mortality and discard mortality. Data from the fishery (or fishery-dependent data) are collected by state and federal agencies and include data on the number of commercial fish harvested, the number of recreational harvest and discards, as well as biological data on the catch (e.g., ages, lengths, and weights). Additionally, many of the data sources used in the assessment are independent of the fisheries. These 'fishery-independent' data sources are important to ensure robust stock assessment results because catch data can be influenced by factors other than stock health (e.g., weather, economics). These fishery-independent data sources are collected by both state and federal agencies, and are used to develop indices that show the trends in the population. They include information on recruitment (i.e., juvenile seine surveys) as well as population abundance at other ages (i.e., trawl or gill net surveys).

A description of the information collected within Maryland and its use follows.

Catch information:
- Recreational Data
  - Harvest and release data used in the stock assessment come from the MRIP. MRIP estimates the number of angler trips, harvest, and live discards, and provides lengths of harvested fish from March-December in Maryland for all recreational fisheries in tidal waters (private, shore, and for-hire modes). Dead discards are estimated using a coastwide average of 9% based on a previous discard mortality study conducted in Massachusetts.
  - Harvest and some discard data for the for-hire sector is also available from the mandatory DNR charter boat logbooks. The logbooks provide information on angler trips, harvest, and number of fish released. While these data are used for some management purposes and the effort data are incorporated into MRIP estimates of for-hire effort, they have not been historically used in the stock assessment due to their incompleteness. Only those charter boats fishing under the state's charter decal are required to submit logbooks to DNR and compliance with the reporting requirement is less than 100%. Additionally, not all captains submit information on all species caught, often omitting some species viewed as less valuable, or not entering the numbers of fish of each species discarded.
- Commercial Data
  - A DNR commercial reporting system provides commercial harvest data. These data are used both for management (to keep the harvest within the annual quota) and in the stock assessment.
  - The ASMFC Striped Bass Stock Assessment subcommittee estimates the commercial discards for the entire Chesapeake Bay as a proportion of the commercial harvest using tagging data and gear-specific discard mortality rates.

Population and length/age structure information:
- Chesapeake Bay information (spawning and resident stocks)
  - Fishery independent data
    - A DNR gillnet survey to characterize abundance and age-at-length of spawning migrants is conducted each April and May (2,146 fish were sexed and measured in 2019, and 342 scales were aged). This survey is required by the ASMFC

fishery management plan and is used as an index in the coastwide stock assessment. Ages from this survey are used to develop spring age-length keys.

- ■ A DNR beach seine survey characterizes the abundance and age-at-length of the young-of-year and age-1 stock. This survey is required by the ASMFC fishery management plan and is used as indices in the coastwide stock assessment. It is examined annually by managers in case it shows low recruitment and a need for management action.
  - ○ Fishery dependent data
    - ■ A DNR creel survey of charter boats from the start of the spring trophy season through June 15 collects information on age-at-length of the migrating and resident spawning stock (In 2019, 47 trips were intercepted, 287 fish were sampled, and 66 scales were aged). These data are used to develop length-weight relationships for spring caught fish, supplement spring age-length keys, and may be used for harvest length information (depending on the number of lengths collected by the volunteer charter survey (below) or MRIP).
    - ■ A voluntary charter captain survey from the start of the spring trophy season through June 15 provides lengths of both kept and released striped bass that are used in the development of the age structure of discards and often harvest in the spring (2,509 striped bass lengths were reported in 2019; 1,061 kept and 1,448 released).
    - ■ A private angler volunteer survey provides lengths of kept and released striped bass in the Chesapeake Bay (in 2019, a total of 477 lengths were submitted. 51 lengths were reported in the Spring season - 47 released, four kept. 426 lengths were reported in the 2019 Summer-Fall-Winter season - 296 released, 130 kept). While there are usually more length samples collected by MRIP of harvested fish, this information is the only source of discard lengths from the striped bass fishery in the summer-fall-winter season.
    - ■ Check station and pound net monitoring provides lengths- and weight-at-age of commercially-harvested fish. Scales are also collected to develop age-length keys. In 2019, 3,565 lengths and weights were sampled, and 155 scales were aged from the Chesapeake Bay gill net check stations in January, February and December; 1,819 lengths and weights were sampled, and 57 scales aged from the Chesapeake Bay summer/fall commercial pound net and hook and line fisheries in June December; and 7,167 lengths were sampled, with 133 scales aged from pound net monitoring in June-November. Since these fish are the same stock as the recreational harvest and discards in the summer, fall, and winter, these weights and age-length keys are applied to develop weight-at-age and catch-at-age of the recreational harvest, as well as the commercial harvest.
- ● Atlantic Ocean information
  - ○ Fishery dependent data
    - ■ Check station monitoring provides data on commercially-harvested striped bass on the Atlantic coast. In 2019, 131 lengths and weights were sampled, and 110 scales aged from coastal check stations. These data are used to develop length-weight relationships and age-length keys which are then used to estimate the catch-at-age from the coastal commercial fishery.
    - ■ A private angler volunteer survey provided 6 lengths of released fish on the coast in 2019. The Department does not get enough information on the lengths of recreational harvest or releases from either MRIP or the volunteer angler survey on the Atlantic coast to accurately describe the coastal catch. In years when MRIP has any estimate of ocean harvest or releases, data are usually borrowed from New Jersey to estimate the lengths of fish harvested and released along Maryland's coast.

