Pilot project; Validation Methods for Headboat Logbooks

FY 2012 Proposal

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1. Overview

1.1. Sponsor

Rob Andrews

1.2. Focus Group

Survey Design and Evaluation

1.3. Background

The National Research Council's independent review (NRC, 2006) recommended "charter, party, and other for-hire recreational fishing operations should be required to maintain logbooks of fish landed and kept as well as fish caught and released". Further, the report states these logbooks should be "verifiable" since unknown biases in the estimators from surveys arise from reliance on unverified assumptions. In order to address this issue, the NRC recommended that those "assumptions should be examined and verified so that biases can be properly evaluated". In the case of the headboat fishery, the Southeast Region Headboat Survey (SRHS) has used logbooks since its inception in 1972. In conjunction with the headboat logbook, a dockside sampling component was also established during the initial design of the program. The objectives of dockside sampling are two-fold; 1) collect biological information, including lengths, weights, and biological samples from the catch, and 2) validate information reported on the logbooks. Historically, the SRHS has focused primarily on verifying fishing effort. A variety of methods are used to verify numbers of trips taken and numbers of anglers on board. That information is used to calculate an expansion factor (estimated total angler days/reported angler days) to account for the effort on unreported trips and to correct for mis-reporting of anglers per trip. Current SRHS dockside sampling focuses on obtaining biological information for estimating average weight and for determining the age composition of the landings. The survey relies on port samplers to maintain a systematic distribution of sampling in an opportunistic/cooperative setting rather than using a probabilistic approach. Given this current sampling design of opportunistic sub-sampling of individual trips with voluntary angler participation, it is not possible to either verify the self-reported logbook data or generate independent total catch estimates.The need to verify self reported catch information becomes a priority as fisheries management shifts towards bag limits and quotas. The current system incentivizes captains to under report landings in order to lengthen fishing seasons. The SRHS is currently completing an MRIP funded project to develop probability based methods for trip/sample selection. The next logical component of improved headboat catch estimates is verification of self-reported log book catches. The SRHS requests funds to develop and test probability based methods of dockside catch verification.

1.4. Project Description

The project will focus on determining and developing preferred methods for 1) verifying self-reported catch reports (both harvest and at sea discards (live and dead) and 2) expanding the reported data into statistically valid estimates total harvest and discards. We anticipate that this project will build on the conclusions drawn from the MRIP charter boat logbook pilot project in parts of Florida and Texas which compared information from dockside angler interviews and captains electronic log books (Kaiser, M. 2011.)We will use two consultants to develop both dockside sampling designs and expanded estimation procedures. The sampling design component will focus on angler selection, particularly at dockside.The program will consist of two components: 1) dockside verification and estimation and 2) a collaborative component for at-sea verification and estimation of discards. The dockside sampling component will evaluate alternative sampling approaches such as conventional interviews and camera based approaches for fish counts. Information collected at dockside will include those categories present on the logbook and filled in by the captain. Geographic coverage of dockside sampling will be restricted to three landing areas where extra samplers are requested (southeast Florida, southwest Florida and northeast Texas).The at sea component will collaborate with the MRIP and Florida through the overlapping ranges of the programs (North Carolina through the Florida Keys for MRIP-SRHS and the Tampa Bay area for the Florida Fish and Wildlife Commission program and SRHS.) The information from those programs will be used primarily in the verification of discards reported in captain's log books. Where the dockside verification sampling occurs, the utility of the dockside and at-sea sampling for verification will be investigated and estimation approaches using the log books, dockside and at-sea reports will be studied. In the areas where only at sea observers are deployed, the at-sea sampling will be compared to log books for verification and estimation approach based on those two sources will be studied. Different estimation approaches will be examined. These will include variations on the current system in which logbook reported landings are assumed known and estimates are made of landings from un-reported trips. Statistical approaches will be used to account for possible bias on reported trips and different estimation approaches including some similar to the model based estimators described in Kaiser 2011 will be investigated for use with the estimated proportions of the catches.

1.5. Public Description

1.6. Objectives

1. Design probability based sampling methods.2. Test dockside validation methods and protocols3. Develop imputation and estimation procedures using 1) only dockside sampling for landings estimation and 2) both dockside and self-reported log book data for landings estimation.4. Develop imputation and estimation procedures using 1) only at-sea sampling for discard estimation and 2) both at-sea-sampling and self-reported log book data for discard estimation.

1.7. References
NRC (National Research Council). 2006. Review of Recreational Fisheries Survey Methods. National Academies Press, Washington, D.C. Kaiser, M 2011. Charter-Boat Logbook Reporting Pilot Study Initial Examination of Data.

2. Methodology

2.1. Methodology
Using a probability based sampling approach; each validation method will be tested to determine its feasibility and merit. Sampling will be conducted using 2 port agents per location in order to effectively collect information from the entire vessel trip. This would include enumeration of anglers and species in the catch. Methods being considered include 1) photographing each angler's catch on a white board as they disembark the vessel. Photos would then be downloaded and viewed and enumerated afterwards. 2) Subsets of anglers would be interviewed for species totals and discard information 3) MRIP At-sea information will be used to verify angler totals, trip duration, species composition and discards.It is possible that additional samplers will be needed to adequately sample anglers from vessels which can carry large numbers of anglers. The possibility that additional samplers will be needed for trips with larger numbers of anglers will be investigated through the use of additional NOAA Fisheries samplers in limited times and areasInformation from each approach will be compared to self reported logbook data for corresponding trips to determine the reliability of the logbook data. Additional analysis will be conducted to examine correction factors, developing catch estimates from dockside sampling, and estimated cost of implementation for each method.

2.2. Region
Gulf of Mexico, South Atlantic

2.3. Geographic Coverage
Fort Pierce to Miami, FL (SEFL), Naples to Cedar Key, FL (SWFL), ; Sabine Pass to Port Aransas, TX

2.4. Temporal Coverage
June 1, 2012 to June 1, 2013

2.5. Frequency
Daily\weekly sampling (52 weeks)

2.6. Unit of Analysis
Headboat trip

2.7. Collection Mode
Dockside interviews and At-sea sampling aboard headboats

3. Communication

3.1. Internal Communication
Project Team members involved with weekly sampling schedules and port agent duties will communicate in some cases on a daily basis via email or phone. The entire project team will communicate on a monthly basis with a scheduled conference call to review progress and discuss any issues affecting the project. Monthly sampling results will be prepared and available to Team members as a shared document via email or by using the MRIP collaboration tool.

3.2. External Communication
The Project Team will provide a monthly report to the MRIP Operations Team to outline the progress related to the milestones and deliverables of the project. This report will point out any concerns or issues that may impact the project. Upcoming activities will be included in the report, along with any follow up items related to the project. If necessary the Project Team will request a conference call with the Operations Team to discuss any issues significantly impacting the project. Results of the project will be in the form of a final peer reviewed report.

4. Assumptions/Constraints

4.1. New Data Collection
Y

4.2. Is funding needed for this project?

4.3. Funding Vehicle
MRIP Operations Team

4.4. Data Resources
Southeast Region Headboat Survey and MRIP At-sea Survey

4.5. Other Resources
The sampling designs used for this project will require input from NOAA Fisheries Service analysts and two private consultants. The project will be based on the collaboration of these experts to develop objective and statistically defensible methods prior to testing.This project will require coordination with headboat operations beyond the current SRHS dockside intercept sampling protocol. Preliminary discussions of designs indicate the need to enumerate entire headboat catches, interview subsets of anglers and possibly other more time consuming approaches. The ability to enumerate the entire headboat catch dockside and interview a subset of anglers will pose some hurdles depending on the number of passengers, the layout of the dock and offloading conditions, and the willingness of anglers and headboat crews to be helpful. We assume that two samplers will be able to accomplish the landings verification component, though the validity of that assumption will be tested. Several methods for enumerating the entire catch will be considered for testing.Impacts on headboat operations will subsequently increase compared to the current sampling protocol. This will be minimized as much as possible by communicating and coordinating sampling efforts with the captains on a regular basis. The variance estimates associated with the dockside sampling based estimates of total catch will be dictated by the number of trips that can be intercepted and the number of anglers that can be intercepted from those trips. The number of trips that can be intercepted by two port samplers will largely be determined by the amount of time it takes to travel to a given port and how long it takes to complete the dockside sampling. This is difficult to predict, but will be an important metric derived from this study.

4.6. Regulations
50 CFR part 622.4 and part 622.5 (b) Charter vessel/headboat owners and operators— (1) Coastal migratory pelagic fish, reef fish, snapper-grouper, and Atlantic dolphin and wahoo. The owner or operator of a vessel for which a charter vessel/headboat permit for Gulf coastal migratory pelagic fish, South Atlantic coastal migratory pelagic fish, Gulf reef fish, South Atlantic snapper-grouper, or Atlantic dolphin and wahoo has been issued, as required under § 622.4(a)(1), or whose vessel fishes for or lands such coastal migratory pelagic fish, reef fish, snapper-grouper, or Atlantic dolphin or wahoo in or from state waters adjoining the applicable Gulf, South Atlantic, or Atlantic EEZ, and who is selected to report by the SRD, must maintain a fishing record for each trip, or a portion of such trips as specified by the SRD, on forms provided by the SRD and must submit such record as specified in paragraph (b)(2) of this section.

4.7. Other

5. Final Deliverables

5.1. Additional Reports
Peer reviewed final report and associated metadata records

5.2. New Data Set(s)
Correction factor for headboat logbook estimates

5.3. New System(s)
Imputation procedures for headboat logbook catch and effort

6. Project Leadership

6.1. Project Leader and Members

First Name	Last Name	Title	Role	Organization	Email	Phone 1	Phone 2
Kenneth	Brennan	Coordinator Southeast Region Headboat Survey	Team Leader	NOAA Fisheries Service\SEFSC	Kenneth.Brennan@NOAA.gov	252-728-8618	

First Name	Last Name	Title	Role	Organization	Email	Phone 1	Phone 2
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Beverly	Sauls	Associate Research Scientist	Team Member	Florida Fish and Wildlife Commision	Beverly.Sauls@MyFWC.com	727 896-8626	
Steve	Turner	Division Chief, SEFSC	Team Member	NOAA Fisheries Service	Steve.Turner @!NOAA.gov	305-361-4482	
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Erik	Williams	Chief, Sustainable Fisheries Branch, SEFSC Beaufort Laboratory	Team Member	NOAA Fisheries Service	Erik.Williams @NOAA.gov	252-728-8603	

7. Project Estimates

7.1. Project Schedule

Task #	Schedule Description	Prerequisite	Schedule Start Date	Schedule Finish Date	Milestone
1	Develop sampling design and protocols.		05/01/2012	06/01/2012	
2	Hire and train samplers		05/01/2012	06/01/2012	
4	Conduct dockside intercepts	1,2,3	06/01/2012	06/01/2013	
5	Compile information on vessel activity, dockside\At sea data and logbook data into database.	1,2,3,4	06/01/2012	06/01/2013	
8	Summary report	1,2,3,4,5,6,7	12/01/2013	04/01/2014	
3	Coordinate sampling responsibilities and schedules.	1,2	05/01/2012	06/01/2013	
6	Validation and analysis of logbook data	1,2,3,4,5	06/01/2012	09/01/2013	

Task #	Schedule Description	Prerequisite	Schedule Start Date	Schedule Finish Date	Milestone
7	Develop correction factors and imputation procedures	1,2,3,4,5,6	09/01/2013	12/01/2013	

7.2. Cost Estimates

Cost Name	Cost Description	Cost Amount	Date Needed
Data Collection Contracts	TX port agents (2)	$60000.00	04/01/2012
Project Staff Contract	Contractor to assist project manager in coordination of project, analysis of data and write reports.	$25000.00	04/01/2012
Data Collection Contracts	SEFL port agents (2)	$140000.00	04/01/2012
Data Collection Contracts	SWFL port agents (2)	$140000.00	04/01/2012
Project Design Consultants	Project design, support and analysis (2)	$40000.00	04/01/2012
Sampling Supplies	Digital cameras, digital counters, misc sampling equipment	$3000.00	05/01/2012
Travel	Travel to present results to various committees.	$3000.00	02/01/2014
TOTAL COST		$411000.00	

8. Risk

8.1. Project Risk

Risk Description	Risk Impact	Risk Probability	Risk Mitigation Approach
Designing the probability based sampling methods will be the collaborative effort of the Project Team and the private consultants. These dockside validation methods and protocols will be tested by the trained samplers in the 3 study locations. The sampling design must be completed in order to meet scheduling goals and to accomplish project objectives.	Any delay in the completion of the sampling design will impact sampler scheduling and duties and ultimately the overall progress of this project.	Medium	If a delay in developing the final sampling design occurs, the samplers will be trained with the standard headboat sampling protocol which includes basic validation methods common to this project. This will allow data to be collected on schedule that is still relevant to the project. The protocol used by the At-sea sampling component of this project will also collect data on schedule in order to mitigate this risk.

