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Management Brief

The creation and utility of a mobile application as a reporting tool in the charter for-hire fishery

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ABSTRACT

Objective: One of the most difficult aspects of recreational fisheries management is the ability to collect and have immediate access to fisheries-dependent data. The advent of smart devices has created a novel way to collect self-reported data. Working with 16 for-hire vessel captains from across the Gulf of Mexico, we developed an electronic logbook application, iSnapper, to test the quality and quantity of data that an app could provide for researchers and fisheries managers.

Methods: Captains tested iSnapper by recording catch and effort data on a tablet or smartphone during the 2011 recreational Red Snapper *Lutjanus campechanus* fishing season (June 1, 2011–July 18, 2011) and provided recreational anglers aboard those vessels with the opportunity to participate in a voluntary socioeconomic survey. Submitted trips were validated by comparing the app data to those collected at dockside creels.

Results: During the 6-week trial, 17,926 fish were caught, from a total of 60 species, with Red Snapper comprising most of the catch (61%). Red Snapper had a reported discard rate of 38%, with 86% of those reported to be released alive. Over 70% of trips with reported depths were fishing between 30 and 59 m. Validation of harvest data showed no major differences between independent creel surveys and data reported to the iSnapper program.

Conclusions: Overall, we demonstrated that an electronic reporting app such as iSnapper can produce high-quality and valid catch data for use by fishery managers. These electronic reporting apps could also be used to help with data gaps in recreational fisheries where little or no data are currently being collected.

KEYWORDS: fisheries, management, survey methods, technology

LAY SUMMARY

Accurate catch, effort, and supplementary data can be collected from the charter for-hire industry using an application created for a phone or tablet.

INTRODUCTION

The state of the world's fisheries has been the subject of much attention in recent years, as many are overfished or fully exploited (Pauly et al., 1998, 2003). Overfishing has clearly contributed to the demise of some fisheries (Jackson et al., 2001), and rebuilding severely depleted stocks is hindered by substantial data gaps. One such hindrance is the lack of real-time fisheries-dependent data, particularly for the recreational sector (Walters & Martell, 2004). Without available real-time data, fisheries managers must use untimely data for their stock assessment models, which may not accurately reflect the current state of the fishery and can result in stakeholders and management groups having very different opinions about the fishery. This can lead to conflicts between user groups and management agencies. The most effective way to manage fisheries is to increase the amount of high-quality timely data collected, providing near real-time trends in the fishery (Claroa et al., 2009).

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To estimate catch and effort data from recreational fisheries, the National Marine Fisheries Service (NMFS) developed a nationwide network of surveys (e.g., in-person creel surveys, telephone, and mail) originating in 1979 as the Marine Recreational Fisheries Statistics Survey (MRFSS). Following a redesign in 2008, the current reporting program (Marine Recreational Information Program [MRIP]), is used to estimate recreational harvest on a state-by-state basis throughout the coastal United States and its territories. Texas Parks and Wildlife (TPWD) has been exempted from these programs, instead opting to continue collecting data with their own intercept surveys that began in 1974. Both programs collect catch and effort data from anglers to determine a total harvest of all reported species. However, predictions based on any type of after-the-fact survey can result in a high degree of error due to recollection bias (National Research Council, 2006). According to the National Research Council (2006), one of the most important tools needed to improve estimates derived from recreational fisheries was better data from the for-hire sector. To address this, NMFS approved a policy in 2013 wherein electronic technologies could be used to complement or improve fishery-dependent data collection programs. These programs included tablet-based field data collection and angler reporting applications ("apps"). Electronic logbooks have the potential to allow for more accurate catch and effort estimations and can easily be validated when paired with traditional creel surveys, and the data are available more quickly than with traditional paper logbooks (Sauls et al., 2012).

Currently, more than 3,000 commercial fishing vessels throughout the United States are using a form of electronic reporting (NMFS, 2022). These programs require a geographic positioning system (GPS) or a vessel monitoring system (VMS) that provides continuous location tracking of the vessel throughout the trip. These systems can be expensive (~US$3,000 for the unit and $30–60 per month service fees; South Atlantic Fishery Management Council, 2024) and unreliable (Gulf of Mexico Fishery Management Council, 2022) and are permanently fixed to the vessel, causing concerns about privacy when mandated for use in the for-hire fishery (New Civil Liberties Alliance, 2021). Large head boats throughout the Gulf of Mexico and up the East Coast to North Carolina are required to report their catch and effort through the Southeast Region Headboat Survey (SRHS). Captains report trips electronically weekly, with generalized fishing locations (fishable waters are gridded into 16- by 16-km boxes) as opposed to active GPS tracking. These reports allow NMFS to collect effort and landings, as well as biological samples from dockside intercepts. Similar to this reporting style, the costs of a mobile app are considerably less than that of a VMS system; almost 90% of adults own a smartphone (Pew Research Center, 2024), so there is no "hardware" cost and users can use their data plans or Wi-Fi to submit trips so no additional monthly charges are accrued.

Most recently, the Gulf of Mexico for-hire industry was required to report their trips using similar electronic data collection methods in January 2021. However, the reporting requirements proved to be intrusive and burdensome to some captains and after significant pushback, ultimately culminating in a federal lawsuit (Mexican Gulf Fishing Co. v. U.S. Department of Commerce, 2023), the mandatory reporting requirements were removed in February 2023. As a result of the litigation, this sector no longer has any legal obligation to report trip or harvest data. This latest policy change highlights the need for a more simplified data collection technique that can cater to and accommodate the variety of vessels and captains in this fleet.