Both commercial and recreational harvest data are important and are used at various stages of the

scientific and management process. Their uses, and the benefits of more accurate data, include:

Assessment - More accurate harvest and release data in the stock assessment improves the quality of the stock assessment model thereby increasing confidence that safe harvest levels are appropriately set to sustain the population.

Allocation – Accurate harvest data are important because most allocation decisions, which state/region gets to harvest how much, are based on harvest history. States/regions with poor harvest records are often disadvantaged during allocation decisions. Accurate harvest data are also important when allocations are made between sectors (i.e., between the commercial and recreational sectors, or within the recreational sector).

Management and Review – Confidence in estimated harvest allows managers to maximize harvest rules because they are more certain they will not exceed prescribed levels. Greater uncertainty results in managers needing to take more precautionary actions.

Overall, the process of assessment, allocation, management and review is a combination of coastwide, regional and state-specific steps.

(b) Level of detail most beneficial for the Department to obtain

Compared to many other species, the Department (and the coast) has a lot of information on striped bass. This is particularly true within the Chesapeake Bay where most striped bass fishing in Maryland occurs (Figure 4). While increased precision from the MRIP striped bass data could potentially be had in the Chesapeake Bay for certain waves (Waves 2 and 6) and modes (shore mode), the precision of the estimates overall is pretty good. The precision of the annual Maryland recreational striped bass estimates produced by MRIP are consistently about 14% for harvest (between 10-22% each year in the past 10 years) and 16% for releases (between 13-30% each year in the past 10 years). MRIP's website suggests "Estimates should be viewed with increasing caution as PSEs increase beyond 30%" and all annual striped bass estimates for Maryland are below this value in recent years. One key reason for the high quality of striped bass estimates is that the angler interviews produce a good representation of the Maryland striped bass fishery. This is because striped bass are widespread and sought after year round.

Figure 4. Distribution of Maryland 2019 Striped Bass Recreational Harvest (left) and Live Releases (right) by Fishing Sector and Area
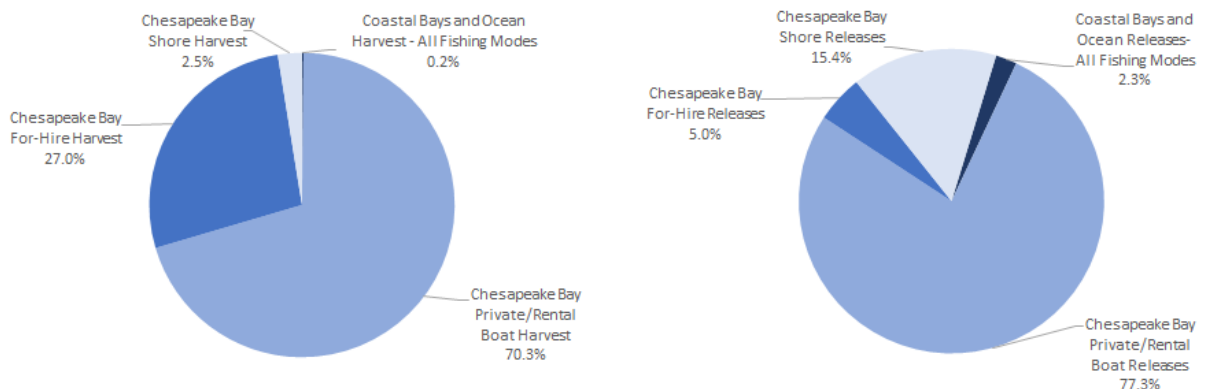
Where DNR lacks data for striped bass is on the Atlantic coast. Not many striped bass trips are intercepted by MRIP in the coastal bays, and under MRIP's survey areas these fish are included in the inland harvest estimates that also include the Chesapeake Bay. While there are methods to separate the inland catch into the Chesapeake Bay and coastal bays components, methods have not yet been provided by MRIP to estimate the precision (PSEs) of these smaller area estimates using the public data sets. Given how few striped bass intercepts are collected by MRIP on the coast (i.e., 49 in 2019 on the coast compared to 1,461 within Chesapeake Bay), any PSEs calculated for the coastal bays and ocean

catch would be very large, indicating very imprecise estimates. Due to the fact the coastal bays catch is estimated to be a very small component of the total inland catch estimates (usually <3%) and the precision of the inland estimates overall, science and management usually assumes that MRIP's inland catch estimates represent the Chesapeake Bay and the ocean estimates represent the Atlantic Ocean.