9. Supporting Documents

"NRC (National Research Council). 2006. Review of Recreational Fisheries Survey Methods. ", page 1

THE NATIONAL ACADEMIES

REPORT IN BRIEF

Review of Recreational Fisheries Survey Methods

Recreational fishing is an increasingly popular activity that, for some species, takes a significant amount of the total number of fish caught in a year—sometimes more than commercial fishing. To ensure that fish populations are not overexploited, managers monitor recreational fishing through surveys. The most efficient way to improve current surveys is to establish a national registry of all saltwater anglers.

According to the best available estimates, about 14 million saltwater anglers made almost 82 million fishing trips in 2004. While each individual angler typically catches a small number of fish, collectively these sport fisheries account for a significant fraction of the yearly catch for some species—in some cases more than commercial fisheries (see Figure 1, p. 2). For example, in 1999, recreational fishing accounted for 94 percent of the total catch of spotted sea trout, 76 percent of striped bass and sheephead, and 60 percent of king mackerel. Current assessments indicate that some marine recreational fisheries have exceeded fishing quotas, and recreational fishing is expected to increase.

Photo courtesy NOAA

Fishery managers need timely data on fishing catch to make sure fish populations are not overexploited, taking actions to limit fishing of certain species if necessary. Recreational catch in U.S. marine waters is monitored primarily through the Marine Recreational Fisheries Statistics Survey (MRFSS), which was set up in 1979 by the National Marine Fisheries Service (NMFS) of the National Oceanic and Atmospheric Administration. The MRFSS conducts both offsite telephone surveys and onsite interviews at marinas and other points where they fish. Although the MRFSS was (and is) intended to be national, not all coastal states take part. Several state programs operate in lieu of or as a complement to the MRFSS.

Since the MRFSS was established, management goals and objectives for the recreational fishing sector have changed and become increasingly complex. The MRFSS program has not had the resources to keep up with these changes, nor has it been able to take advantage of recent advances in statistical sampling theory. In response to concerns about the coverage and quality of the MRFSS data, NMFS asked the National Academies to review current marine recreational fishing surveys and to make recommen-

As of the May 2006 release of this report, Congress was considering legislation that would take several steps toward establishing a national sampling frame for recreational fisheries.

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"NRC (National Research Council). 2006. Review of Recreational Fisheries Survey Methods. ", page 2

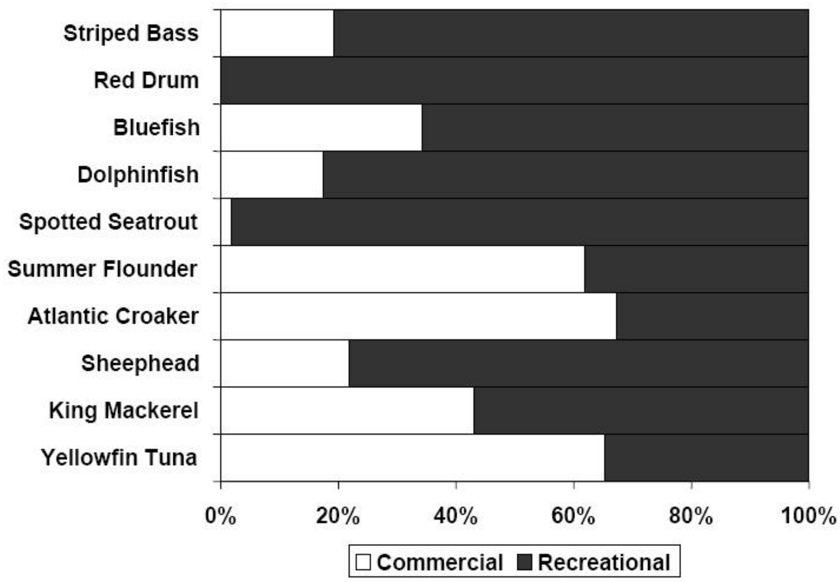

Figure 1. Top Ten Recreational Species Versus Commercial Harvest for 2004. Comparisons between the top ten species in descending order of abundance by weight for U.S. recreational fish harvests and commercial landings. The figure does not include data for Alaska and Texas because no NMFS recreational surveys are conducted in those states (National Oceanic and Atmospheric Administration, 2005, Fisheries of the United States: 2004. Silver Spring, MD).

dations for improvements and possible alternative approaches.

The report finds that current survey methods are inadequate to provide the quality and timeliness of data necessary to manage recreational fisheries. The report concludes that the establishment of a comprehensive, universal sampling frame with national coverage—most likely in the form of a national registry of saltwater anglers—would be the most efficient way to improve the quality and quantity of data used to assess recreational fishing.

Improving How Saltwater Anglers are Surveyed

It is much more difficult to collect data on recreational fishing than on commercial fishing because of the large number of saltwater anglers spread throughout the country, and the many different places and ways they fish (e.g., from charter boats, private boats, private property, and so on). In addition, the telephone survey depends both on the accuracy of the angler's memory of past fishing trips and on the angler's willingness to provide this information to the caller. Designing a survey that will provide accurate and timely information, with good coverage and at acceptable cost, is a major challenge.

Specific challenges in conducting reliable surveys (or sampling) include the following:

- Onsite methods fail to intercept anglers who have private access to fishing waters, or intercept them only sporadically. To compensate, fishing habits and success rates are assumed to be similar at private and public access sites.
- Reaching anglers in telephone interviews is complicated by the increasing use of cell phones. The use of random-digit-dialing is inefficient because it reaches many households where there are no anglers. In addition, telephone surveys are restricted to coastal counties and must be adjusted (based on results from the onsite interview survey) to account for anglers living inland.
- Offsite sampling methods that rely on lists of saltwater anglers who buy fishing licenses are not currently feasible because of the many license exemptions based on age, residence, access points, existence of a boat license, mode of fishing, and other factors.
- Catch and release fishing (release of fish that survive capture) is increasingly common in marine recreational fisheries, but since not all fish survive after they are let go there could be additional effects on fish populations. Fish are often injured during capture, hence mortality may be high, in some cases exceeding 50 percent. Additional studies are needed to provide reliable estimates of the mortality and number of fish caught and released. This shortcoming affects estimates of catch and total removals.
- The correct identification of fish species, especially in places with many different species, is a difficult challenge, both for anglers and for those conducting surveys.

"NRC (National Research Council). 2006. Review of Recreational Fisheries Survey Methods. ", page 3

Some of these shortcomings would be most efficiently resolved by the report's recommended establishment of a national registration of all salt-water anglers. This goal could also be achieved by new and existing state saltwater license programs, if they include all anglers without exemptions[1] and provide appropriate contact information from anglers fishing in all marine waters, both state and federal. A salt-water fishing registry would provide a targeted survey base, eliminating current inefficiencies and expanding coverage beyond anglers in coastal counties.

The report recommends that the for-hire sector of marine recreational fisheries be considered a commercial sector for survey purposes. Charter, party, and other for-hire recreational fishing operations should be required to maintain logbooks of fish caught and released as well as of fish landed and kept. In addition, the onsite sampling frame for the MRFSS should be redesigned to better account for variation of catch rate at different access points.

Improving Statistical Estimation in Surveys

The report concludes that the designs, sampling strategies, and collection methods of recreational fishing surveys are not adequate for the current demands of fisheries management. Estimates of catch are likely to be affected by biases in the survey data that have not been sufficiently addressed. Also, procedures used to analyze the MRFSS survey results do not fully exploit recent advances in sampling theory.

Photo courtesy NOAA

The report recommends that the statistical properties of various sampling, data-collection, and data-analysis methods be determined. Assumptions should be examined and verified so that biases can be properly evaluated. An independent research group of statisticians should be employed to design new analyses based on recent developments in sampling theory.

A greater degree of coordination between federal, state and other survey programs is necessary to achieve a national perspective on the status of marine recreational fisheries. Currently, many of the independent surveys conducted by the states, as well as state-run surveys that are components of the MRFSS, differ in important ways, including sampling, data collection, and preparation of estimators, from each other and from the central MRFSS. Many of the surveys conducted by state agencies (with various degrees of federal funding) suffer from the same shortcomings as do the central MRFSS surveys. As a result, most of this report's recommendations also apply to state surveys.

Incorporating Trends in Where, When, and Why People Fish

Good survey coverage relies on tracking data on the human dimensions of fishing, including the social and economic factors that might affect the number and location of fishing access sites. For example, development can bring more people into an area, while storm damage or hurricane threats can drive people from an area. The MRFSS is not designed with human dimensions in mind, but instead largely focuses on biological factors (e.g., numbers, sizes, and kinds of fish landed).

The report recommends that an independent national trip and expenditure survey be developed to support economic valuation studies, impact analyses, and other social and attitudinal studies. The national database on marine recreational fishing sites should be enhanced to support social and economic analysis. The data set should include site characteristics that matter to anglers, such as boat ramps, facilities, natural amenities, parking, size and type (beach, pier, launch point, and so forth). To account for changes in the number and patterns of trips and the changing characteristics of sites, a periodic updating of the data should be undertaken.

[1] There is no scientific reason that a state should not continue to allow certain groups (e.g., seniors) to fish for free, as long as everyone is required to register in the universal sampling frame.

Need for Greater Program Support

The MRFSS program staff have been severely handicapped by a lack of resources in their efforts to implement, operate, and improve the survey, including implementing the recommendations of earlier reviews. Despite the dedication and capabilities of the staff, they have too few resources, such as the lack of a Ph.D.-level mathematical statistician, to operate a national survey of such complexity. Also, the financial resources allocated to the MRFSS program are modest in comparison to the challenge of conducting an efficient and timely survey.

The MRFSS (as well as many of its component or companion surveys conducted either indirectly or independently) should be redesigned to improve the effectiveness and appropriateness of its sampling and estimation procedures, its applicability to various kinds of management decisions, and its usefulness for social and economic analyses. After the revision is complete, provision should be made for ongoing technical evaluation and modification as necessary to meet emerging management needs.