The Gulf of Mexico Red Snapper fishery provides an ideal testing ground for a simplified electronic logbook for to the for-hire recreational fishing industry. Red Snapper is the most economically important reef fish in the Gulf of Mexico; however, until only recently, it had been classified as overfished and undergoing overfishing (Southeast Data, Assessment, and Review, 2018). The overall goal of this project was to develop a user-friendly electronic reporting app through the cooperation of scientists, managers, and fishermen to determine the quantity and quality of data that an electronic logbook is capable of collecting during the 2011 Red Snapper recreational fishing season. Data submitted through the app were compared with dockside creel surveys (MRIP and TPWD) to calculate reporting rates and reporting errors to evaluate the potential for self-reported electronic data to be used for harvest estimation. With the recent push for electronic reporting in fisheries data collection, we also provide recommendations and considerations for future app design.

METHODS

Development

To develop an app that was a suitable platform as an electronic logbook for use in the for-hire sector, we evaluated several operating systems and determined that Apple's iOS software platform provided a good combination of computing power, ease of use, and brand name recognition by the participants. In addition, the iOS platform was available as both a smartphone (iPhone) and a tablet (iPad), providing a similar working environment between devices. We also chose these devices because both provide a fast, wireless Internet connection and can be GPS enabled, allowing for the collection of location-specific data whether in or out of cellular range. Additionally, an iPad was specifically requested by many users.

The app was designed to record catch and trip data from individual vessels by having the captain enter information such as number and species of fish harvested, the weight and fate of those fish, and the locations fish were captured using the internal GPS. Upon submission, these data were uploaded to the Bluefin reporting software used by the SRHS. The integration was critical, as some boats were already providing their data in the SRHS and we did not want them to have to report in both systems. The app was also designed to include a voluntary socioeconomic survey for individual anglers (paying clients) to complete at the end of the trip. In addition, a Web portal was developed that interfaced with iSnapper and allowed fishermen to submit data from a traditional computer if they could not or chose not to use the iSnapper app on their device. The iSnapper website also allowed captains access to each submitted trip and the ability to edit trips, export data, and print reporting forms.

For-hire captain recruitment

Once a prototype was developed, 16 for-hire vessels were recruited to participate in the iSnapper pilot. The recruitment

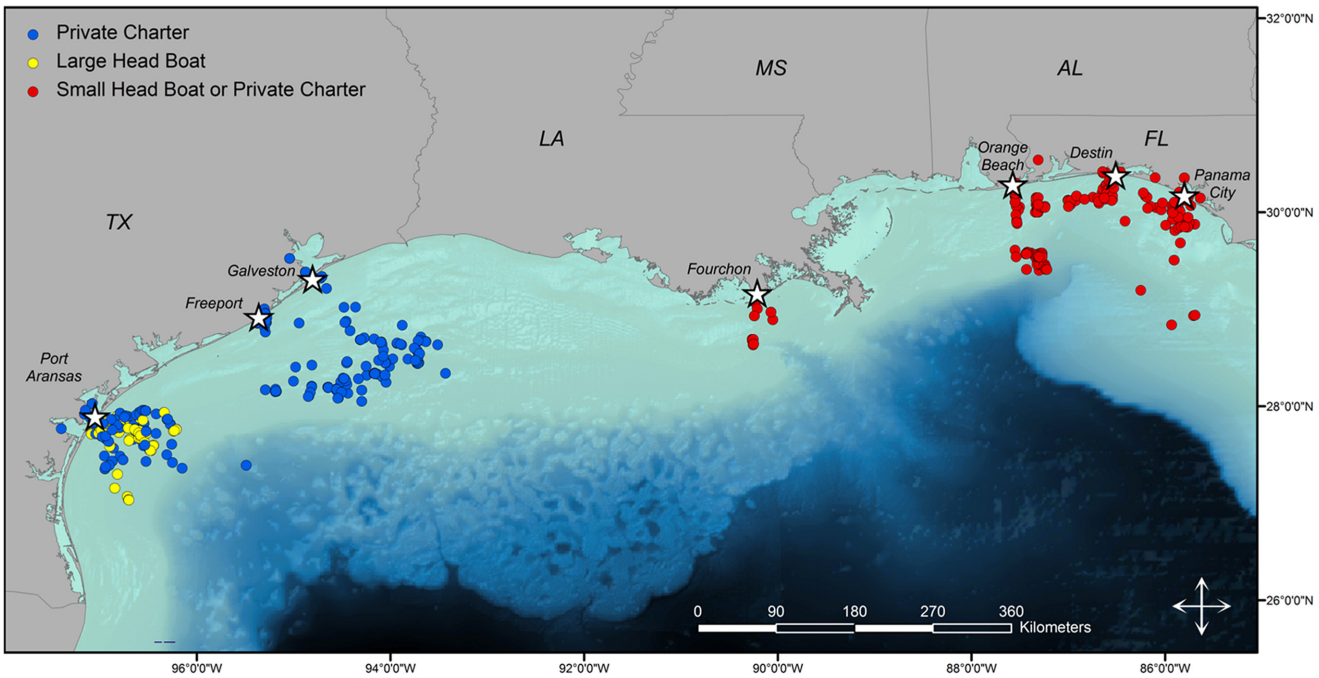

Figure 1. Vessel port of origin (stars) and general fishing locations as recorded by iSnapper pilot program during the 2011 Red Snapper recreational season (June 1, 2011–June 18, 2011). Locations were either automatically recorded by the internal GPS on the iPhone or iPad or manually edited by vessel captains. Locations on land are due to captains completing the survey after the trip was completed.