With ASMFC's 2019 striped bass stock assessment determining the stock to be overfished with overfishing occurring, the data needs have increased as managers develop methods to reduce fishing mortality on the stock. Managers usually focus on reducing harvest through the use of size limits, bag limits, or season length. As changing the season length could just shift effort throughout the year, managers tend to favor the first two options as they are more certain to achieve harvest reductions. However, for a fishery like striped bass where the majority of fish caught are released, these typical methods that reduce harvest will not reduce the number of dead discards and in some cases, have the unintended consequence of increasing the numbers of dead discards. This leaves fewer options for managers to consider when trying to reduce fishing mortality.

These realities have put greater demands on the use of MRIP data, often in situations that were never envisioned when MRIP was designed. Additional data have also been needed to determine the effects of alternative regulatory strategies than those used previously. Specifically, this includes information on what fishing methods anglers are using, detailed hooking mortality estimates, and harvest estimates at scales smaller than the areas and two month waves provided by MRIP. While these additional information could be useful to management, it remains to be seen how much of this detailed information could be incorporated into coastwide stock assessments.

Even with this additional information, uncertainty would still remain when estimating the specific outcomes of regulatory actions. These analyses assume angler behavior remains the same, but angler behavior could change when new regulations are enacted. Effort, or the number of fishing trips taken each year by anglers, is also hard to predict year-to-year and is usually assumed constant. However, effort can change each year due to weather, economic conditions, etc. Year classes entering and exiting the fishery can also drastically change the effect of the intended management actions, resulting in more or less fish available to the fishery. Even under constant regulations, these variables can cause the harvest and releases to change drastically year-to-year, much less trying to predict what future catches will be under new regulations.

(3)   Consideration of the advantages, disadvantages, and feasibility of implementing various methods for obtaining more accurate harvest data for the recreational striped bass fishery

Option 1: Implement a Census Reporting System for Recreational Striped Bass Anglers

Census reporting is when all participants in a fishery are required to report. These types of systems require that all participants are licensed or permitted so that compliance can be tracked. To achieve high levels of compliance, it is also usually necessary to implement a system of consequences for non-reporting.

This is not a realistic option for the recreational sector in Maryland due to the scope of the fishery. The commercial fishery is able to have census reporting because it is a relatively small group of individuals Commercial authorizations are limited by regulation to under 8,000 with approximately 6,000 authorizations in use. These authorizations represent approximately 2,000 individuals who are active in the commercial fisheries each year. Due to these authorizations, which have to be renewed each year, DNR knows who is entering and leaving the fishery each year and who should be filing reports, which are required to be submitted by law.

Census reporting may be possible in the future for the for-hire industry who, similar to the commercial industry, comprise a small number of people who are required to be licensed to guide recreational anglers. In addition to their licensing requirements, charter captains and fishing guides can choose to

purchase the charter boat decal, which allows anglers to fish with them without requiring the anglers to have their own individual recreational licenses. Those who purchase the decal are required to submit logbook reports weekly to DNR. However, as mentioned above, not all captains are required to fill out these logbooks and of those who do, they are often not filled out completely, sometimes omitting information on species deemed less valuable or not including any information on the species they released. In spring 2020, DNR expanded the pilot FACTS e-reporting system to charter boat operators, allowing them to submit their logbooks electronically in a much more timely manner than the weekly paper reports currently required for charter boat decal holders. Additionally, the use of a hailing system and dockside monitoring, as well as onboard observers, has provided the ability for data validation. As of October 1, 2020, of the 423 vessels required to report via logbooks, 291 (69%) were reporting through the pilot FACTS program.

In contrast, Maryland's private recreational fishery is open access, meaning that the anglers are both state residents and out-of-state visitors, and the anglers are different each year. Anglers can purchase either annual or short-term licenses and licenses can be bought at any time of year. Additionally, there are many license exemptions such as youth under the age of 16, individuals fishing on free fishing days, and those with a valid commercial license. Other large groups of the angling public are not required to have a Maryland fishing license, but are required to have a free angler registration. These include those fishing under someone else's boat license, those fishing from free fishing areas, or people fishing from their own private shoreline. It is suspected, however, that compliance with the free license registry is low given the numbers of boat licenses sold each year and the number of free registrations purchased. This makes it hard to know at any given time how many recreational anglers there are.

The scale of the private recreational and commercial fisheries is also completely different. Most of Maryland's recreational striped bass harvest is by anglers fishing from private or rental boats in inland areas (mostly Chesapeake Bay, Figure 4). The MRIP estimates that approximately 1.6 million private angler trips (boat or shore) were made in Maryland in 2019 that targeted striped bass and that approximately 558,361 striped bass were harvested (PSE=16.2%) across all trips (not just those targeting striped bass). Experience in other states has shown that, even with mandatory reporting, the results would likely have a substantial rate of error. These errors are due to under-reporting (anglers not submitting data when they're supposed to), anglers misreporting the number of fish they actually harvested or released, or even anglers misidentifying the species reported.