The report also suggests the existing MRFSS program be given a firm deadline linked to sufficient program funding for implementation of this report's recommendations. The recommended changes to the design and operation of the MRFSS program and its continued development and operation will likely require funding above current levels. Additional funding will be required for a survey office devoted to the management and implementation of marine recreational surveys, including coordination between surveys conducted in various state and federal agencies.

Need for Better Communication and Outreach

It is difficult for individual anglers to see the effects of angling on their target species and to distinguish daily and seasonal fluctuations from trends. As a result, even if a marine recreational survey is well designed and implemented, it will not fully succeed without the cooperation of anglers. If anglers understand the basic purpose of recreational fishing survey data and how those data are interpreted and used, they are more likely to have confidence in the survey and to participate and provide dependable information.

The report recommends several ways to improve outreach and communication. MRFSS scientists should advise anglers and managers on the constraints that apply to the use of the data for various purposes. Outreach and communication should be established as an integral part of the ongoing program to develop expertise and emphasize the importance of more effective dialogue and dissemination of information. Further, angler associations should be engaged as partners with survey managers through workshops, data collection, survey design, and participation in survey advisory groups.

Photo courtesy NOAA

COMMITTEE ON THE REVIEW OF RECREATIONAL FISHERIES SURVEY METHODS:

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This report brief was prepared by the National Research Council based on the committee's report. For more information, contact the Ocean Studies Board at (202) 334-2714 or visit http://nationalacademies.org/osb. *Review of Recreational Fisheries Survey Methods* is available from the National Academies Press, 500 Fifth Street, NW, Washington, D.C. 20001; (800) 624-6242; www.nap.edu.

Charter-Boat Logbook Reporting Pilot Study
Initial Examination of Data

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Prepared for

Marine Resources Assessment Group Americas

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1 Introduction

This report describes an examination of data collected as part of a pilot study conducted by the Marine Recreational Information Program (MRIP) in portions of the Gulf of Mexico. The primary objective of the pilot study is to determine the feasibility of using a logbook reporting system to monitor activity and catch by the for-hire recreational charter fishery in the Gulf of Mexico. The design of data collection systems used in the pilot study have been described elsewhere. This examination of data collected from September 2010 through May 2011 will make use of data from three sources.

1. Activity Monitoring.

   The intention of activity monitoring data is to determine the level of compliance of charter-boat operators in submitting logbook information for all trips taken. The data collected in this portion of the project are called "Prevalidation" data by MRIP. They consist of recorded status of vessels at times of visitation of docking sites. Status of vessels is recorded as 1 =Vessel In, 2 =Vessel Out Charter Fishing, 3 =Unable to Validate Status, 4 =Vessel Out Not Fishing, and 5 =Vessel Out, Status Unknown. The primary concern is the proportion of days for which it could be verified that vessels were out fishing that the captains filed logbook reports.

2. Dockside Sampling.

   Dockside monitoring data were gathered by samplers when vessels returned from fishing trips and is intended to be compared with information entered by captains in logbook records. The primary concern is how records of the numbers of individuals of various species compare between logbook and dockside sampling data. Numbers of individual species are recorded in dockside sampling data as falling into one of 8 categories, 1 =released alive $<$ 120 ft., 2 =released alive $>$ 120 ft., 3 =plan to eat, 4 =bait, 5 =plan to sell, 6 =discard mortality, 7 =other, 9 =information refused. These are not the same categories used by captains in filling out logbook records, but categories 3, 4, 5 and 7 were combined for comparison with what the logbooks record as harvested. While catch composition and disposition are perhaps the primary concern in validation of logbook data by dockside sampling, there are a number of other common variables that might prove useful in monitoring effort. In particular, both logbook and dockside sampling data record the number of passengers and anglers, primary gear, hours fished, area fished, minimum depth and maximum depth, and percent of time in EEZ waters, State waters, or Inland waters. Dockside sampling also collected some biological data such as length and weights of a few individuals, but these data are not used in this report.

3. Logbook Data.

   Logbook data are submitted by vessel captains and contain overlapping variables with dockside sampling data as described in item 2. The disposition of individuals of various species are recorded in logbook records as harvested, released alive < 120 ft., released alive > 120 ft., and discard mortality.

Many other variables, some related to dates and times of trips, are included in the three data sources listed previously. These variables were used to match records between data sources and to attempt to untangle discrepancies in logbook records for individual trips. These issues will be described more fully in what follows.

The data examination reported on here was focused on two questions related to the overall objective of determining whether logbook data could be used in monitoring effort and catch in the charter fishery.

1. Can logbook data be used as an essential census of trips taken by the charter-boat fishery? This question is largely concerned with completeness and accuracy of the logbook data source. To consider logbook data as a census of

the fishery requires, first, verification that logbook records are reported for essentially all trips known to have been taken (within a small measure of reporting error). The comparison to be conducted is the proportion of known fishing trips, as documented in the activity monitoring or prevalidation data, for which logbook records were submitted. Another necessary attribute of logbook data needed to consider this source in a census-like manner is that there be a high level of agreement in trip characteristics (hours fished, number of anglers, etc.) and catch composition (numbers and dispositions of individuals by species) between logbook and dockside sampling data sources.

2. If sizable discrepancies between logbook and validation data sources exist, are those discrepancies consistent enough across time and regions (Florida versus Texas) that quantitative adjustments could be made to logbook data? For example, if the proportions of known fishing trips (based on activity monitoring data) for which logbook records are submitted are nearly constant across months, then even if those proportions are not exactly (or essentially) 1.0, a correction would be available to estimate the total number of trips taken based on logbook data. The same issue exists for variables related to fishing effort and catch composition.

2 Data Characteristics and Issues

This section reports a number of summaries that describe the amount of data available from the three data sources for Florida and Texas across months of the study, and describes a number of issues encountered in initial data processing, primarily with regard to the logbook data source. This this section, and the remainder of the report, "month of study" will be taken as $1, 2, \ldots, 9$ with 1 corresponding to September 2010, and 9 corresponding to May 2011. Thus, month of study in the tables and graphs to follow is not calendar month.

2.1 Fishing Activity

The activity monitoring or prevalidation data recorded the numbers of vessels and their status as presented in Table 1. Recall that status 1 =In, status 2 =Out

		Month of Study								
Region	Status	1	2	3	4	5	6	7	8	9
Florida	1	662	587	617	203	651	610	713	645	513
	2	24	55	16	0	7	3	64	121	95
	3	66	32	43	8	49	94	111	87	54
	4	11	29	17	10	66	93	85	66	26
	5	56	67	54	19	51	57	92	124	61
	Tot	819	770	747	240	824	857	1065	1043	749
Texas	1	424	638	497	347	412	320	342	142	482
	2	33	18	3	1	1	4	5	1	29
	3	77	87	69	33	98	284	444	204	621
	4	0	14	19	13	17	25	62	21	59
	5	4	24	16	4	1	5	6	3	4
	Tot	538	781	604	398	529	638	859	371	1195

Table 1: Numbers of vessels recorded by activity monitoring by region, status, and month of study.

Fishing, and status 3 =Unable to Verify. Also note, as mentioned previously, that month of study is not calendar month; month of study 4 is December 2010. The status monitoring in the first 9 months of this project resulted in a large number of vessel/days on which charter trips could not be verified. This will lead to substantial uncertainty in estimating the proportion of trips known to have been taken for which logbooks were filed. Apparently, it is difficult to verify the activity of vessels that are not in at the time of observation, and this seems especially the case for Texas.

If there is a good deal of movement of vessels, either into and out of the fishery or among docking sites, observation of vessel status at those sites may be an inefficient way to determine how much fishing activity is occurring. This is not necessary for our current purposes, but it may make the status monitoring procedure used in this study somewhat ineffectual for an alternative use as a method to determine the level of fishing activity.

The number of logbook reports filed over time appears to reflect a sharp decrease in fishing activity in the months of December, January, and February. The number of logbook reports filed over months of the study is presented in Table 2. The values of Table 2 suggest that the Texas fishery is tremendously smaller than

	Month of Study								
Region	1	2	3	4	5	6	7	8	9
Florida	465	1149	342	57	22	62	622	1036	1153
Texas	57	42	11	5	2	2	26	10	37

Table 2: Numbers of logbook reports submitted by region and month of study.

the Florida fishery, more so that do the values of Table 1 (which were, of course, influenced by sampling effort as well as size of fleet). Examining the data from logbooks and status monitoring (prevalidation) shows that there were 217 unique vessel identification numbers in the Florida logbook data but only 21 in the Texas logbook data. Concomitantly, there were 231 unique vessel numbers reported in the status monitoring data for Florida and 62 in Texas. Thus, assuming that all vessels represented in the logbook data were included in status monitoring at some time (or that the vessels included in status monitoring are the entire collection of vessels in existence in a region) about 94% of vessels in Florida filed a logbook report at least once, while only 34% of the vessels in Texas did so. While the premise of this calculation might not be strictly true, the discrepancy between Florida and Texas in this aspect of the data is quite striking.

Assuming nothing about characteristics of the charter fisheries in Florida and Texas, the information from Table 1, Table 2 and the immediately preceding observation would seem to suggest a picture in which the charter fishery in Texas is smaller, possibly more mobile, and either less cooperative or harder to identify than is the fishery in Florida. If this is the case, sampling in Texas or regions with similar characteristics, be it for verification of a self-reporting logbook system or to provide data for direct estimation, may be more difficult and costly than for Florida.

2.2 Trip Characteristics and Catch

The number of trips for which dockside samples were obtained is presented in Table 3 by region and month of study. These sampled trips come from a total of 112 different vessels in Florida and 13 different vessels in Texas.

	Month of Study									
Region	1	2	3	4	5	6	7	8	9	Total
Florida	54	108	36	1	1	7	17	71	105	400
Texas	4	9	2	2	0	1	3	2	15	38

Table 3: Number of trips having dockside samples by region and month of study.

It is clear from the values of Table 3 that an insufficient number of dockside samples were obtained in a number of months to compare catch variables with corresponding logbook records on a month-by-month basis. This conclusion could have already been reached for Texas based on the number of logbook reports available as reported in Table 2, but the same is true for Florida at least over the stretch of months from December 2010 (month of study 4) to March 2011 (month of study 7). The decision was made to compare logbook and dockside sampling data for month of study 1, 2, 3, 4-7, 8, and 9 in Florida, and only aggregated over all months in Texas.

A large number of individual species were reported in both dockside sampling data and logbook reports, as demonstrated in Table 4.

Region	Logbook	Dockside Samples
Florida	154	78
Texas	47	32

Table 4: Number of unique species recorded in logbook and dockside sampling data sources.

Based on these values it might appear that the fishery in Florida is more diverse than the fishery in Texas, but this suggestion must be tempered by the fact that so few trips in Texas had either logbook or dockside sampling records. Note that the values in Table 4 are not cross-classified. That is, the logbook records from which the number of unique species identities were calculated includes all logbook reports (rightmost column of Table 2), not only trips also included in the dockside samples.

2.3 Data Issues

A number of data issues were identified during the process of data organization and summarization, most notably with logbook data files. The more substantive of these are summarized in the following points.

1. Vessel identification numbers were only unique to an individual region, here Florida or Texas. If a logbook reporting system is developed for Gulf-wide application this will become much more than the minor issue it was in the current analysis.

