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# Mixed-mode surveys reveal shared regulatory preferences in an overfished recreational fishery

David R. Smith [ID][a], Stephen R. Midway [ID][a], Jason W. Adriance[b], Harry R. Blanchet[c], and Rex H. Caffey[d]

[a]Department of Oceanography and Coastal Sciences, Louisiana State University, Baton Rouge, Louisiana, USA; [b]Office of Fisheries, Louisiana Department of Wildlife and Fisheries, New Orleans, Louisiana, USA; [c]Office of Fisheries, Louisiana Department of Wildlife and Fisheries, Baton Rouge, Louisiana, USA; [d]Department of Agricultural Economics and Agribusiness, Louisiana State University, Baton Rouge, Louisiana, USA

**ABSTRACT**

Population declines of spotted seatrout *Cynoscion nebulosus* have reached levels that warrant management action in Louisiana, USA waters. As regulatory adjustments are necessary to recover the stock, we evaluated the viability of recovery options while gathering preference data from respondents through three survey modes. The modes applied were: (1) a series of public scoping meetings, (2) a probability-based sample of fishing license-holders, and (3) an open-access online survey. Among survey modes, significant differences were seen in avidity, typical harvest, and perceptions of the fishery, indicating that we captured responses from three distinct user groups. Despite these differences, several common themes emerged among all three survey types. Respondents in all survey types indicated strong levels of support for regulations decreasing allowable harvest relative to regulations at the time of survey execution. Specifically, our study presents a viable recovery scenario while accounting for the preferences of multiple user groups.

## Introduction

It is well established that non-probabilistic sampling methods can lead to distinct patterns in avidity (Alessi & Miller, 2012; Cornicelli & Grund, 2011; Laborde et al., 2014; Sutton, 2006), successful outings (Alessi & Miller, 2012; Laborde et al., 2014), and target species (Hunt et al., 2010) when comparisons are made to the general population of natural resource recreationists. While some studies have displayed shared attitudes and preferences among probabilistic and non-probabilistic samples (e.g., Cornicelli & Grund, 2011; Laborde et al., 2014; Peterson & Messmer, 2010), these approaches are not considered substitutable methods with probability-based sampling designs as the industry standard for gathering data reflective of the general population. Though biases exist, non-probabilistic sampling can improve cost- and time-efficiencies and is advantageous when used to characterize user groups with a strong connection to a resource (Sutton, 2006; Sutton & Ditton, 2001). For example, public scoping meetings are among the most commonly utilized means of stakeholder engagement by fisheries and wildlife agencies (Lord & Cheng, 2006). These

sessions allow for increased public understanding of management issues while concurrently gathering input from stakeholders meaningfully invested in the resource (Cornicelli & Grund, 2011; Peterson & Messmer, 2010; Sutton, 2006). Due to these advantages, non-probabilistic sampling is often considered in situations expected to yield novel insights.