This is why other logbook programs, which consist of self-reported data, rely on validation of the data submitted. These data-related issues are being discussed coastwide, not just for private recreational logbooks, but for for-hire reporting as well. Harvest is usually validated through intercept surveys where anglers are intercepted at the docks and the interviewer records the number of each species harvested. Harvest validation can usually only occur at publicly accessible access points, resulting in the assumption that anglers who access the water from private access points have the same reporting and fishing habits as those who use public access sites. Discards are much harder to validate, often relying on either video monitoring on vessels or on-board observers. In both cases, the observed values are then compared to what was reported and the reported values are adjusted to account for errors (either unreported or misreported trips). Therefore, a survey would have to be conducted to estimate the error associated with the reported values. The final estimates would still be the result of a survey, just as the MRIP estimates are the result of a survey.

Option 2: Increase the Accuracy of the MRIP Recreational Harvest Estimate

Two separate surveys are combined to obtain the MRIP estimate of striped bass recreational harvest – the(APAIS, and the FES. Accuracy can be described in two ways: how unbiased the estimate is and how certain one is of that estimate. Bias can be introduced into recreational fishing surveys if the sample populations are not representative of the overall total angling population. Adequate sample design is paramount to addressing this issue, and it's why both the APAIS and FES utilize random sampling

designs. To increase the certainty in the estimates, the most common (and guaranteed) method for increasing precision is to increase sample size.

The FES is used to estimate the number of fishing trips anglers take. The FES is a dual-frame survey that utilizes the postal service's address data frame and states' saltwater angler registries. Within each state, the households are first stratified by coastal and non-coastal counties. The sample is then further stratified into those whose address match the saltwater angler registry and those who do not. While surveys are randomly sent to both licensed and unlicensed households, this stratification helps to optimize the sampling. Previous research by MRIP found that people on the angler registry were more likely to respond to the fishing survey, and were more likely to have fished within the previous two-month period. Sample sizes for each state and wave are determined by MRIP, with a goal of achieving a coefficient of variation of 0.2. To ensure high participation, the survey asks about weather in addition to fishing, making it more likely non-fishing households will also reply. They also include a reward for participation and send reminder letters to remedy nonresponse. While it is unclear whether a state could pay to increase the number of effort surveys sent out or how large the increase would have to be to increase the precision of the MRIP estimate, one method within the state's ability to improve the effort estimates would be to increase the completeness of Maryland's angler registry. As mentioned above, while the angler registry is incomplete in part due to license exemptions which are unlikely to go away (i.e., kids), a larger issue is likely the lack of anglers signing up for the free registration required when they fish under someone else's boat license, fish from their own private property, or fish in free fishing areas. Efforts to make our angler registry more complete will hopefully help improve the precision of the effort estimates by allowing for greater optimization of the survey procedures.

The APAIS is used to estimate the catch rates of various species along the coast. Some states choose to provide additional funding to this survey to increase the number of sampling assignments conducted in their state. These add-ons can be assigned to try to target specific fishing modes or times of year.

In order to determine the potential effect adding sampling assignments could have on the precision of striped bass harvest estimates, an analysis of the past MRIP data was conducted. Sampling assignments for the APAIS are calculated separately for the fishing modes (shore fishing, private/rental boats, charter and party boats). Analysis of data available through the NMFS website provided the historical relationship between interviewer assignments (site clusters) and recreational harvest PSE for each fishing mode. As was shown in Figure 4, the dominant recreational fishing mode is private/rental boat anglers. Analysis of historical annual inland data showed that the precision for this fishing mode is still excellent (consistently less than 30% error) and that there is very little relationship between sample size (number of site clusters sampled) and error (Figure 5).