2. The variables TRIPSPERDAY and TRIPREPORTNUM in the data file Trips.txt both proved unreliable. TRIPSPERDAY is apparently supposed to be the number of trips taken on a given day for which a logbook report has been

filed. TRIPREPORTNUM is supposed to be a unique identifier for each trip (maybe unique at least on the given day). As a simple example of what was a widespread problem with TRIPSPERDAY, the values of TRIPSPERDAY ranged from 1 to 11 in the data file. But, looking at the records that have 11 for that variable produces records for 3 different trips taken in May by 3 different vessels (vessel ids 6, 108, and 38). So this is confusing.

3. Without reliable variables that directly indicate single or multiple trips in one day, the process of determining when a given vessel may have taken more than one trip on a given day was not well defined. Some logbook records that indicate there was more than one trip in a day seem correct. For example, vessel 21 in Florida lists 2 trips on 9/17/2010 with different report numbers. The first departed at 6:00, lists 3 hours fished, and return at 10:00. The second lists depart at 13:00, 3 hours fished, and return at 17:00. The same number of party and anglers was on both trips, but there was a difference in maximum depth fished between the two sets. So this looks like the same party that went out two times on that day.

   More frequently, logbook records that indicate more than one trip in a day do not seem correct. For example, vessel 3 in Florida lists 2 trips on 9/17/2010. Both are listed as departing at 5:30, 12 hours fished, and return at 17:30, and both have the same report number. This must have been only one trip. On other records there appears to have been more than one trip based on departure and arrival times for the same date, but all have the same trip report number. On other records, several trips are listed for the same day, but in which all of the other variables, such as departure time and arrival time, are identical for all trips. This would seem to be impossible for one vessel to accomplish.

   The most reliable variables for determination of days that may have had more than one trip by a given vessel seemed to be matching departure and arrival times for the same date. If non-overlapping sets of departure and arrival times that seemed consistent with number of hours fished (i.e., defined time intervals about 0.5 to 2 hours greater than number of hours fished) then multiple trips were taken for that vessel on that day. This process could be automated, but left about a dozen cases with remaining conflicts. Determination of whether these cases corresponded to logbook reports having more than one trip in a day, or mistakenly reporting more than one trip in a given day, or simply having data entry errors, was painstaking and less than exact. That is, judgment calls were required in a number of cases, and decisions required individual examination of the values of all of the reported variables in a case-by-case examination. A separate summary of situations in which this occurred will be provided to data managers at MRIP.

After data cleaning there were logbook records for $4,908$ trips in Florida and 192 trips in Texas (see row totals for Table 2). In Texas, all vessels reported only one trip on any given day. In Florida, there were 242 records given as the second trip of a day, and one record given as the third trip.

4. There are implications of data discrepancies for taking a logbook reporting program to a Gulf-wide basis. Any time data are recorded by a relatively large number of individuals (here captains) one expects there to be a certain level of inconsistency in the manner that variables are recorded. There may also be a maddeningly large array of specific data entry errors that are then difficult to categorize and run checks for in an automated manner. While the number of such occurrences in these data was actually fairly small (based on my experiences with other situations), the need for individual consideration of cases involving one or more conflicts can be prohibitively time consuming even in data bases with only moderate numbers of records. As a rough guess, I would say that identification and resolution of conflicting data records in the fairly small amount of data I dealt with in this project (small by most

data-base standards) took about 10 to 15 minutes per case. This was caused by the fact that there was not a single or even small number of well-defined variables that could be used to resolve conflicts. The rate of cases in need of individual consideration was about 3 per 1000 or somewhere approaching one third of one percent of the total data records. When other relatively minor discrepancies are included (e.g., data records for month 1 in 2010, which clearly should have been 2011 given the time span of this study), the time commitment needed for data cleaning and editing is not inconsequential. If one supposes that a Gulf-wide program would expand the volume of data by about five-to-tenfold, increase the number of individuals (captains) recording data and hence also the number of unique errors committed, and also increase the complexity of geographic considerations as well, I would hazard a guess that such a program would require about three to four weeks of time from one talented data manager to be devoted solely to data cleaning. Note here that this comment concerns data files as provided to me that I presume had already been worked with to some degree by data management personnel at MRIP, so my caution concerns additional effort beyond that already devoted to data considerations in the pilot study by MRIP.

5. A better system for matching dockside sampling reports with logbook entries would be beneficial. In the Florida data there were 400 trips having dockside samples taken (see Table 3). Each of these contained a unique report number in the dockside sampling data file. Of these 400 trips, 23 were from sampling two trips by the same vessel on the same day. The only way to match these against logbook reports was by time of departure in both logbook and dockside sampling data files. Given that logbook entries are usually made some time after a trip has been completed, it is a reasonable assumption that the reliability of variables in logbook reports decreases across the sequence of departure year, month, day, hour, and minute. In fact, some logbook records that were

matched to dockside sampling reports did differ in departure time (dhr and dmin) but these could usually be resolved through individual inspection. For example, dockside sampling report 59 in Florida was for vessid id 102 on 5 September 2010. In the dockside report departure hour was 15 and departure minute 30 (i.e., 15:30). Logbook reports record two trips for vessel 102 on this day, one departing at hour 7 minute 0 (7:00) and the other departing at hour 15 minute 0 (15:00). While this discrepancy is not difficult to correct by hand, automating the matching of dockside sampling reports and logbook reports is again made difficult. If one uses too "crude" or too "fine" a level of matching, one may either eliminate sampled trips or replicate the same trip several times. This reinforces the point of the previous item.

6. The coding system for species may be too detailed for the use of logbooks as a data source. There are many instances of records in logbook and dockside sampling data sources that list different species codes that are most likely the same species and should not be taken as discrepant. For example, a trip by Florida vessel 29 on 2 September 2010, lists four different species caught in both logbook and dockside sampling data sources. The following are records of the species codes and dispositions given in the dockside sampling report (number 29) and corresponding logbook record.

Data Source	Species Code	Harvest	Released < 120	Released > 120	Mortalities
Dockside	168566	1	1	0	0
	168693	1	0	0	0
	168853	0	4	0	0
	169207	5	0	0	0
Logbook	168566	1	0	0	0
	168853	0	4	0	0
	169180	5	0	0	0
	172435	2	0	0	0

In these records, species 168566 agree in harvest but differ in number released at less than 120 feet. Species 168853 agrees exactly. The other two species codes differ between dockside sampling and logbook data sources. Dockside sampling records give species code 169207 (Red Porgy) with 5 individuals harvested, while logbook records give species code 169180 (Porgy Family) with 5 individuals harvested. These would seem to be referring to the same fish, but would register as a discrepancy between dockside and logbook data sources in any computer algorithm constructed with the given species codes. Dockside sampling also lists species code 168693 (Banded Rudderfish) with 1 individual harvested while logbook records list species code 172435 (King Mackerel) with 2 individuals harvested. This would appear to be a true discrepancy between data sources. The point is that it is not possible without individual inspection of corresponding dockside sampling and logbook records to determine which differences in species codes represent slight differences in identification, and which represent more meaningful discrepancies. This appears to be a difficulty with the majority, if not all, pairs of logbook and dockside sampling records.

3 Assessing Number of Trips

This section concerns an assessment of the reliability of logbook data records in determination of the total number of trips taken by the for-hire recreational fishery in the study areas under consideration. The basic concern is comparison of the number of verified trips with logbook records. For logbook records to be useful as a census of the trips taken there should be a corresponding logbook entry for each of the trips verified as taken by status monitoring, subject to a small level of reporting error. If not all, or not nearly all, of the verified trips have corresponding logbook records, a question is whether trips taken that do not have logbook records were reported as inactive for the week the trip occurred, or whether there was a lack of compliance by the captain in filing either a logbook or inactive report. In addition, there is some information in these data that may be used to examine the effectiveness of the status monitoring procedure as employed in this study.

3.1 Basic Evaluation

The comparison to be made is straightforward. Taking the activity monitoring data (prevalidation data sets) with status 2 (see Table 1) as reflecting combinations of days and vessels for which it is known fishing trips were taken, the proportion of those trips for which a corresponding logbook record is available is computed. As previously indicated in Section 2.2, this comparison is conducted for Florida with 6 time blocks consisting of individual months 1, 2, 3, 8 and 9 of the study (September 2010, October 2010, November 2010, April 2011 and May 2011, respectively), and the aggregate of study months $4, 5, 6$, and 7 (December 2010 through March 2011). A cross-classification of known trips in Florida by these time periods and whether or not a corresponding logbook record existed is presented in Table 5.

	Logbook Record		
Study Months	Yes	No	Proportion Yes
1	13	11	0.54
2	36	19	0.65
3	12	4	0.75
4-7	47	27	0.64
8	83	38	0.68
9	70	25	0.74

Table 5: Numbers and proportion of known trips with logbook records for Florida by time period.

A Chi-squared test of independence between time period and logbook record or, (assuming that the number of trips in each time period is fixed at the row marginal total) a test of equality for proportion of trips with logbook entries, gives a test statistic value of $T = 4.726$ which, with 5 degrees of freedom, results in an approximate (i.e., asymptotic) $p-$value of $p = 0.4503$. Thus, we would appropriately conclude that the data do not contain sufficient evidence to reject a hypothesis that the proportion of trips with logbook records differs across time periods considered. While this is not, of course, the same as accepting a hypothesis that the proportions are the same over time periods, it provides some motivation for making that assumption in further analysis.

Collapsing Table 5 across time periods gives a total of 385 known trips of which 261 had corresponding logbook records. Assuming no effect of time (motivated by the previous Chi-squared test result), we would then estimate the proportion of trips taken in the Florida charter-boat fishery for which logbook records will be available as $\hat{p} = 0.678$. Based on a sample size of $n = 385$ the estimated variance of $\hat{p}$ is $\hat{V}(\hat{p}) = \hat{p}(1 - \hat{p})/n = 0.000567$ and an approximate (i.e., asymptotic) 95% interval estimate of the proportion of compliance would be

$$\hat{p} \pm 1.96\,[\hat{V}(\hat{p})]^{1.2} = (0.631,\, 0.724). \tag{1}$$

Of the $385 - 261 = 124$ verified trips lacking logbook records, 28 had corresponding inactive reports filed for the week of the trip, and 96 had neither logbook nor inactive reports; there were no trips having both logbook and inactive reports because this had already been looked at by MRIP prior to the time data was made available for this examination. If "compliance" with the program is defined as having filed either a logbook or inactive report, of the 385 Florida trips verified by status monitoring to have been taken, $261 + 28 = 289$ or 75% were in compliance. Another way to summarize this is that, of the 124 trips known to have been taken and for which no logbook report was submitted, 96 or 77% were due to captains failing to submit a report of any type. The low level (about 68%) of trips for which logbook records are submitted is caused by captains failing to submit a report of any kind, not by the submission of an inactive report instead of a logbook report.

To examine whether the low level of compliance (about 75%) might have been depressed due to confusion and unfamiliarity with the reporting requirements of the program when it was intially started, similar calculations were made using only data from 2011 (months $5-9$ of the project). Here, there were 290 confirmed trips in Florida, 200 of which had corresponding logbook reports, 19 of which had no logbook but an inactive report, and 71 of which had neither logbook nor inactive reports, for a compliance of $219/290 = 0.76$ or 76%. Thus, the overall level of compliance computed over 9 months of data was not depressed due to low compliance early in the project.