process was done through word of mouth. Several well-known charter captains were initially contacted, some of whom provided recommendations of other captains to reach out to and/or talked about the project to their counterparts within the industry. An initial 1-d workshop was provided for all participating captains. During this workshop, captains filled out an initial questionnaire asking their motivations and opinions about electronic monitoring. Captains were then trained about the functionality of the app and the process of submitting their data. These captains indicated in their initial questionnaires that they all had a desire to be part of this study, knowing that if electronic reporting was possible, it could revolutionize data collection. They also were willing to provide continuous feedback about the app as they began working with it and critique what could be improved. Each vessel captain was required to report their catch in iSnapper before returning to the dock from any for-hire trip that the vessel took, regardless of trip type, for the 2011 Red Snapper recreational fishing season (June 1, 2011–July 18, 2011). Captains were also asked to offer their customers a socioeconomic survey at the end of the trip and to evaluate the utility of the app and suggest modifications to improve the app for future use. Nine of the vessels were based in central Texas, and the remaining seven were in north Texas (two); Panama City, Florida (two); Fourchon, Lousiana; Orange Beach, Alabama; and Destin, Florida (Figure 1). The vessels represented a variety of vessel types (private charter, small head boats, and large head boats) and captains had a variety of experience using apps prior to downloading iSnapper. To determine the type of for-hire vessel, we calculated the mean number of anglers per trip that were reported in iSnapper. Vessels were assigned into one of three categories: large head boats were any vessel that had a reported mean number of anglers >20, private charters were any vessel with a reported mean number of anglers ≤6, and small head boats were any vessel with a mean of 6–20 anglers (Table 1). As an incentive for their participation in the pilot study, each vessel captain was provided with an iPhone or iPad and was reimbursed for a monthly data plan. Reimbursement was contingent on active participation in the program. At the end of the project, captains were invited to participate in a final meeting to provide feedback about the app and see summary data from the study.

Program description and use

The iSnapper app was designed to collect data from individual vessels; thus, a login system was created where each vessel was assigned a unique identification code (Vessel ID), and each captain had a unique identification number. The login system was important because some of the participating head boats had numerous captains running the same vessel, and this allowed the ability to link all the trip information back to the same vessel. After logging in, participants started a new trip report for that day and began entering basic trip information (number of passengers, anglers, crew, fishing method, and target species). The program was designed to allow data input throughout the day at each stop made by the vessel to provide catch information for all fishing locations. The iSnapper app automatically recorded the vessel's position using the internal GPS when catch information was entered at a new fishing stop.

Table 1. Detailed vessel information for iSnapper participants. A large head boat was any vessel that had a reported mean number of anglers >20; a private charter was any vessel with a reported mean number of anglers ≤6; a small head boat was any vessel with a reported mean number of anglers between 6 and 20. Port of origin is the location where the vessel is docked and/or the launch location. Device indicates which type of platform was given to the captain to submit catch data.

Vessel type	Port of origin	Device	Mean number of anglers	Mean number of trips	Percent of total trips (%)
Large head boat	Port Aransas, TX	iPad	42	38	12
Large head boat	Port Aransas, TX	iPad	40	35	11
Private charter	Freeport, TX	iPad	3	19	6
Private charter	Galveston, TX	iPad	5	26	8
Private charter	Port Aransas, TX	iPad	6	7	2
Private charter	Port Aransas, TX	iPad	4	10	3
Private charter	Port Aransas, TX	iPhone	4	21	6
Private charter	Port Aransas, TX	iPad	4	13	4
Private charter	Port Aransas, TX	iPhone	4	16	5
Private charter	Port Aransas, TX	iPad	2	3	1
Private charter	Port Aransas, TX	iPad	6	4	1
Small head boat	Destin, FL	iPad	7	27	8
Small head boat	Fourchon, LA	iPhone	16	11	3
Small head boat	Orange Beach, AL	iPad	9	27	8
Small head boat	Panama City, FL	iPad	9	34	10
Small head boat	Panama City, FL	iPad	11	36	11

At each fishing location the species caught, number harvested and discarded, and total (approximated) weight of harvested fish were recorded. At the end of the day, the "trip close" information was entered, which included trip duration, pay type, minimum and maximum depth fished, total hours fished, and general fishing location (inland, <10 mi offshore, or >10 mi offshore). When the captains returned to port or were within cellular data range, they would submit the trip, and the information was wirelessly uploaded and stored in Bluefin, a cloud-based online hosting server. All the data was available to download by the Harte Research Institute for storage and analysis. As programming problems were uncovered, updates to iSnapper were done wirelessly by prompting the user to manually load the app and allowing it to update. Despite different screen sizes, each smart device collected identical information.

Validation

All of the vessels could be randomly intercepted for a creel survey by MRIP or TPWD creel agents during the season; therefore, for validation purposes we obtained data from those agencies that corresponded to the vessels in our program. Specifically, we compared the number of Red Snapper harvested and discarded for trips that were both submitted using iSnapper and intercepted by a creel agent to calculate the reporting error. The reporting error for Red Snapper harvested weight was also compared between reporting methods. A Pearson's correlation was calculated to determine the relationship between the two methods of reporting for the number of harvested and discarded Red Snapper.