Figure 5. Relationship of Precision of Maryland Striped Bass Recreational Harvest and Number of Private and Rental Boat Sampled Site Clusters, 2004-2019
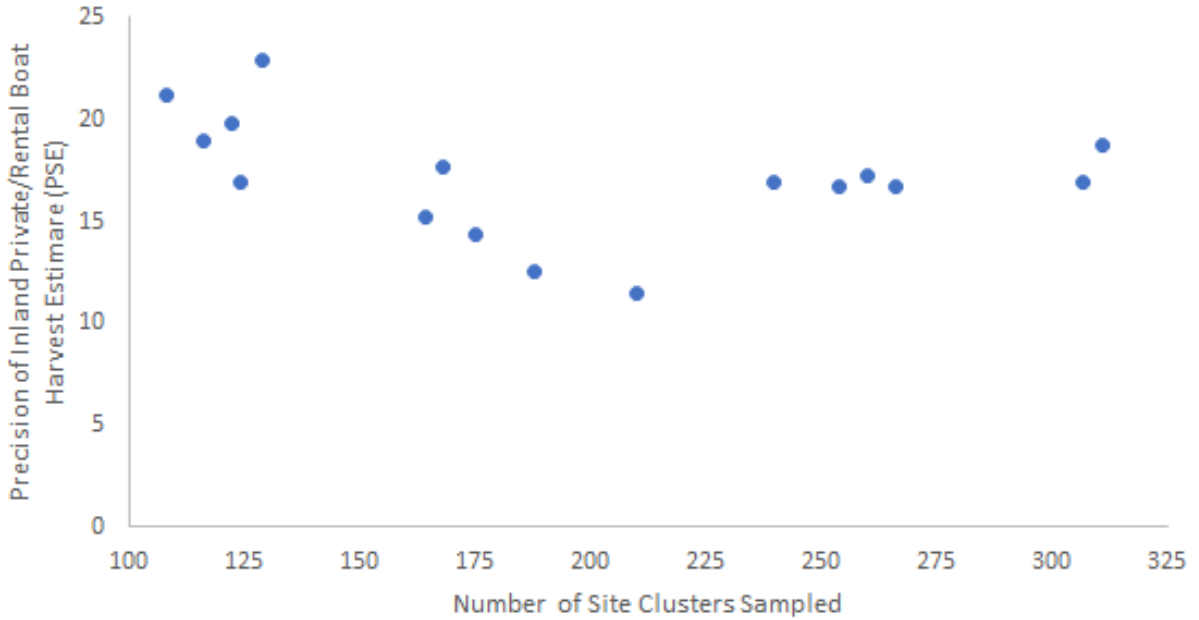
The second most dominant fishing mode was charter. Analysis of historical annual inland data showed that the precision for this fishing mode is also still excellent (consistently less than 30% error) and that there is very little relationship between sample size (number of site clusters sampled) and error (Figure 6).

Figure 6. Relationship of Precision of Maryland Striped Bass Recreational Harvest and Number of Charter Boat Sampled Site Clusters, 2004-2019
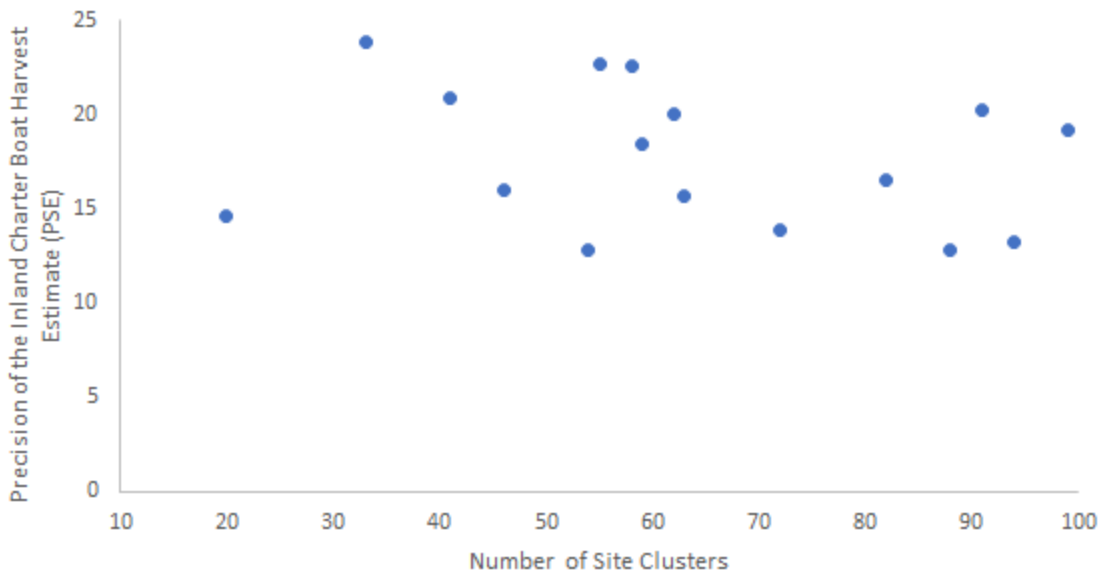
These analyses show that, for the range of site clusters sampled between 2004-2019, there is very little decrease in annual PSEs for striped bass harvest as the number of sampling assignments increase. As mentioned above, striped bass are widespread and available year round. This means that the striped bass estimates are already pretty good, and substantial increases in sampling would be needed to see any additional decreases in PSE.

While it is unlikely that we will see much, if any improvement, in the PSEs for striped bass without increasing the number of assignments in APAIS significantly, increasing the number of assignments may decrease the PSEs for other, more rarely encountered species. Decreasing PSEs for MRIP catch estimates is the number one priority listed for the Atlantic coast in the 2017-2022 Atlantic Coast MRIP Implementation Plan. In 2020, MRIP notified the Atlantic coast states that $900,000 in additional funding would be available to increase the APAIS sampling. For 2021-2024, Maryland expects to receive funding from NMFS for approximately 290 additional assignments over current base sampling levels. While the focus of this additional sampling is not necessarily on striped bass, striped bass are so commonly encountered that it is likely additional intercepts will occur with the additional sampling.