The proportion of known trips with corresponding logbook reports in Florida does not support use of logbook reports as a true census. There is some evidence that the proportion of trips for which logbook reports are filed may be consistent enough across time that an adjustment could be made to logbooks as a estimation procedure, at least for the purpose of estimating the number of trips taken.

In Texas, there is no possibility of assessing the consistency of logbook reporting over time due to the small numbers of both verified trips and logbook reports (Tables 1 and 2). Across all months, there were 95 confirmed trips and 64 of these had corresponding logbook reports. Assuming that the proportion of trips that file logbook reports is constant over time, that proportion is then estimated as $\hat{p} = 0.674$ with a 95% interval of (0.579, 0.768) which are in quite good agreement with values for Florida. The interval estimate is a bit wider due to smaller sample size.

Of the $95 - 64 = 31$ trips with no logbook report, 24 did file inactive reports for the corresponding week, while 7 submitted neither logbook nor inactive reports. Among trips verified to have been taken we would then estimate reporting compliance as $88/95 = 93\%$, substantially greater than for Florida, although computed from a much smaller sample. While the value of 93% would seem to indicate a high level of compliance in Texas, this must be assessed relative to the definition of compliance (which is, according to information provided for this exercise, filing a report, regardless of its accuracy). Of the total of 95 verified trips in Texas, about 67% had corresponding logbook reports, similar to Florida. But of the 31 verified trips without logbook reports in Texas, 24 or 77% either falsely or mistakenly filed an inactive report, compared to 22% (28 of 124 trips) in Florida. Conversely, of the verified trips without logbook reports, 7/31 = 22% filed no report in Texas, compared to 77/124 = 77% in Florida.

There is little discrepancy between Florida and Texas in the number of verified trips for which logbook reports were submitted (about 67% in both regions). There is a discrepancy in terms of the number of trips that failed to file logbook reports that would also be flagged as out of compliance with reporting requirements (77% in Florida and 22% in Texas). A conjecture might be that in Florida there seems to be little concern that one might be identified as not complying with reporting requirements, while in Texas there seems to be an attempt to remain technically in compliance even if fishing trips that were taken were not reported in the logbook system. This discrepancy may have implications for designing attempts to increase participation in a mandatory logbook reporting system, should one be implemented on a Gulf-wide basis.

3.2 Effectiveness of Sampling Protocol

As a check on the efficacy of status monitoring as conducted in this study for the potential alternative purpose of determining the level of fishing activity, the proportions of vessel/days recorded in other status categories (other than charter fishing) can be examined. Values for Florida in status categories 1 =Vessel In, 3 =Unable to Verify, 4 =Out, but not fishing, and 5 =Out, fishing status unknown are presented in Table 6. In Table 6, columns labeled n are sample sizes (same as values from Table 1) and columns labeled $\hat{p}$ are the proportion having logbook entries.

The values of Table 6 are encouraging relative to the effectiveness of the sta-

	Status 1		Status 3		Status 4		Status 5	
Study Month	n	$\hat{p}$	n	$\hat{p}$	n	$\hat{p}$	n	$\hat{p}$
1	662	0.03	66	0.03	11	0.00	56	0.12
2	587	0.01	32	0.00	29	0.00	67	0.28
3	617	0.01	43	0.00	17	0.00	54	0.31
4	203	0.00	8	0.00	10	0.00	19	0.05
5	651	0.00	49	0.00	66	0.00	51	0.00
6	610	0.00	94	0.01	93	0.00	57	0.05
7	713	0.05	111	0.06	85	0.00	92	0.26
8	645	0.06	87	0.08	66	0.04	124	0.32
9	513	0.06	54	0.07	26	0.04	61	0.29

Table 6: Proportions of logbook records in Florida for vessels/days with status other than fishing.

tus monitoring procedure employed in the study. The proportion of vessels/days recorded as being In (Status 1) that filed logbook reports is generally less than 5%, never greater than 6%, and positive values occur during some of the busier fishing months in the data (September 2010, March, April, and May 2011). Some trips are expected for vessels recorded as being In because the sampler cannot be present for an entire 24 hour period. But the reasonably low level of these occurrences supports a conclusion that the timing of visits by samplers was quite effective in determining vessel activities for the day. Similarly, values for vessels listed as Out, But Not Fishing (Status 4) indicate that these assessments were largely accurate, with only slight discrepancies again occurring during more active fishing periods. Perhaps somewhat surprisingly, the proportion of vessels that could not be verified (Status 3) that filed logbook reports was also reasonably low, although approaching levels that might cause some concern in the months of April and May 2011 (study months

8 and 9). It appears that, at least in Florida, the inability of samplers to verify vessel status was more indicative of vessel inactivity than other possible causes. The proportions of vessels/days listed by status monitoring as Out, But Fishing Activity Unknown that filed logbook reports is both greater and more variable than the other categories, which would seem indicative of good adherence to protocol by samplers. According to my understanding, samlplers were instructed to not list a vessel as Status 3 (Out Fishing) unless that status could be certified with high confidence. This would then suggest that any number of vessels that were out fishing would be classified as Out, but Fishing Unknown (Status 5), and that the number of such instances might fluctuate over time depending on how easy it was for samplers to obtain verification of fishing activity.

3.3 Tentative Conclusions Regarding Fishing Activity

The following tentative conclusions are supported by the examination of the data reported in this Section.

1. Logbook records cannot be considered a complete census of the number of fishing trips taken in the for-hire recreational fishery.

2. The proportion of verified trips taken for which logbook reports were filed is reasonably consistent over time periods, at least in Florida (data were insufficient for a similar determination in Texas). This holds out the possibility that logbook reports might provide a useful source of data when viewed as a sampling, rather than census, mechanism. Overall, it appears that about 68% of trips taken result in logbook reports for both Florida and Texas, with a range of uncertainty being about 63% to 72% in Florida and 58% to 77% in Texas.

3. The procedures used for status monitoring (resulting in prevalidation data) in the pilot study were effective in meeting the objectives of the study. That the

proportion of trips classified as "Unable to Verify" for which logbook reports were filed was consistently low suggests that, although the occurrence of this category was higher than that of verified fishing, it did not vitiate the sampling effort. The implication of this conclusion is that, if logbook reports were to be considered a source of sample data, periodic assessment of the necessary adjustment to arrive at an estimate of the total number of trips taken could reasonably be obtained through the same procedure of status monitoring used in this pilot study.

4. The reporting requirement used in this project is ineffectual for either producing a high level of participation, or for tracking "true compliance", defined as filing a logbook report for fishing trips that were taken. In particular, requiring reports of inactivity for a week appears to yield no useful information whatsoever in the absence of a separate activity monitoring program. In Florida that requirement is largely ignored, while in Texas it may be used as a way to avoid filing logbook reports while still remaining in technical compliance in terms of reporting.

4 Assessing Trip Characteristics

This section presents a comparison of variables connected with the physical characteristics of trips recorded in logbook and dockside sampling data. Such variables include number of anglers, hours fished, primary gear, and areas fished. The presentation will first consider data aggregated over all months of the study, and then divisions of data into time periods for Florida, consisting of months of study 1, 2, 3, 8, 9, and 4-7; see Table 3 and following discussion.

4.1 Aggregated Data

Of the 400 trips with dockside samples in Florida (see Table 3) 263 had corresponding logbook reports. Taking these together (i.e., aggregating over all months of the study) Table 7 presents the number of trips (out of 263) for which variables connected with trip characteristics matched exactly between dockside sampling and logbook reports. As might be expected, the proportion of exact matches was generally higher

Variable	Matches	Mismatches	Proportion Matching
Anglers	202	61	0.77
Gear	261	2	0.99
Hours Fished	136	127	0.52
Min Depth	114	149	0.43
Max Depth	113	150	0.43
Area Fished	166	97	0.63
EEZ %	211	52	0.80
State %	196	67	0.74
Inland %	245	18	0.93

Table 7: Exact matches between 263 dockside sampling and corresponding logbook reports in Florida over all study months.

for variables with fewer distinct values in the data (gear had only 3 distinct values) and lower for variables with more distinct values (maximum depth had 77 distinct values). The one exception to this is area fished, which had 11 distinct values (and 63% agreement), the same as percent of time fishing in inland waters (11 values and 93% agreement).

The same information for Texas is presented in Table 8. Of the 38 trips with dockside samples (see Table 3) 24 had corresponding logbook reports. Although the number of matched logbook and dockside samples is much smaller for Texas than for Florida, the values of Table 8 are comparable to, and reflect largely the same patterns, as those of Table 7.

Variable	Matches	Mismatches	Proportion Matching
Anglers	19	5	0.79
Gear	24	0	1.00
Hours Fished	7	17	0.29
Min Depth	10	14	0.42
Max Depth	8	16	0.33
Area Fished	15	9	0.62
EEZ %	22	2	0.92
State %	19	5	0.79
Inland %	21	3	0.88

Table 8: Exact matches between 24 dockside sampling and corresponding logbook reports in Texas over all study months.

As demonstrated by the values of Tables 7 and 8, logbook reports cannot be taken as one-to-one substitutes for what would have resulted from dockside sampling. It has already been stated in Section 3.3 that logbook records cannot be considered a complete census of the number of fishing trips taken, and Table 7 indicates that neither can logbook records be taken as exact replacements for the results of dockside sampling as regards trip characteristics. But it was also suggested in Section 3.3 that logbook records might be reasonably adjusted (subject to periodic re-assessment) as an estimator of the total number of trips taken. Similarly, we might question whether logbook records, taken as a data source for estimation of effort related variables, could provide estimates that are largely in concert with what might result from dockside sampling. For example, total effort in the fishery might be estimated as a product of estimated number of trips and estimated effort per trip. With this in mind, a composite effort variable was constructed as the product of number of anglers and hours fished for each trip for both dockside sampling data and corresponding logbook data. Three variables, number of anglers, hours fished, and the constructed variable of effort, were then examined for differences between dockside sampling and logbook sources of data. Comparison involved four measures of discrepancy, two at the individual level, and two at an aggregate level. Let D_i; $i = 1, \ldots, n$ denote any of the three variables of interest for dockside sampling of trip i and, similarly, let L_i; $i = 1, \ldots, n$ denote the same variable for logbook data from trip i. Quantities used to summarize the level of discrepancy between variables for individual trips (then averaged over all trips) were mean absolute error (mae) and root mean squared error (rmse). These are defined as,

$$\begin{aligned} mae &= \frac{1}{n}\sum_{i=1}^{n} |D_i - L_i|, \\ rsme &= \left[\frac{1}{n}\sum_{i=1}^{n}(D_i - L_i)^2\right]^{1/2}. \end{aligned} \tag{2}$$

Mean absolute error represents the absolute difference in a variable that would be expected on any given trip between logbook records and dockside sampling. Root mean squared error is a measure associated with squared error loss in estimation theory (the quantity that is often minimized to select among several possible estimators). If estimation of average anglers, hours fished, or effort per trip were to be based on either dockside samples or logbook records, estimates would most likely be formed as sample means, and uncertainty in estimation quantified as sample variances or standard deviations. The difference that would be realized between estimation from the two data sources may then be summarized by looking at differences between sample means and standard deviations,

$$\begin{aligned} M_d &= \bar{D} - \bar{L} \\ R_d &= \frac{s_D}{s_L} \end{aligned} \tag{3}$$

where $\bar{D}$ and s_D^2 are the usual sample mean and variance of data from dockside samples $\{D_i : i = 1, \ldots, n\}$ and similarly for $\bar{L}$ and s_L^2.