Socioeconomics survey

To test the utility of mobile technologies in collecting socioeconomic data from participants in the reef fish fishery, we created a survey page within the iSnapper program. Participation by anglers (paying clients) was strictly voluntary and anonymous. Questions mirrored some of those used in the Coastal Household Telephone Survey and Angler Catch Survey (intercept) as part of the MRIP program. The one-page survey was designed so that the respondent would not have to spend more than 5 min answering the questions and was approved by the Texas A&M University's Institutional Review Board. Captains of private charter vessels offered their customers the opportunity to participate in the survey while traveling among sites or after the vessel has returned to the dock. All head boats were excluded because the crowds on the vessels were larger than could reasonably be expected for the captain to interact with while safely operating the vessel. At the discretion of the captain, the device would be handed to the angler, and the angler would choose whether to participate in the survey. Customers were advised to only answer questions they felt comfortable with.

RESULTS

App creation and modification

Engagement with and feedback from the for-hire captains was a critical part of the app creation process. During initial training and following an entrance questionnaire, a majority (85%) of captains felt less than 20 min a day was appropriate and reasonable for submitting their data electronically. In addition, several screens were redesigned based on initial feedback to allow for more intuitive navigation during data submission. Captains were apprehensive about iSnapper collecting GPS locations, with concerns about the loss of secret fishing spots if the data were published. As a result, GPS related data were truncated to reduce resolution, and the captains were given the option to turn off the internal GPS and manually enter a location. Additionally, captains were allowed to edit and enter the latitude and longitude of their fishing locations, making it possible to submit this information at the end of the day.

Trip information and data collection

Between June 1 and July 18, 2011, there were 327 trips logged using iSnapper by participating for-hire captains in the Gulf

Table 2. Summary of vessel participation and trips logged by state during the iSnapper pilot program. Red Snapper trips is the total number of trips where at least one angler caught a Red Snapper, and the number in parenthesis indicates the percentage of trips that caught Red Snapper in each state. Red Snapper harvested is the number of Red Snapper harvested in each state, and the number in the parentheses is the total percentage each state harvested.

State	Number of vessels	Number of trips	Red Snapper trips (%)	Red Snapper harvested (%)
Texas	11	192	147 (77)	4,363 (65)
Florida	3	97	90 (93)	1,686 (25)
Alabama	1	27	25 (93)	368 (6)
Louisiana	1	11	9 (82)	302 (4)
Total	16	327	271	6,719

Table 3. Primary target species recorded in the iSnapper pilot program.

Primary target species	Number of trips	Percent of trips
Red Snapper *Lutjanus campechanus*	201	61.5
King Mackerel *Scomberomorus cavalla*	76	23.2
Others	13	4.0
Gray Snapper *Lutjanus griseus*	9	2.8
Blacktip Shark *Carcharhinus limbatus*	7	2.1
Blue Marlin *Makaira nigricans*	7	2.1
Sand Seatrout *Cynoscion arenarius*	3	0.9
Greater Amberjack *Seriola dumerili*	2	0.6
Yellowfin Tuna *Thunnus albacares*	2	0.6
Blackfin Snapper *Lutjanus buccanella*	1	0.3
Bull Shark *Carcharhinus leucas*	1	0.3
Cobia *Rachycentron canadum*	1	0.3
Red Drum *Sciaenops ocellatus*	1	0.3
Red Grouper *Epinephelus morio*	1	0.3
Silver Seatrout *Cynoscion nothus*	1	0.3
Vermilion Snapper *Rhomboplites aurorubens*	1	0.3

of Mexico. Most of the trips were reported in Texas, with this region having the most participating vessels (11 total). Red Snapper were the most dominant species, caught on 83% of the trips, with Florida and Alabama reporting the highest percentage of trips collecting Red Snapper, followed by Louisiana and Texas (Table 2). Although Texas had the lowest percent of trips with Red Snapper caught, they harvested the greatest percentage of Red Snapper (65%), likely due to having the highest vessel participation and that Texas was the only state that included reporting from large head boats (two vessels). Captains also provided the primary and secondary species targeted for each trip. Interestingly, despite this pilot being conducted during Red Snapper season, approximately 39% of trips targeted species other than Red Snapper (Table 3).

A total of 10,920 Red Snapper were captured during the 2011 recreational season, comprising 61% of the overall catch, of which a total of 6,719 were harvested (Table 4). Red Snapper also had the highest discard rate (38%), and captains reported that the majority (86%) were released alive (Table 4). The next most common species caught were Vermilion Snapper and King Mackerel, which, when included with Red Snapper, made up 85% of the total catch (Table 4).

Large head boats harvested 50% of the total Red Snapper, which is not surprising, as they also reported the greatest number of anglers (Table 1). They caught approximately one-third of the total number of Red Snapper but discarded very few individuals (9%). Small head boats made up an additional 35% of the total Red Snapper harvest but also discarded a large portion of their catch (49%). Private charters caught and harvested the fewest Red Snapper but discarded approximately 52% of their catch.

Of the 517 fishing locations reported to iSnapper by the captains, 113 (22%) were from locations that were not fishable and likely reported at the end or after the trip, based on their pin location following trip submission. This included locations inland, near the passes, and inside harbors. The remaining 78% of locations were within the Gulf of Mexico (Figure 1). Excluding errant reporting locations, iSnapper vessels travelled an average of 65 km per trip. To examine the use of various habitat types, trips taken by vessels in the Port Aransas, Texas, area were mapped with known structured habitats (natural banks, standing rigs, artificial reefs; Figure 2). While the location data was truncated to encourage reporting, there was an obvious preference to fish well-known structured habitats (either natural or man-made). In this area, vessels were typically fishing in waters less than 80 m. Overall, a total of 296 (90.5%) trips reported their maximum fishing depth. Of these trips, 91.6% were in waters less than 60 m. A vast majority (71.6%) were between 30 and 59 m, with only 8.4% occurring at depths greater than 60 m.