While the precision of the MRIP estimates could be improved with additional sampling, estimates would still conform to the survey design of MRIP, which estimates catch at the two-month wave level and combines the Chesapeake Bay and coastal bays into one inland area.

Option 3: Develop a Specialized Survey to Estimate Striped Bass Harvest

In the 2017 National Academies of Sciences review of MRIP, they discuss limitations of the MRIP survey in addressing certain state specific needs, such as the development of catch and effort estimates at small spatial scales (i.e., for assessments or state management of species) or the in-season monitoring of catch limits. These issues have been difficult to address, particularly when they would require a large increase in sampling effort, becoming cost prohibitive, or they are so specialized that they are difficult to integrate into the standard MRIP survey. For these reasons, some states/regions have developed specialized surveys that focus either on fish species not often intercepted by the usual MRIP survey, fisheries that occur over a small temporal or spatial scale, or fisheries that require close in-season monitoring of catch. Examples include: the Large Pelagic Survey, Florida's State Reef Fish Survey (formally the Gulf Reef Fish Survey), Alabama's Snapper Check, and Mississippi's Tails n' Scales.

NOAA's Large Pelagic Survey collects information from Maine to Virginia on tuna, sharks, billfishes, swordfish, and other offshore recreational species. It consists of a suite of surveys similar in design to MRIP with: the Large Pelagics Intercept Survey for estimating catch rates per vessel; the Large Pelagics Telephone Survey, which estimates the number of trips taken for large pelagic species through phone interviews of those with Highly Migratory Species permits; and the Large Pelagics Biological Survey, which collects age, length, and weight information necessary for stock assessments and to document life history characteristics. This survey was deemed necessary because the species intercepted are relatively rare and require specific fishing methods that were not adequately sampled in MRIP.

Florida's State Reef Fish Survey was designed to collect data on red snapper and 12 other reef species within the snapper-grouper complex. To land any of the specified reef species in Florida (even if the fish was caught in federal waters), private boat anglers are required to get a free State Reef Fish Angler designation. While there are still some exemptions for who needs a designation, some anglers who are exempt from needing a fishing license are still required to get the reef fish designation (i.e. those 65 years or older). This survey is similar to MRIP in that it consists of a mail survey to measure effort and a dockside intercept survey. The mail survey is conducted monthly (unlike the two month waves used by MRIP) and utilizes the State Reef Fish Angler designation to inform who is mailed the survey. The State Reef Fish Survey is complementary to the MRIP and they are run side-by-side.

Mississippi and Alabama's red snapper programs differ from each other in some design features, but both rely on a capture-recapture survey design. Under this type of system, anglers are required to report their catch electronically before landing at the docks. These surveys, however, acknowledge that you will never

get 100% reporting (e.g., a census). To account for this, both states also conduct a dockside intercept survey to validate the self-reported data. This allows for the reported harvest to be adjusted for those anglers who may not submit a report, even though it is required, and to correct for anglers misreporting their harvest. Mississippi's Tails n' Scales requires one report per vessel per trip landed in Mississippi, regardless of where the fish was caught, and vessels must start a trip in the mobile app before beginning to fish. By starting a trip, an authorization number is issued that is valid for 24 hours. A new trip/authorization number cannot be issued by the system until the vessel report for a previous trip is completed. Alabama's Snapper Check also requires one trip report per vessel per trip, and that the trip report is submitted before docking or removing trailered vessels from the water. Crucial components of both of these programs include the ability to match angler reports (if submitted) with the appropriate dockside intercept, allowing comparisons to be made, and enforcement on the water of report submission. If anglers are compliant and submitting reports correctly, estimates of the reported harvest will have lower PSEs and more closely match the harvest reported electronically. However, if many anglers aren't submitting reports or they're not accurate, greater adjustments will be made to the reported harvest resulting in potentially higher PSEs.

Florida's Gulf Reef Fish Survey, Mississippi's Tails n' Scales, and Alabama's Snapper Check were all certified by MRIP in 2018, allowing for their estimates to be used in federal stock assessments, and making them eligible for MRIP funding to be used for implementation and improvements of the surveys.

These four examples of specialized surveys aim to address issues the MRIP survey couldn't handle well: either focusing on specific species or species complexes that are relatively rare in the regular MRIP datasets, species with short seasons or pulse fisheries, and/or species where it was imperative to measure catch in season to make sure catch limits were not exceeded. None of these conditions are true for striped bass in Maryland. Striped bass are a popular species in Maryland year round. MRIP already encounters many striped bass anglers in their intercepts, and it is unlikely that a specially developed survey would provide a greater number of intercepts than is already encountered by MRIP. Also, recreational striped bass catches are not managed to a quota and have no need for in season monitoring.