When managers began considering alternative regulatory strategies for the spotted seatrout *Cynoscion nebulosus* fishery in Louisiana, USA, an opportunity arose to gather survey responses to aid in developing an alternative management strategy (Caffey et al., 2020). The Louisiana spotted seatrout fishery is an important recreational fishery with minimal commercial harvest, characterized as overfished with declining trends in abundance and recreational landings (West, Zhang, et al., 2019; Figure 1). While environmental factors can play a large part in spotted seatrout
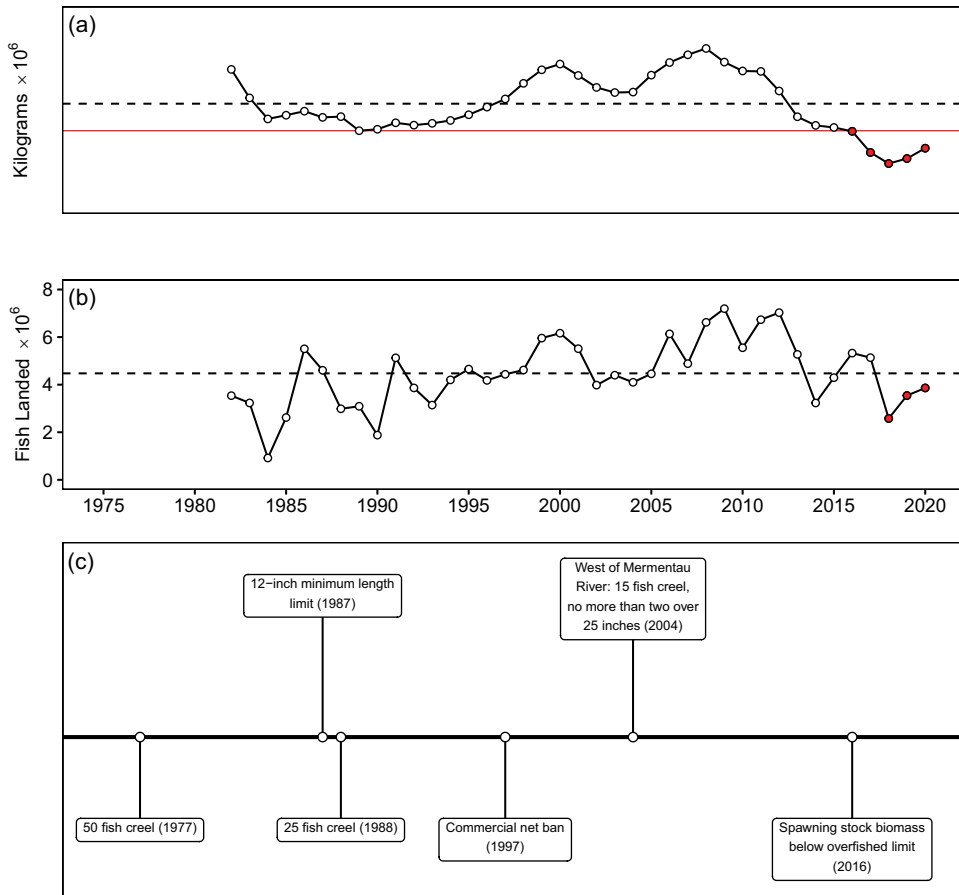


**Figure 1.** Dashed lines in plots indicate time series averages. Annual estimates in red indicate estimates below time series averages since the stock fell below the overfished threshold (2016). (a) Historic spawning stock biomass estimates for Louisiana spotted seatrout (1982–2020). Solid red line indicates the overfished threshold. Estimates derived from age-structured stock assessment models. (b) Annual estimates of spotted seatrout recreationally landed in coastal Louisiana (1982–2020). Estimates derived from Louisiana Department of Wildlife and Fisheries LA Creel (West & Zhang, 2018)., (c) Timeline of historic spotted seatrout regulation changes within coastal Louisiana (1975–2020). 12 and 25 inches correspond to 305 and 635 millimeters, respectively.

population fluctuations (Ellis et al., 2017; Froeschke & Froeschke, 2011), management action is warranted as recreational exploitation is occurring above the overfished limit (estimate derived from historic spawning stock biomass estimates; West, Zhang, et al., 2019). Coastal Louisiana anglers target spotted seatrout more than any other coastal species with the estimated annual economic welfare of the fishery reaching approximately USD$700 million (adjusted for inflation, including trips where multiple species were targeted; Smith et al., 2022). Due to the economic importance of this fishery, gathering stakeholder preference data for potential regulatory scenarios was a key component of the decision-making process. Moreover, management success is ultimately reliant on the behavior of anglers (Arlinghaus et al., 2013; Murphy et al., 2019) illustrating the importance of understanding stakeholder preferences when considering regulatory adjustments.