Validation

For the seven vessels being monitored by the SRHS, 122 trips were logged electronically using iSnapper. From these trips, a 9.0% validation rate (11 trips) occurred, resulting from data submitted by only three vessels (Table 5). A total of 16 dockside intercepts occurred, wherein five trips intercepted by creel agents were not reported in the iSnapper program, indicating that some portion (in this case, at least 31%) of trips fished during the season were not self-reported. The number of harvested Red Snapper between the two reporting systems was equivalent for all but one trip, resulting in a highly significant correlation between the reporting methods ($r = 0.998$, $P < 0.001$). The difference in harvest was one fish, for an overall reporting error of 1.0%. The reported discards varied between the two survey methods (Table 5). The overall discard reporting error was −6.0%; however, the two reporting methods were still significantly correlated ($r = 0.931$, $P < 0.001$) despite the variability. The harvested weight of fish was only measured in seven creel surveys. Overall, the total weight of harvested fish was underestimated by 15.9% when reported using iSnapper. However, this discrepancy is expected since few vessels weigh fish while at sea and participants were estimating weights by fish size when logging data.

Socioeconomics

Overall, 64 socioeconomic surveys were completed on 34 different non-head-boat trips (191 non-head-boat trips total). Although it is unknown how many individual passengers were given the opportunity to participate in the socioeconomic survey, we assumed based on the voluntary nature of this project

Table 4. Catch summary data from iSnapper. The table only includes fish with at least 10 individuals captured.

Common name	Scientific name	Number captured	Number harvested	Discard rate (%)	Released alive (%)
Red Snapper	*Lutjanus campechanus*	10,920	6,719	38	86
Vermilion Snapper	*Rhomboplites aurorubens*	3,301	3,214	3	91
King Mackerel	*Scomberomorus cavalla*	951	807	15	93
Red Porgy	*Pagrus pagrus*	397	391	2	100
Gray Triggerfish	*Balistes capriscus*	370	231	38	99
Gray Snapper	*Lutjanus griseus*	308	308	0	–
Atlantic Sharpnose Shark	*Rhizoprionodon terraenovae*	246	187	24	100
Red Grouper	*Epinephelus morio*	179	90	50	73
Dolphinfish	*Coryphaena hippurus*	178	165	7	100
Gag	*Mycteroperca microlepis*	138	1	99	72
Cobia	*Rachycentron canadum*	129	102	23	96
Sand Seatrout	*Cynoscion arenarius*	128	98	23	83
Greater Amberjack	*Seriola dumerili*	127	1	99	95
Blackfin Snapper	*Lutjanus buccanella*	96	85	11	82
Banded Rudderfish	*Seriola zonata*	58	58	0	–
Little Tunny	*Euthynnus alletteratus*	57	53	7	75
Wahoo	*Acanthocybium solandri*	32	32	0	–
Scamp	*Mycteroperca phenax*	31	22	29	67
Blackfin Tuna	*Thunnus atlanticus*	26	26	0	–
Spanish Mackerel	*Scomberomorus maculatus*	22	22	0	–
Great Barracuda	*Sphyraena barracuda*	20	14	30	100
Almaco Jack	*Seriola rivoliana*	17	17	0	–
Atlantic Spadefish	*Chaetodipterus faber*	17	17	0	–
Blacktip Shark	*Carcharhinus limbatus*	14	4	71	100
Dog Snapper	*Lutjanus jocu*	13	13	0	–
Red Drum	*Sciaenops ocellatus*	11	5	55	100
Bull Shark	*Carcharhinus leucas*	10	1	90	100
Yellowtail Snapper	*Ocyurus chrysurus*	10	10	0	–
Total catch		17,926	12,774	29	87

that at least one client was given the opportunity to take the survey on every trip, since captains were already willing to submit catch and effort data. Therefore, the minimum trip survey response was 18%. However, the response rate was potentially higher if captains declined to provide clients with this additional survey. There were cases where surveys were administered to multiple customers on the same vessel. Of those that took the survey, there were very few individual questions with no response (29 out of 512, or 5.6%). Thirty percent of the respondents' saltwater fishing time was spent fishing offshore (2.5 d out of 8.2 d per year). The average number of days for the entire trip (travel, fishing, other recreation) was 3.8, and the clients travelled an average of 330 mi to get the charter boat location. In addition, 55% of the respondents indicated a household income over $100,000% and 80% of the respondents were male (Table 6).

Exit interview questionnaire

Two final wrap-up presentations were completed at the end of the project, with 11 captains in total attending at least one. These presentations were provided to allow for face-to-face interactions with the captains and to discuss their experiences with electronic reporting. Following the summary presentation and discussions, all captains were asked to fill out a questionnaire to evaluate the app and its potential use in the for-hire fishery. A total of four surveys were completed. While this is not enough to draw any statistically significant conclusions, we did find several similarities in responses. When asked if the program was user-friendly, all four captains indicated that yes, it was easy and/or intuitive to use. One captain mentioned that he would have preferred to use a tablet due to the larger screen size as opposed to the phone (captains were given a choice between the two). When asked how iSnapper compared to other electronic reporting systems, all respondents indicated that it was better than the other systems. The critiques of the app included connectivity issues when not in Wi-Fi range, field considerations (waterproofing, difficulty seeing the screen in direct sunlight), navigation within the app, and the utility of providing discard data.