The four measures of discrepancy, mae, $rmse$, M_d and R_d were computed for the variables of number of anglers, hours fished, and effort, resulting in the values presented in Table 9, which also includes the values of the sample means and standard deviations $\bar{D}$, $\bar{L}$, s_D and s_L. The values of Table 9 indicate that we would

Region	Variable	mae	$rmse$	$\bar{D}$	$\bar{L}$	M_d	s_D	s_L	R_d
Florida	Anglers	0.450	1.220	6.290	6.397	−0.107	2.988	2.810	1.063
	Hrs Fished	0.676	1.286	3.991	3.893	0.098	1.611	1.527	1.055
	Effort	5.603	11.298	25.918	25.261	0.657	18.416	15.260	1.207
Texas	Anglers	0.458	1.061	3.958	4.417	−0.458	1.517	1.442	1.052
	Hrs Fished	1.531	2.237	6.917	6.406	0.510	2.068	1.408	1.468
	Effort	10.167	14.948	28.896	28.688	0.208	16.864	12.113	1.392

Table 9: Discrepancy measures for variables connected with fishing effort.

expect the difference between the logbook record for a trip and what would have been recorded if that trip had been subject to dockside sampling to be slightly less than 0.50 anglers in both Florida and Texas, somewhat over 0.50 hours fished in Florida and three times that in Texas, and about 6 person-hours of fishing effort in Florida but 10 hours of effort in Texas. That mean absolute errors are substantially greater for effort than the product of absolute error for anglers and hours fished indicates that discrepancies in anglers and hours fished are positively related (i.e., tend to be either both greater or both less for one data source than the other). Thus, discrepancies in effort tend to be greater than those in anglers or hours fished individually. If differences are of a constant direction (i.e., always greater for logbook records) these differences would cause concern in using logbook values as expansion factors for estimation in the entire fishery. That this is not the case (expect perhaps for anglers in Texas) is shown by the values of $\bar{D}$, $\bar{L}$, and M_d in Table 9. In particular, the average values of effort show much less discrepancy than do the average absolute discrepancies for effort in both Florida and Texas. Thus, while individual trip records differ, they do not appear to do so in a systematic manner in either region. Variability in values is consistently greater for dockside sampling than it is for logbook records (i.e., all values of R_d in Table 9 are greater than 1.0) although not tremendously so. Variances for Texas are likely not terribly precise given the small number of paired logbook and dockside samples available (only 38 in Texas compared to 262 in Florida).

4.2 Data by Time Period

There is insufficient data from Texas to examine trip characteristics between logbook records and dockside samples by time, but this may be accomplished for Florida if the months from December 2010 through March 2011 are aggregated, as previously described in Section 3.1. Here, time period 1 will correspond to September 2010, time period 2 to October 2010, period 3 to November 2010, period 4 to December 2010 through March 2011, period 5 to April 2011, and period 6 to May 2011. The number of paired logbook records and dockside samples were 30, 75, 28, 14, 43, and 72 for time periods 1 through 6, respectively.

Because the previous subsection has indicated that individual logbook records cannot be considered equivalent to individual dockside samples over the entire study period, there is no need to examine this question by time period. Also, because the previous subsection has indicated that considerable discrepancies exist between the two data sources as an average discrepancy over trips, there is little need to examine the measures of mse and $rmse$ for individual time periods. The results of the previous subsection did suggest that the averages of number of anglers, hours fished, and effort were comparable between the two data sources for the entire study period. Figure 1 presents the averages of number of anglers for logbook data and dockside samples considered by time period. Similarly, Figure 2 presents the averages of hours fished, and Figure 3 the averages of effort.

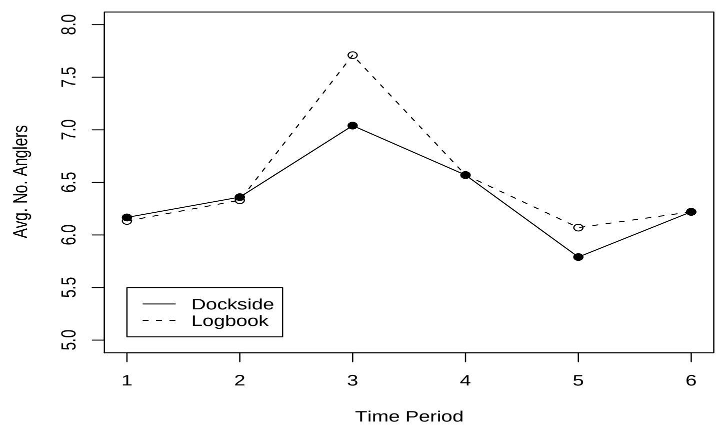

Figure 1: Average number of anglers for trips over time period from logbook and dockside data sources.

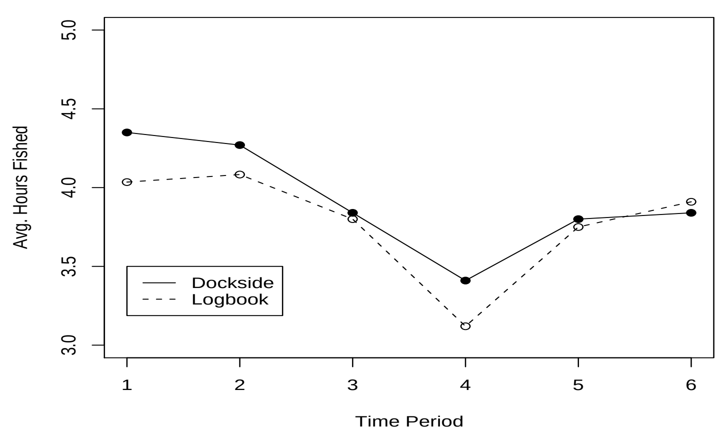

Figure 2: Average hours fished for trips over time period from logbook and dockside data sources.

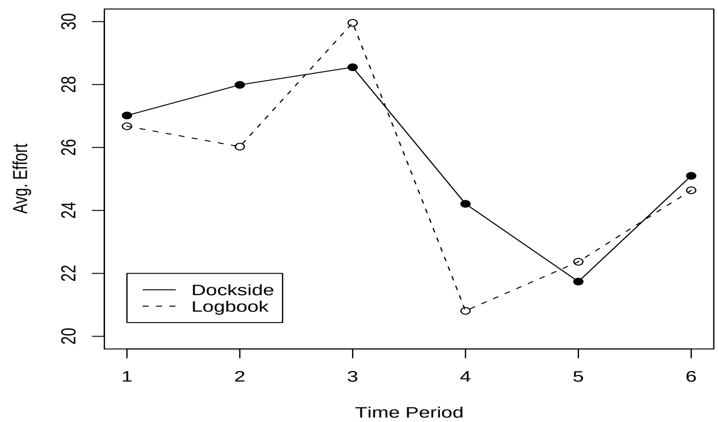

Figure 3: Average effort for trips over time period from logbook and dockside data sources.

Overall, Figures 1-3 show good agreement between logbook and dockside sampling data sources in the averages of the three quantities considered, for all of the time periods. In particular, the directions of changes in these quantities over time appear to agree for the most part. The difference in effort between time periods 4 and 5 provides the most notable exception, but that appears to be due primarily to a low value for logbook data at time period 4; recall that time period 4 contained only 14 pairs of data records, by far the fewest of any time period.

4.3 Tentative Conclusions Regarding Trip Characteristics

The following tentative conclusions are warranted from the examination of data reported in this section.

1. Logbook records cannot be considered as one-for-one replacements of what would have been obtained from dockside sampling, in terms of variables con-

nected with characteristics of trips.

2. As a source of data for estimation of the expected values of variables connected with fishing effort (including a constructed effort variable) logbook records would provide similar estimates as dockside samples. The level of uncertainty in estimates of effort would be (estimated as) smaller for logbook data than for dockside sampling data, but perhaps only moderately so. If the variability of dockside sampling data is taken to be "correct", then the use of logbook data to estimate average effort would lead to an moderate underestimate of the actual uncertainty we should have.

3. The conclusions in items 1 and 2 appear to apply with a reasonable level of uniformity to all time periods considered.

5 Assessing Catch Composition

Assessing the level of discrepancy between dockside sampling and logbook data sources in terms of variables connected with catch was made difficult by the problem of species identification as noted in item 6 of section 2.3. This difficulty might be at least partially mitigated by forming species groups, but that was not possible given the time available for the current data examination. The degree of discrepancy in catch composition between dockside sampling and logbook data sources was assessed in two ways. A number of characteristics that avoid matching individual species identifications were considered, as described in what follows. In addition, matching of species identifications was conducted for several species that were (1) among the most common in the dockside sampling records, and (2) may be among those for which individual management plans exist. For the species-independent comparison, paired dockside samples and logbook records were examined to determine the degree of discrepancy in

1. The number of species caught (number of distinct species codes).
2. The total number of individuals harvested (regardless of species code).
3. The total number of individuals released < 120 ft.
4. The total number of individuals released > 120 ft.
5. The total number of mortalities.

For examples of species-specific comparison, the number of individuals harvested, released, and mortalities were matched for the particular species codes of 168853 (Red Snapper) and 172435 (King Mackerel).

5.1 Species-Independent Comparison

In Florida, the 263 trips with paired dockside samples and logbook records (see Section 4.1) yielded the following exact matches for the variables listed previously. Not surprisingly, the proportions of exact matches between dockside samples and

Variable	Matches	Mismatches	Proportion Matching
No. Species	88	175	0.33
Harvest	50	213	0.19
Rel < 120	98	165	0.37
Rel > 120	183	80	0.70
Mortalities	202	61	0.77

Table 10: Exact matches between 263 dockside sampling and corresponding logbook reports in Florida over all study months.

logbook records is lower for these variables related to catch than they were for variables related to physical characteristics of trips (c.f., Table 7). The proportion of exact matches was only 19% for number of harvested individuals. The higher agreement for number of individuals released > 120 ft. and mortalities is caused primarily by the fact that a large number of 0 entries occur for these variables in both logbook records and dockside samples. The same information contained in Table 10 for Florida is presented for the 24 paired logbook records and dockside samples from Texas in Table 11. Again, the proportion of exact matches is generally lower

Variable	Matches	Mismatches	Proportion Matching
No. Species	10	14	0.42
Harvest	8	16	0.33
Rel < 120	12	12	0.50
Rel > 120	14	10	0.58
Mortalities	23	1	0.96

Table 11: Exact matches between 24 dockside sampling and corresponding logbook reports in Texas over all study months.

than it was for trip characteristics. The values of Tables 10 and 11 reinforce the conclusion that logbook records cannot be considered as one-to-one replacements for dockside samples. In terms of trip characteristics, however, logbook entries might be considered a legitimate data source for estimation of average effort in the population, as evidenced by the comparison of Table 9. The same quantities used to summarize discrepancies in trip characteristics in Section 4.1 were applied to the summary variables of catch considered here. The results are presented in Table 12. The values of Table 12 tend to paint the same picture as those of Table 9 did relative to physical trip characteristics. Average measures of discrepancy (mae and $rmse$) again indicate substantial differences between data sources for individual trips (averaged over trips). But measures of discrepancy among average measures (M_d and R_d) indicate reasonable agreement of the data sources in terms of what they indicate about the mean values of number of species, harvest, releases, and mortalities in the population of trips.