Additionally, the snapper fisheries are much smaller and more manageable to collect data on than the striped bass fishery in Maryland. Alabama's 2020 private angler red snapper season was only anticipated to be open 35 days while Mississippi's was expected to be open 52 days (May 22-July 12). Mississippi reported on their red snapper website that between 2017-2019, the number of red snapper trips taken per year ranged from 4,185-5,423 vessel trips and the number of red snapper harvested per year ranged from 22,126-27,189 fish. In contrast, Maryland's 2020 striped bass season is open 208 days, 4-6 times longer. Maryland's estimated harvest from the shore and private modes between 2017-2019 ranged from 558,361 to 840,654 fish, 20-30 times larger than the number of red snapper estimated to have been harvested in Mississippi over the same years.

While a specialized survey could allow catch to be estimated over shorter time periods or different spatial areas as compared to MRIP, Maryland's striped bass fishery is so much larger in scope and scale that any specialized program design would prove incredibly expensive, complicated, and in some cases financially or politically untenable, since it would be necessary to promulgate regulations requiring that each recreational angler report their activity to the Department within a predetermined time frame. Failure to comply would likely result in some sort of penalty to ensure compliance with the new regulatory burden. Beyond this, a specialized program would require development of striped bass specific electronic reporting apps/software and data storage, the creation and enforcement of reporting requirements, a large staff to validate the data self-reported through random dockside intercepts, which are expensive and will neglect the large number of anglers with private water access, and technical staff to produce estimates. All initial costs will be borne by the state or will require the acquisition of grant funding as MRIP will potentially fund those surveys that they have certified (a multiyear process). **Lastly,** the final estimates would still be the result of a survey, just as the MRIP estimates are the result of a survey, with no guarantee that the resulting survey estimates will be any more precise than what is currently provided by MRIP.

Option 4: Utilize Electronic Reporting from the Recreational Sector

Electronic reporting on its own is not a survey method that can be used to estimate the total number of striped bass harvested and released, but rather one possible method of collecting data from anglers on their fishing trips and catch.

DNR uses electronic methods to collect data from private recreational anglers on fish they catch through the use of volunteer angler surveys. These surveys are available on DNR's website as well as the DNR app and ask anglers for information on their trips (where they fished, for how long, the number of anglers, how many fish were kept, how many were released, etc.) as well as biological information on the fish they kept and released (usually lengths and disposition for each fish caught). The Striped Bass Volunteer Angler Survey is a critical piece of information for management and analysis, as it is the only information available on the lengths of striped bass released by anglers. Participation, however, has been hard to maintain. When outreach efforts were high in the early years of the survey, the number of striped bass lengths submitted was in the high hundreds, though still usually from the Chesapeake Bay. As the amount of outreach has decreased, so has the amount of data submitted. In 2019, a total of 483 striped bass lengths were submitted, 477 from the Chesapeake Bay and 6 from the Atlantic coast. Splitting the Chesapeake Bay data out further, 51 lengths were submitted from the spring season (47 released and four kept) and 426 from the summer-fall-winter season (296 released and 130 kept).

Opt-in data collection, where anglers volunteer their data, can be useful, particularly when other data are sparse or non-existent, but it also comes with the risk of the data being biased. Opt-in data collection tends to be biased toward more avid anglers, those more involved in fishery management, or those with more familiarity with technology. It is unknown how representative these data are of the angling population as a whole who may not fish as often, or may not have the same level of technological experience. These concerns are likely more problematic when using the data to calculate things like catch rates, where experience would matter more, than say the collection of length information. Some of these concerns may be alleviated by having large sample sizes, but it highlights the need of a randomized component of any survey if one wants to reduce bias.

A study was published in 2016 in Fisheries regarding the use of smartphone apps to collect recreational fishing data for red drum, common snook, and spotted seatrout in Florida using the iAngler app. They found that when data from enough trips had been collected, the catch rates (catch per angler trip) were similar to those estimated by MRIP at the county level. In their abstract, they summarize that "Self-reporting programs often suffer from biases concerning angler avidity, drop-out, and lack of angler representativeness but have the ability to provide data where traditional methods cannot. If methods to correct such biases are developed, programs like iAngler have the potential to provide valuable catch rate data to fisheries managers." They specifically recommend in the text that "electronic apps like this may be best utilized by actively soliciting data for species that are undersampled by MRIP." It should also be noted that their study only compared catch rates. Given the opt-in nature of the data collection in the iAngler app, they did not have the ability to compare total effort or total catch estimates.

The use of electronic data collection has also been a focus of MRIP in recent years, and they are currently working on ways to incorporate recreational electronic data collection in their surveys. In 2018, MRIP initiated a pilot study using a web survey for the FES rather than having respondents respond to the survey by mail. Additionally, since 2019, tablets have been used by APAIS on the Atlantic coast to increase the timeliness of intercept data submission. MRIP has also certified surveys in Mississippi and Alabama that use apps for submission of catch data. These programs, however, are mandatory reporting programs with legal consequences for non-compliance. They also utilize probabilistic sampling surveys to correct for underreporting or misreported harvests.