DISCUSSION

This project demonstrated the versatility and functionality of smart devices as electronic logbooks to capture near real-time catch data in the recreational reef fish fishery. Because of the availability of smart devices, there are few other data collection methods that could be integrated as easily or as rapidly. These devices are user-friendly, portable, capable of running apps that can collect virtually unlimited amounts of catch and effort data, easily modified, able to seamlessly integrate with databases, and commonly used by the general public. Results from the iSnapper program also suggest that some captains in the for-hire industry are willing to be proactive in developing a solution for obtaining valid catch data, and they were instrumental in the success of this pilot study. Despite the project being incentivized (iPad or iPhone to keep following the project), we

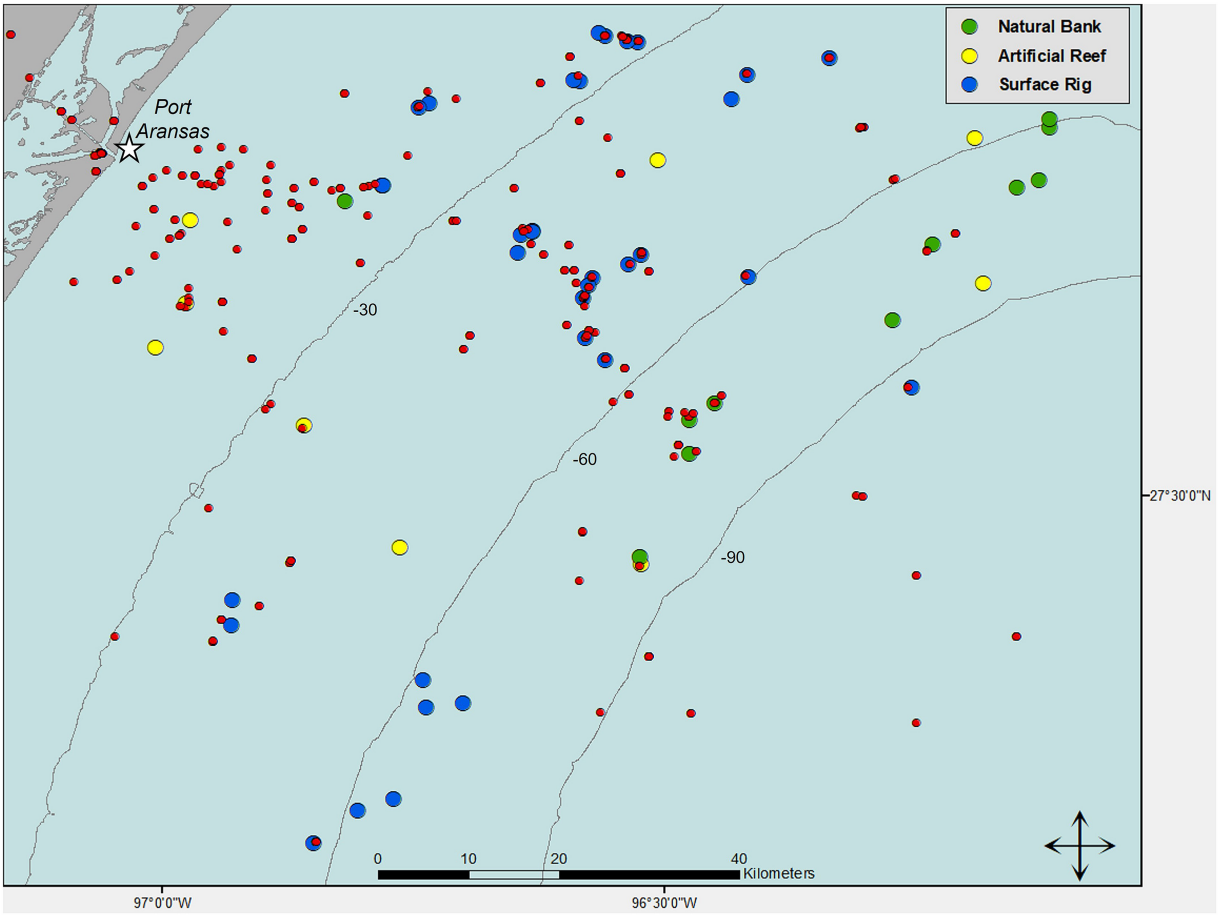

Figure 2. Example of how reporting locations can be useful for fishery managers when combined with habitat and bathymetry data. Smaller dots are the reporting locations, with larger dots denoting natural banks, artificial reefs, and surface oil/gas rigs.

Table 5. Individual trip validations comparing the dockside creel data with iSnapper data for harvested and released Red Snapper.

Vessel	Number harvested (creel)	Number harvested (iSnapper)	Difference	Number released (creel)	Number released (iSnapper)	Difference
Vessel A	16	16	0	30	30	0
Vessel A	16	16	0	4	10	6
Vessel B	5	4	1	0	1	1
Vessel C	8	8	0	30	31	1
Vessel C	8	8	0	20	16	–4
Vessel C	4	4	0	14	14	0
Vessel C	8	8	0	15	9	–6
Vessel C	10	10	0	6	5	–1
Vessel C	8	8	0	10	3	–7
Vessel C	9	9	0	8	8	0
Vessel C	12	12	0	12	13	1
Total	104	103	1	149	140	–9

do not think that was the ultimate motivator for why these captains agreed to participate. Instead, our interactions with them indicated that they had concerns about the way the fishery was being managed and saw this as a potential way to help solve a problem. In addition to these conversations, some captains (18 in 2012, 10 in 2013) continued voluntary reporting with no incentivization for 2 years following the project. All of these indicate a motivated group of individuals willing to actively participate in data collection. However, the data reported by these captains may not be representative of the entire for-hire fleet, due to the recruitment process and the limited number of individuals participating.