Region	Variable	mae	$rmse$	$\bar{D}$	$\bar{L}$	M_d	s_D	s_L	R_d
Florida	No. Species	1.445	2.215	5.068	3.935	1.133	2.428	2.267	1.071
	Harvest	8.992	19.601	32.103	30.304	1.798	33.979	36.277	0.937
	Rel $<$ 120	9.578	20.354	17.441	17.316	0.125	27.501	31.355	0.877
	Rel $>$ 120	9.000	11.727	7.129	5.719	1.411	15.886	13.716	1.158
	Mortalities	1.053	3.963	0.817	1.065	-0.247	4.354	4.245	1.026
Texas	No. Species	0.875	1.242	3.792	3.167	0.625	2.000	1.711	1.169
	Harvest	3.167	5.809	9.792	10.375	-0.583	8.782	9.559	0.919
	Rel $<$ 120	3.917	7.200	3.833	1.167	2.667	6.274	3.319	1.890
	Rel $>$ 120	0.000	7.853	5.250	3.917	1.333	10.900	8.787	1.240
	Mortalities	0.125	0.612	0.000	0.125	-0.125	0.000	0.612	0.000

Table 12: Discrepancy measures for variables connected with catch composition.

5.2 Red Snapper

Red snapper (species code 168853) was recorded as caught on 282 trips in Florida by dockside sampling. Of these, there were 157 trips with corresponding logbook records. For these 157 trips, the number of exact matches between dockside samples and logbook records is presented in Table 13. Although the proportion of exact

Variable	Matches	Mismatches	Proportion Matching
Harvest	133	24	0.85
Rel $<$ 120	77	80	0.49
Rel $>$ 120	103	54	0.66
Mortalities	120	37	0.76

Table 13: Exact matches between 157 dockside samples and corresponding logbook reports for Red Snapper in Florida.

matches between dockside samples and logbook reports is greater for harvested Red Snapper than it is across all species (see Table 10) the overall picture represented by the values of Table 13 is similar to that for values across all species. Logbook records cannot be considered one-to-one replacements of what would result from dockside sampling of trips in terms of Red Snapper.

In Texas, there were 22 dockside samples that recorded catch of Red Snapper. Of these, 11 had corresponding logbook records. The numbers of exact matches between dockside samples and logbook records are presented in Table 14. Even

Variable	Matches	Mismatches	Proportion Matching
Harvest	9	2	0.82
Rel $<$ 120	6	5	0.54
Rel $>$ 120	6	5	0.54
Mortalities	11	0	1.00

Table 14: Exact matches between 11 dockside samples and corresponding logbook reports for Red Snapper in Texas.

though the number of paired dockside samples and logbook records for trips that dockside sampling recorded as having caught Red Snapper was small (i.e., 11) the values of Table 14 are consistent with previous results for Red Snapper in Florida and for all species in both Florida and Texas. Note that all 11 trips represented in the paired data records of Table 14 recorded mortalities as 0, both dockside samples and logbook records.

Discrepancy measures for the paired data records for which dockside samples indicated Red Snapper had been caught are presented for both Florida and Texas in Table 15. The values of Table 15 for Red Snapper largely mirror the patterns exhibited by the same quantities computed from records across all species (Table 12). Data for individual trips from dockside samples and logbook records can be expected to differ. For example, the average discrepancy in the number of fish

Region	Variable	mae	$rmse$	$\bar{D}$	$\bar{L}$	M_d	s_D	s_L	R_d
Florida	Harvest	0.599	2.223	5.911	5.924	-0.013	7.657	7.629	1.004
	Rel $<$ 120	4.962	9.710	11.809	12.439	-0.631	20.057	20.137	0.996
	Rel $>$ 120	4.229	9.377	6.299	5.854	0.446	12.469	10.505	1.187
	Mortalities	0.949	3.293	0.879	1.255	-0.376	4.757	4.696	1.013
Texas	Harvest	0.818	1.931	4.818	5.636	-0.818	4.996	4.884	1.023
	Rel $<$ 120	2.909	5.576	1.545	1.364	0.182	3.012	4.523	0.666
	Rel $>$ 120	1.545	2.541	4.818	5.455	-0.636	7.884	8.116	0.971
	Mortalities	0.000	0.000	0.000	0.000	0.000	0.000	0.000	—

Table 15: Discrepancy measures for variables connected catch of Red Snapper.

released less than 120 ft. can be expected to differ by about 5 for trips in Florida, and 3 for trips in Texas (although this figure for Texas is computed from such a small sample size as to be suspect). Despite this, the mean values over all trips for which both dockside samples and logbook records existed were quite similar for all of the variables considered in both Florida and Texas, and variability was not dramatically different between the two data sources.

5.3 King Mackerel

King Mackerel (species code 172435) was recorded as caught on 110 trips by dockside sampling in Florida. Of these, there were 50 trips with corresponding logbook records. For these 50 trips, the number of exact matches between dockside samples and logbook records is presented in Table 16. Note that all records for both data sources recorded the number of individuals released $>$ 120 ft. as 0, and all records were 0 for mortalities except one dockside sample which recorded 1 mortality. In addition, there were only 5 non-zero records for releases $<$ 120 ft. in the dockside samples, only two of these were non-zero in the logbook records, and only one was

Variable	Matches	Mismatches	Proportion Matching
Harvest	34	16	0.68
Rel $<$ 120	46	4	0.92
Rel $>$ 120	50	0	1.00
Mortalities	49	1	0.98

Table 16: Exact matches between 50 dockside samples and corresponding logbook reports for King Mackerel in Florida.

an exact match to the corresponding dockside sample. Thus, the values for all variables other than harvest in Table 16 are largely without force. In particular, if one considers the proportion of trips on which King Mackerel were released (from any depth), dockside samples would give $5/50 = 0.10$ while logbook records would result in $2/50 = 0.04$. If these proportions are used as "expansion factors" for the total number of trips that logbook records indicate catch of King Mackerel, which was 1013, one would obtain 101 trips releasing King Mackerel based on dockside sampling but only 40 trips based on logbook records. If one then further takes into account that roughly 68% of Florida trips resulted in a logbook record (see Section 3.1) one obtains estimates of 148 trips releasing King Mackerel based on dockside samples, and 59 trips based on logbook records. Thus, even though the proportions of exact matches for Rel $<$ 120, Rel $>$ 120, and Mortalities in Table 16 appear high, this is caused by the prepoderance of 0 values. There are substantial differences that would result from using dockside samples and logbook records as data sources in estimaton of the number of trips releasing or having mortalities of King Mackerel.

In Texas, the number of trips having catch of King Mackerel in both dockside samples and logbook records was only 8, and this was deemed too few to give any indication of matches or discrepancy measures for this species in Texas. Thus, a comparison of data sources for King Mackerel in Texas was not considered. Similarly, the few trips on which King Mackerel was recorded as released (either alive or dead) in both dockside samples and logbook records in Florida precluded meaningful comparison of quantitative discrepancy measures in that region. For harvest in Florida, the following quantities were computed: $mae = 0.58$, $rmse = 1.27$, $\bar{D} = 3.92$, $\bar{L} = 4.02$, $M_d = -0.10$, $s_D = 4.08$, $s_L = 4.09$, $R_d = 1.00$. These values are roughly consistent with the patterns observed for all species combined and also for Red Snapper. In terms of number of harvested individuals, dockside samples and logbook records would result in similar values for the average over trips.

5.4 Tentative Conclusions Regarding Catch Composition

The examination of data on catch composition reported in this section supports the following tentative conclusions.

1. As for trip characteristics, logbook records cannot be considered as one-for-one replacements of what would have been obtained from dockside sampling in terms of variables connected with catch and catch composition.

2. As a source of data for estimation of the average number of species caught, total harvest, total number of releases (either < 120 ft. or > 120 ft.) and total number of mortalities, logbook data may provide a reasonable alternative to dockside sampling.

3. The conclusion of the previous item appears to hold for commonly caught individual species at least in terms of the number of individuals categorized as "harvested". Whether this is also true for number of individuals released alive or dead is less certain. As the frequency of releases and/or mortalities becomes smaller, the magnification of discrepancies by expansion of estimates to the population level becomes a greater percentage of the overall value. Whether this is of import to management of the Gulf fisheries should be considered.

6 Overall Conclusions

Tentative conclusions have been offered with respect to the assessment of number of trips (Section 3.3), trip characteristics (Section 4.3) and catch composition (Section 5.4). This section offers some (tentative) overall conclusions that result from combining these sections with considerations of data issues (Section 2.3).

1. Logbook records cannot be considered an accurate census of the for-hire recreational fishing trips taken in the Gulf of Mexico. Logbook records appear to be available for roughly 67% to 68% of the total number of trips taken, at least in the regions considered in this study, and this appears to be fairly stable over time. A reasonable assessment of uncertainty in this value results in an interval of about 63% to 72% (somewhat wider in Texas for which less data were available).

2. Logbook records cannot be considered as substitutes for what would have resulted from dockside sampling for individual trips, either in terms of trip characteristics (such as number of anglers, hours fished, and areas fished) or in terms of catch (number of species, numbers of harvested individuals, etc.). This then also applies to variables that might be constructed from the observed quantities, such as fishing effort.

3. The use of logbook records as a data source would require an increased level of data examination, assessment, and cleaning on the part of the National Marine Fisheries Service or state agencies. This stems largely from the number of different individuals that would be recording data. It can be anticipated that the greater the number of variables requested in logbook records, the greater the resources that would need to be devoted to data verification and assessment.

4. If a mandatory logbook reporting program is instituted, the definition of com-

pliance with reporting requirements needs additional consideration. In particular, filing a report of nonactivity while continuing to make active fishing trips should not be considered to be in compliance with a reporting program. The question of whether reports of no activity have value should be considered. If it is determined that reports of no activity are of value, having reporting requirements that differ in temporal frequency for active fishing and nonactivity certainly increases the complexity of a reporting system and can only increase, not decrease, confusion for vessel operators. A system in which one report is filed for each day, even if that was simply a report of no fishing activity, would promote regular reporting behavior and decrease excuses (either legitimate or contrived) for lapses in reporting. The suggestion offered here is that a reporting requirement consist of either (1) one logbook entry for each trip taken and nothing else, or (2) one report for each day containing logbook entries for each trip taken or an indication of no fishing.

5. Logbook records do appear to be a potentially useful source of information for estimation of average effort, number of species caught, total number of individuals harvested and released, and total mortalities. Logbook data and dockside sampling data appear to provide similar estimates of population averages of these quantities. Uncertainty may be slightly to moderately underestimated using data from logbook records.

6. The previous conclusion seems to apply to particular species in terms of number of individuals harvested, but may be somewhat more suspect relative to number of individuals released (alive or dead), particularly for species that are not frequently encountered. This is entirely in concert with the observation that logbook records do not correspond individually to dockside samples, but do in aggregate. The fewer individual records incorporated into an aggregate value, the more the influence of individual discrepancies and the less certain

agreement at the aggregate level.

7. It is not certain that values for numbers of mortalities (or discards) are accurate for either logbook or dockside sampling data sources. Both of these data collection schemes make use of information provided by captains or crew after a trip has returned to a dock site. If these values are reliable, it appears that the number of mortalities in the for-hire recreational fishery is low. Apparently some data were collected from at-sea observation, but these data are small in number and were not considered in the examination reported on here.