Opt-in programs, where participation is voluntary, can provide useful information for management, but their voluntary nature means that not all trips and catches will be reported. MRIP's website on electronic

reporting summarizes the current state of electronic opt-in reporting well: "'opt-in,' or non-mandatory, angler reporting apps cannot on their own produce population-level estimates of recreational catch. Instead, a statistically valid probability-based sampling survey must be used to validate self-reported data, monitor the extent of reporting, and account for unreported trips. The addition of this survey will impact data collection costs, while the accuracy and rate of app reports will impact the quality of the resulting estimates." While opt-in programs are unable to determine the total number of fish caught, they are often useful in providing additional data not collected through the MRIP program, such as discard lengths or additional information on angler behavior (i.e., specific gears used, reasons for discards, etc.). As MRIP does not collect lengths of discarded fish, this is an area where voluntary reporting programs can supplement data from MRIP to improve fisheries stock assessment and management.

NOAA has also been exploring how private recreational electronic reporting could be used in the future. A new Recreational Electronic Reporting Task Force, under NOAA's Marine Fisheries Advisory Committee, was appointed in April 2020 to:
1. Identify and prioritize known data gaps relative to NOAA Fisheries' role in supporting management of marine recreational fisheries that could be addressed through mandatory or voluntary private recreational angler electronic reporting programs.
2. Identify realistic and achievable goals for voluntary (also known as opt-in) and mandatory electronic reporting for private recreational anglers, as well as associated challenges and solutions, where identifiable.
3. Provide recommendations on how the aforementioned goals could be best supported or achieved by NOAA Fisheries.

This group has only recently formed, but it will be interesting to see what recommendations come out of the Recreational Electronic Reporting Task Force in the future.

While DNR currently solicits information on anglers' catch for specific species through the volunteer angler surveys on the Department's website and through the DNR app, DNR has also begun exploring the potential data that anglers could provide electronically through the use of apps such as iAngler. iAngler is one potential app though others are also in development along the Atlantic coast. Specifically, there is a project currently underway between the SAFMC, North Carolina Division of Marine Fisheries, and ACCSP to develop a customizable citizen- science app. Their eventual goal is to develop a customizable tool that Atlantic states partners could use without having to develop their own apps for every new project or data need. In 2018, ACCSP's Recreational Technical Committee received a request from the SAFMC to develop data standards for private angler voluntary reporting programs. In October 2020, the Recreational Technical Committee reached out to the ASMFC Assessment Science Committee for their input on the potential uses of opt-in data for stock assessment and management as well as critical data elements to include in a potential citizen-science app. Based on their recommendations, the Recreational Technical Committee will begin drafting data standards in 2021.

These activities at the national, Atlantic coast, and state levels all highlight the continued interest anglers have in supporting fisheries management through private angler electronic reporting, the desire to make voluntary reporting by anglers as easy as possible, and the work currently underway to determine on how best to incorporate these data into the assessment and management process.

(4)   Recommended methods for obtaining more accurate harvest data for the recreational striped bass fishery.

Given the infeasibility and impracticability of implementing a census reporting system, the low likelihood that any specialized striped bass survey would provide better estimates of striped bass harvest and releases than MRIP without large increases in program staff and money, and the fact that MRIP already provides reasonably precise estimates of striped bass catch in Maryland, DNR recommends continuing to use MRIP data for striped bass science and management, continuing our cooperative work with NMFS

and other states along the coast to improve MRIP, and supplementing the information available from MRIP with volunteer data where needed.

An updated hooking mortality study within the Chesapeake Bay, with input from the ASMFC and the Striped Bass Technical Committee, could also be useful. While the Striped Bass Technical Committee is developing ideas on how to better incorporate detailed hooking mortality information into the stock assessment, these data would also be useful to managers when developing methods to reduce discard mortality. An ideal hooking mortality study design would need to include various hook types, fishing methods, salinities, and water temperatures. Dissolved oxygen may also prove important, especially since hypoxic conditions are more common during summer months. Better estimates of discards and discard mortality will improve stock assessments and lead to more successful management decisions. A new discard mortality study is underway in Massachusetts and DNR has provided a letter of support for grant proposals submitted by academic institutions in Maryland to study discard mortality within Chesapeake Bay.

These recommended methods will be discussed further with stakeholders, the SFAC and the newly created Tidal and Coastal Recreational Fisheries Committee (a subcommittee of SFAC). The Department will be seeking direct input from these groups on the recommendations in this report.

(5)   Recommended enforcement measures that would need to be implemented to support any methods recommended under paragraph (4) of this subsection.

Given that enforcement of voluntary reporting is not an option, DNR recommends finding other methods to improve data and estimates from the Fishing Effort Survey. One method would be to improve participation in Maryland's saltwater angler registry. An education campaign with the angling public on who needs to get a free registration and why it is important would likely improve compliance.

Similarly, the charter logbook data could be improved with increased use of the FACTS e-reporting system. Compliance and timeliness of DNR's for-hire data collection has increased under the pilot program. Increasing the reporting rate would improve the completeness of the data DNR is receiving.

Prepared by Angela Giuliano, Research Statistician
Fishing and Boating Services
Maryland Department of Natural Resources