Data were gathered from coastal Louisiana anglers to characterize stakeholder preferences surrounding specific regulation scenarios for the spotted seatrout fishery while applying a mixed-mode of surveys (Dillman et al., 2014) using both probabilistic and non-probabilistic means. We conducted (1) a series of public scoping meetings targeting an audience with a high level of connection to the fishery, (2) a survey using a convenience sample of respondents that openly accessed an online survey as a means of gathering non-probabilistic responses without public interface, and (3) a survey using a random sample of Louisiana saltwater license-holders as a means of targeting the general angler population. The primary objective of this study was to determine a sustainable management strategy for the fishery inclusive of stakeholder engagement with a secondary objective of evaluating differences between each mode of stakeholder engagement, particularly focusing on regulatory preferences. While the differences between probabilistic and non-probabilistic surveys are well established (e.g., Alessi & Miller, 2012; Cornicelli & Grund, 2011; Hunt et al., 2010; Laborde et al., 2014), the methodology utilized to evaluate policy approaches with real-time management implications is novel within fisheries and can provide meaningful insight for human dimensions research within fisheries and wildlife management agencies.

## Methods

### *Survey Development and Distribution*

Beginning in early 2020, a working group was formed with representatives from the Louisiana Department of Wildlife and Fisheries (LDWF), Louisiana State University, and Louisiana Sea Grant to develop potential regulatory alternatives for the Louisiana spotted seatrout fishery. Simulations were performed representing reductions in recreational yield to ultimately assess what level of harvest reduction was necessary to recover the stock above the overfished limit within a five-year window (West, Allgood, et al., 2019). The resulting evaluation determined that a 20% reduction in recreational yield was necessary to attempt to recover the stock within a five-year window when these measures were considered (February 2020). Using information gathered from angler harvest surveys (West & Zhang, 2018), the working group calculated various combinations of hypothetical creel and size limit adjustments to achieve the 20% reduction in yield to deliver a series of potential regulatory alterations to recover the stock.

*Public Meetings* – Once targets were developed for sustainable harvest, the working group shifted focus toward public outreach. This process began with a series of eight public scoping meetings (hereafter referred to as the Public Meetings) held throughout Louisiana between February 10, 2020, and February 29, 2020, near population centers with an interest in saltwater recreational angling determined after consultation with LDWF and Louisiana Sea Grant. The number of respondents varied significantly by meeting locations with the lowest amount of participation at the meeting located in Ruston (eight respondents) and the highest amount of participation at the meeting located in Metaire (157 respondents; Figure 2). In total, responses were gathered from 643 Public Meetings attendees.

During each of the Public Meetings, an LDWF biologist presented basic information on spotted seatrout biology, LDWF sampling, trends in landings, stock status, and potential management scenarios. Embedded throughout the presentation was a series of 22 audience-polling questions (Appendix A) that were conducted using hand-held electronic transmitters from Turning Technologies, Inc. Each question was built using a multiple-choice format to gather a variety of audience data including angler attitudes, perceptions, avidities, and demographics. The presentation concluded by measuring audience preferences (5-point Likert scale ranging from *strongly oppose* to *strongly support*) for specific regulatory scenarios (each meeting the 20% harvest reduction). The specific regulatory scenario applied in these meetings are listed in Table 1 (apart from the *Creel and Size III* scenario).
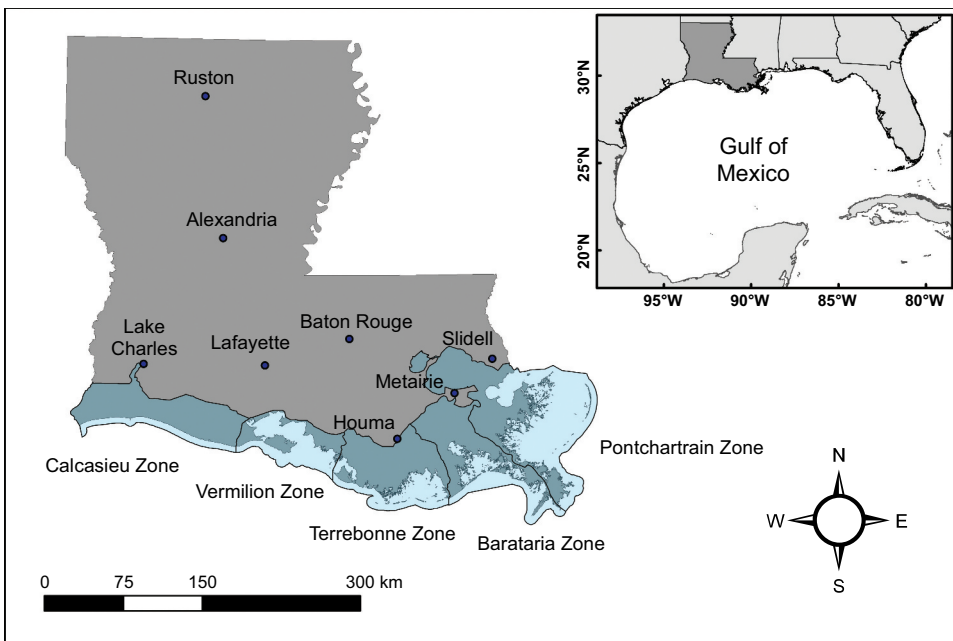