One important consideration was the overall design of the app itself. Keeping the data entry simple and intuitive seemed to reduce the intimidation factor for captains, since iPhones/iPads were still unfamiliar and novel to most participants.

Table 6. Socioeconomic survey questions provided to recreational anglers following a fishing trip. Participants were also asked for their zip code, but this information was not included in the table.

	Socioeconomic survey questions ($n = 64$)	Mean
1	How many people in total, including yourself, live in your household? Please include those people who fish and who don't fish.	3.9
2	How many people in your household, including children and adults, have been recreational saltwater fishing in the last 12 months anywhere in the Gulf of Mexico region including inshore and offshore?	2
3	How many days did you spend saltwater fishing in the last 12 months?	8.2
4	How many of these days were spent offshore?	2.5
5	If this fishing trip is part of a longer trip in which you will spend at least one night away from your permanent residence, how many days will this trip last?	3.8
6	Distance traveled to destination	329 mi
7	Gender of respondent	Male = 53 Female = 11
8	Which of the following best describes your household's annual income, before taxes?	
	Less than $10,000	1
	$10,000–14,999	1
	$15,000–24,999	0
	$25,000–34,999	3
	$35,000–49,999	0
	$50,000–74,999	7
	$75,000–99,999	8
	$100,000–149,999	21
	$150,000–199,999	10
	$200,000 or more	7
	Don't Know/Not Applicable	6

The data entry burden was also considered appropriate by the captains when discussed during the final workshop, as most reported that they spent less than 20 min per day entering their trip and catch information. Many expressed that they liked being able to enter data throughout the day rather than having to log it into a journal and then enter it into a program dockside at the end of the day. However, some of the recorded fishing locations were near their port of origin, suggesting that these captains entered their catch information while or after returning to port. Captains may have done this because they did not want to report their actual fishing locations, as many tend to be protective of their spots. No matter the reason, this study shows potential utility of using the GPS capabilities of smartphone and tablet devices in allowing for easier data submission. However, for captain buy-in, it was critical that the GPS data was truncated and editable. Finally, despite requiring captains to report prior to returning to the dock, they did have the option to use the Web portal (www.isnapper.org) to enter their data when they were back in port. However, during the pilot program none of the reports were entered using the Web portal, despite some of the trips being logged outside of fishable locations and therefore had the potential to be entered using a computer or Web browser. This indicates that the app was the preferred method of data input, both with captains that adhered to mandatory reporting and those that reported following the trip. This is encouraging from a design standpoint, demonstrating that the app was an easy and convenient way to report trip information as opposed to a Web page.

The primary goal of this project was to determine the feasibility of using an app to collect meaningful real-time fisheries-dependent data and if that data could be usable for management purposes. iSnapper generated substantial data throughout the 48-d mandatory reporting period, including the number of trips logged by state and port, number of vessels targeting specific species, capture and harvest by species, discard rates, and general fishing locations. Participation was anticipated to be high, and self-reported harvest and effort were potentially more accurate than with a general user, as individuals were selected due to an expressed desire to provide their data.

For electronic data to be used for management purposes, submitted data must be validated to assure proper reporting (Sauls et al., 2012). Both the nonreporting and error rates are required to extrapolate self-reported data to a total estimate of fishing effort and harvest. These rates can be estimated with a robust validation component, if the electronic data fields mirror the in-person creel intercept survey (Liu et al., 2017). Site pressure estimates from the creel survey can then be used to calculate the total harvest and effort for the reported fishery (Liu et al., 2017). Accurate estimates rely on high validation rates and require users to submit trips prior to being intercepted at boat ramps. Despite the mandatory reporting requirement, at least 30% of trips were not reported based on the validation data. It is unclear if captains forgot to report or assumed that they did not have to due to being interviewed at the dock, but whatever the reason, this is a serious consideration and these factors would have to be addressed if the purpose of electronic data collection is for effort and harvest estimation.

Although the amount of data available for validation of iSnapper data was limited, the reporting error between iSnapper data and creel survey data demonstrates that electronic self-reporting can be accurate depending on the motivations of the user and data being collected. The number of Red Snapper reported harvested was almost identical to what was seen at dockside interviews. Despite this, discard estimates were variable when compared to the dockside surveys. The data submission process for both harvest and discards was the same, so the

accuracy should have been similar. However, in the exit interview questionnaire, one captain wrote, "Most discard data from me is only wild guessing." Depending on the number of anglers on the boat and that captains typically go to known fishing hot spots, reporting discards can easily become overwhelming for one person to attempt to quantify during that fishing period, and even more difficult to recall when intercepted by a creel agent upon returning to port. Due to the nature of data collection (automatically recorded GPS locations), it is a reasonable assumption that the iSnapper data were more accurate due to there being an unlikelihood of recall bias, provided the captains were entering their data at each site. We believe this to be the case based on the discussions with captains at the final workshop and the comments from the exit questionnaire. In addition, a majority of Red Snapper were reported to be released alive. However, the fates of these fish following release is unknown. Captains were not asked about their gear or release methods, and release data were not validated. This additional data would need to be collected and validated before being incorporated into management. Thus, this small pilot project reveals the extent of data collection that is possible with electronic reporting in a portion of the recreational fisheries sector. Total recreational harvest for Red Snapper is managed based on the estimated harvest and an assumed discard mortality rate. However, the discard mortality rate for this sector is poorly understood due to the difficulty in collecting accurate discard rates. An electronic app such as iSnapper could be a tool to collect such data.