7 Potential Uses of a Logbook Reporting System

A consistent conclusion across each aspect of logbook data examination has been that logbook records cannot be considered a complete census of the for-hire recreational fishery. There have also been consistent indications, however, that logbook records could provide a reliable source of data for estimation. Specifically, the proportion of trips documented by activity monitoring (resulting in the "prevalidation" data set) for which logbook records are available appears reasonably constant over time. Average values of quantities connected with trip characteristics agree reasonably well when computed using data from dockside sampling and logbook records. As noted, this may also be true for at least some individual species, although a broad conclusion about species-specific values in general is not warranted at this time. The question arises, then, how logbook data might be used in an estimation procedure. Two possible estimation strategies are briefly sketched here. Some of the details of these procedures would require additional analysis of existing data, and this is not meant to provide a complete outline for analysis. Also, although these strategies seem fairly basic, they should not be taken as exhaustive of the possibilities.

7.1 Estimation Based on Effort

Many estimators in fisheries science have the form of effort multiplied by catch-per-unit-effort (cpue). Such a strategy could be employed in the for-hire recreational fishery of the Gulf, in the following way. Assume that the quantity to be estimated is a population total τ, such as the total number of individuals of a given species in a given region and time span that are harvested, and let N denote the total number of trips taken. Let κ denote the average effort (in fishing hours) across all trips, and let ψ denote the cpue (in number per fishing hour). Then

$$\tau = N \, \kappa \, \psi. \tag{4}$$

An estimated version of τ results from (4) by replacing N, κ and ψ with estimators $\hat{N}$, $\hat{\kappa}$ and $\hat{\psi}$. Deriving the standard error of an overall estimator $\hat{\tau}$ formed as such a product is difficult, and is typically approached in survey sampling theory through the use of a Taylor expansion and asymptotic results. A straightforward alternative is the use of a Bayesian strategy, in which a posterior distribution for τ is produced through simulation, automatically quantifying uncertainty.

For estimation of N, the fundamental idea would be to divide the number of logbook records available by the proportion of trips that have logbook records, as estimated from the data in this project. Let θ denote that proportion. Suppose θ has been assigned a prior distribution $\pi(\theta)$, most likely a beta distribution with fixed parameters α_0 and β_0. Given a total of m trips verified by activity monitoring of which z had corresponding logbook records, an appropriate data model for z is binomial with parameter θ. The posterior of θ in this well-known formulation is then a beta distribution with parameters $\alpha_0 + z$ and $\beta_0 + m - z$. Importantly, a posterior distribution for the number of trips results from simulating values from the posterior of θ and dividing the number of logbook records by these simulated values.

For estimation of κ, we might assign a parametric distribution to effort, defined as number of anglers multiplied by hours fished. Preliminary examination of these values suggests that the distribution of effort has an extremely long and thin right tail. Distributions such as (one type of) generalized gamma or extreme value might be useful in modeling effort. Alternatively, one could assign distributions to both number of anglers and hours fished. In either case, prior distributions would again be assigned to the parameters of these distributions, and data from logbook records used to update those priors as posterior distributions. It is likely that for either effort or its component quantities (anglers and hours fished) posterior distributions will not be able to be derived analytically. Posterior distributions would thus most likely be produced through the use of Markov Chain Monte Carlo (MCMC) methods. Along with basic estimation as summary quantities of posterior distributions, an objective here would be to simulate from the posterior distribution of κ (which may well be a function of other model parameters) and possibly the posterior predictive distribution of effort, which could be easily accomplished as part of an overall MCMC procedure.

Estimation of ψ would require a model for either number of individuals (in the appropriate category) or the constructed variable of cpue. This may well present the greatest modeling challenge, in part because cpue may be highly skew or spread out, and in part because it may be difficult to define a general model that applies to many different species. But, given that an appropriate model can be arrived at, the procedure would parallel that for κ as sketched in the previous paragraph. If ψ is the expected value of cpue it will be a parameter in the distribution chosen for modeling, or a function of parameters in that distribution. The objective would again be to derive or simulate the posterior distribution of ψ based on available data. A major issue in dealing with cpue is whether logbook data could be deemed reliable for individual species. If so, then the entire estimation procedure could be conducted with logbook data alone (and prior knowledge about the proportion of trips submitting logbook reports gained from this project). If not, then there would be a need for data from a direct observation program such as the dockside samples obtained in this project.

The overall strategy, then, would be to simulate values from the posterior distributions of N, κ, and ψ, from which values from the posterior distribution of τ are available by construction. This would provide a point estimate as the mean (or perhaps mode) of the simulated values, and automatically give credible intervals as the central portion of the empirical distribution of simulated values. This procedure assumes that the number of trips taken N, expected or average effort κ, and catch-per-unit effort ψ may be considered independent. If an examination of data fails to support such an assumption, joint distributions for several of these quantities might be required (most likely effort and cpue) which would complicate some of the details involved but not change the overall structure of the procedure.

7.2 Estimation Based on Probabilities of Events

An alternative form for an estimator arises from a different representation of the total number of individuals contained in a given category (e.g., harvest). Continuing to let N represent the total number of trips, let y_i now denote the number of individuals of interest for trip i. Then the total τ is,

$$\tau = \sum_{i=1}^{N} y_i. \tag{5}$$

Now, let the trips that caught the given species be represented as the set $\mathcal{C}$, and the subset of $\mathcal{C}$ for which the disposition was as specified be represented as $\mathcal{D}$ (note that $\mathcal{D} \subset \mathcal{C}$). Let $|\mathcal{C}|$ and $|\mathcal{D}|$ denote the sizes of these sets. Then (5) may be written as,

$$\tau = \sum_{i=1}^{N} y_i = \sum_{i \in \mathcal{D}} y_i = N \frac{|\mathcal{C}|}{N} \frac{|\mathcal{D}|}{|\mathcal{C}|} \frac{1}{|\mathcal{D}|} \sum_{i \in \mathcal{D}} y_i. \tag{6}$$

Expression (6) simply says that the sum over all trips of the number of individuals in a given disposition category is equal to the sum over non-zero values, and this is not changed if it is multiplied by 1. But (6) also provides the key for estimation in pieces. As before, N is the total number of trips in the fishery. The factor $|\mathcal{C}|/N$ is the proportion of trips on which the species of interest is caught, and $|\mathcal{D}|/|\mathcal{C}|$ is the proportion of those trips on which individuals were included in the given disposition category. Finally, $1/|\mathcal{D}|\sum_{i\in\mathcal{D}} y_i$ is the average number of individuals per trip in the disposition category, given that at least some individuals were. To write (6) in a form suitable for estimation based on a sample of trips, let $\{Y_i : i \in \mathcal{D}\}$ be random variables connected with the number of individuals of a given species that fall into a given disposition category when any individuals of that species fall into that category. Note that the possible values of Y_i are $y_i \in \{1, 2, \ldots\}$ (that is, Y_i cannot be 0). Also, let C denote the event the species is caught and D the event the species occurs in the disposition category of interest. Then a version of (6) written in terms of probabilities and expected values is,

$$\tau = N\, Pr(C)\, Pr(D|C)\, E(Y_i). \tag{7}$$

An estimator of τ may then be developed by substituting estimators of N, $Pr(C)$, $Pr(D|C)$, and $E(Y_i)$ into (7), and such estimators may be developed from a sample of trips. In particular, N may be estimated in the same manner as outlined in the previous section. The probabilities $Pr(C)$ and $Pr(D|C)$ may be estimated from binomial data models in a manner quite similar to N. These are all situations for which few modeling decisions are needed, the obvious choices of data models being binomial with conjugate beta priors. Estimation of $E(Y_i)$ requires modeling according to some parametric distribution in the same manner that was outlined for estimation of κ and ψ in the previous section. Given simulated values from the posteriors of N, $Pr(C)$, $Pr(D|C)$, and $E(Y_i)$, values from a posterior for τ are available by construction, again providing both point estimates and quantification of uncertainty directly.

One final aspect of the estimation strategy outlined in this section is that it may be quite straightforward to extend this structure to simultaneous estimation of all disposition categories for a given species. This would be accomplished by extending the event D to the vector of events (D_1, D_2, D_3, D_4), where D_1 is harvest, D_2 is released < 120 ft., D_3 is released > 120 ft. and D_4 is mortality. The binomial data model for one of these component events, as in (7), would be replaced by a multinomial data model, and the beta prior would be replaced with a Dirichlet prior.

The main question in terms of data sources for this type of estimator is the same as for the estimator of the previous section with regard to ψ – could logbook records provide the needed information for estimation of $E(Y_i)$? Only two specific species were examined in this report. Those species were chosen because of frequency of occurrence in the data and because they may be species of particular interest. More individual species or species groups could be examined, but the difficulty of species identification described in Section 2.3 would need to be resolved first.

8 Additional Work

8.1 Logbook Verification in Practice

If logbook data are to be used in practice, it is natural to consider the design of some type of additional sampling program to provide a check on the representativeness of logbook data over time. If logbook records could be considered one-to-one equivalents of what would result from dockside sampling, a small monitoring program consisting of intercepts of trips as they return from fishing trips would be a potentially effective strategy. But it is clear from the examination of data sources considered in this report that logbook records cannot be considered one-to-one equivalents of dockside sampling. Logbook data appear to give similar aggregate values as do data from dockside sampling, but a small number of dockside samples should not be expected to agree with a small number of corresponding logbook reports. This implies that any external program with the objective of verifying the representativeness of logbook data should be conducted only on a larger scale, which may then imply it be conducted only on occasion, rather than continuously.

The data available from this project could be used to examine the agreement or disagreement of aggregate values from logbooks and dockside samples under various levels of sampling effort. This would most likely take the form of a Monte Carlo assessment in which a large number of M (e.g., $M = 10,000$) samples of various sizes are selected at random from the dockside and logbook data sources. The average values of quantities such as those used in Sections 4 and 5 of this report (averages over the M Monte Carlo repetitions) are then approximations to the expected values of those quantities. Comparison of these quantities for different potential sample sizes would then hopefully provide guidance about the level of sampling effort that would be required in a verification effort at a future point in time. Similarly, data from activity monitoring in this project could be used in a simulation-based assessment of how large a sample would be needed to verify that the “correction factor” used to estimate the total number of trips is still relevant.

8.2 Data From June-August 2011

It is anticipated that additional data of the same types as those examined in this report will be available for the period of June through August 2011. Initial conversations between individuals involved with MRIP and MRAG supposed that those data could be subjected to a similar examination as reported on here. While this is certainly still possible, it may not be entirely necessary. It is unlikely that these three additional months of data will change the conclusion that not all trips taken (or even essentially all) result in logbook reports. Unless the behavior of captains in filling out logbooks (or that of dockside samplers) changes markedly in these three months from the fairly consistent patterns identified in this report, it is unlikely that conclusions regarding the potential use of logbook data will be altered dramatically. If MRIP determines that it would like to pursue estimation from the logbook data source along the lines of the potential estimators briefly described in Section 7, a more efficient use of the additional data might be to implement one of these estimation strategies using logbook data on the one hand, and data from activity monitoring (for estimation of the number of trips N) and dockside sampling (for estimation of other necessary quantities) on the other. A comparison of estimates produced using these different data sources would verify (or cast doubt upon) the tentative conclusions reached in this report.