Additionally, the app collected other ancillary data, such as the depth at which vessels were fishing. This depth information paired with release data proved to be important in Red Snapper stock assessments because it was one of the only sources of data available in the entire Gulf. Moreover, spatially referenced data obtained from iSnapper have the potential to provide important fisheries information relevant at multiple scales. By integrating with a GIS mapping program and other commercially available data sets (e.g., bathymetry, reef locations, and oil platform locations), critical information related to aspects of the fishery like travel routes, bottom types fished, high-use areas, seasonal patterns, and vessel home ranges could be examined for a single port, among regions, or Gulf-wide. Understanding how recreational anglers are fishing (e.g., depth, general locations, number and fate of discards) could be helpful in stock assessment models, which has the potential to affect management decisions and regulations. The need for accurate discard data is becoming a higher priority with NMFS, and using a platform like iSnapper with some specific modifications could be a solution to this problem. While the discard data from iSnapper were highly correlated with the creel data, both reporting systems are not specifically designed to accurately collect this data. However, the app could easily be modified for the purpose of collecting discard data if submission was done concurrent with fishing so that anglers do not have to remember how many fish were released at each site, thereby eliminating errors due to recall bias. This self-reported discard data would have to be validated, potentially with the use of mounted cameras or using fishery observers, similar to what is being done for commercial vessels.

There are also many benefits of using app technology, not just in the for-hire but the entire recreational sector. For example, because the program can be modified by sending updates to each device wirelessly, it can easily be modified and adapted and allows the ability for critical or timely information to be sent out to the entire fishery at once (e.g., harvest estimates and changes in open/closed fisheries). Additionally, the iSnapper app could supplement data collected through dockside surveys, thus allowing managers to track species harvest in near real time while also minimizing recall bias. Another benefit of iSnapper is that it also allows for collecting socioeconomic information about fishermen. The program collected informative data about the anglers participating in the for-hire industry; however, there were relatively few surveys completed compared to the number of trips taken throughout the 2011 Red Snapper season, especially when considering that each vessel had multiple passengers. Responses from the exit questionnaire indicated that clients were skeptical of the survey or that the captains did not want to bother their customers by having them fill out the survey during a recreational trip. Following discussions with captains at the final meeting, it was also mentioned that deckhands, in particular, were not willing to offer the survey because they were afraid that it would affect their tip at the end of the day. These factors would need to be considered for further implementation of these types of surveys, and perhaps if this information collection should be mandatory. Thus, we recommend including "survey refusal" (by a client) and "declined to offer survey" options as part of the data collection (Fisher, 1996).

Following the success of the pilot of iSnapper during the 2011 Red Snapper recreational fishing season, several other Gulf states began their own electronic reporting apps. For example, Snapper Check (Alabama), Tails 'N Scales (Mississippi), and iAngler (Florida) were all created to help collect data predominately for the Red Snapper recreational fishery, with two of the apps having been developed using iSnapper's framework. Throughout the years, these apps have since been modified in a variety of ways based on the current interests of state fisheries managers and researchers. In the case of iSnapper, this includes creating an Android version, options to use the app if the user is either private or for-hire (or both), allowing for the user to create their own username and password for ease of recollection, and eliminating the site-by-site reporting with a total trip harvest and discard for each species caught. In addition, virtually any type of data can be incorporated into the reporting process; the key is to make the process efficient and user-friendly. Based on our results, data entry should be limited to less than 20 min per trip to prevent user burnout.

For an electronic reporting app to be integrated into management, it has to be certified by NMFS. This process involves stock assessment modelers being able to standardize their data with the new electronic data, which is a laborious process. For example, LA Creel, which was fully implemented for all saltwater recreational fisheries in January 2014, did not become a certified data source until January 2018. It is unclear whether iSnapper could be certified or if there is any benefit to such a process, as Texas does not participate in the MRIP. The current benefit of iSnapper is its versatility and adaptability, having a reporting system that can be changed dependent on the current needs of fishery managers. While harvest estimations from the app might not be integrated in stock assessments, it is possible

that the cursory data could actually be of greater value. As mentioned earlier, more accurate discard data are becoming a priority for NMFS, and an electronic reporting app such as iSnapper could easily be modified to address and answer such questions.

It was clearly demonstrated that iSnapper has the potential to generate near-real-time, valid, and usable data for fisheries managers. Building on these successes, managers could create an app such as iSnapper to address many of the data gaps in recreational fisheries not currently collected. This study showed that smart-device apps are viable tools for data collection in recreational fisheries, where data are more difficult to accurately obtain because fishermen are the final consumer, leave and return to a variety of destinations including private docks where no state surveys can be conducted, and return from fishing after intercept surveys are completed. Electronic logbooks provide an ideal format to collect catch and effort data if time is taken to create them with both fisheries managers and recreational anglers in mind.

DATA AVAILABILITY

Research data are not shared.

ETHICS STATEMENT

There were no ethical guidelines applicable to this study.

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CONFLICTS OF INTEREST

There is no conflict of interest declared in this article.

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