**Figure 2.** Map of public scoping meeting locations held throughout Louisiana, USA and the Louisiana Department of Wildlife and Fisheries coastal management zones. Eight attendees provided responses at the Ruston meeting, 10 attendees provided responses at the Alexandria meeting, 49 attendees provided responses at the Lake Charles meeting, 93 attendees provided responses at the Baton Rouge meeting, 97 attendees provided responses at the Slidell meeting, 99 attendees provided responses at the Lafayette meeting, 130 attendees provided responses at the Houma meeting, and 157 attendees provided responses at the Metairie meeting.

**Table 1.** Hypothetical spotted seatrout regulation scenarios utilized during each of the three surveys (probability-based survey, open-access survey, public meetings). The Creel and Size III scenario was not shown during public meetings. Each scenario represents a 20% reduction in recreational yield that was determined necessary to recover the stock. MLL stands for minimum length limit. Current Louisiana regulations refers to the regulations in place at the time of survey execution.

| Regulation Scenario | Size Limit (mm) | Creel Limit (fish per day) |
|---|---|---|
| *Current Louisiana Regulations* | 305 (12-inch) MLL | 25 |
| *Creel Change Only* | 305 (12-inch) MLL | 10 |
| *Size Change Only* | 356 (14-inch) MLL | 25 |
| *Creel and Size I* | 331 (13-inch) MLL | 12 |
| *Creel and Size II (Slot)* | 331–508 (13–20 inch) slot limit | 12 |
| *Creel and Size III* | 343 (13.5-inch) MLL | 15 |

As Public Meetings progressed, numerous public comments requested a regulation scenario with a creel limit of 15 fish, which was not initially offered among regulatory scenarios (Caffey et al., 2020). Comments from Public Meetings attendees were collated with over 600 different mentions of a 15 fish creel limit identified. With the large number of comments surrounding this specific regulation scenario, the working group revisited simulations and determined that with a 343-millimeter (13.5-inch) minimum size limit, the targeted level of harvest reduction could be met with a 15 fish creel limit. While we did not gather preference data from this regulation scenario (*Creel and Size III*) during the public scoping process, we felt the inclusion of this scenario was important within the following electronic surveys (hereafter referred to as the Probability-Based Survey and Open-Access Survey), given the large number of public comments.

*Probability-Based Survey* – In parallel with the public scoping meetings, we sought to deliver a traditional probabilistic survey though the utilization of an electronic survey. All survey actions were completed using the survey software Qualtrics with Louisiana State University Institutional Review Board approval (IRB#E12158). Apart from the additional regulation scenario, questions were nearly identical to those presented during public scoping meetings (Appendix B). The survey sample was gathered from Louisiana license holders with recreational saltwater fishing privileges between June 1, 2018, through March 1, 2020, to capture annual fishing license holders in the current year at the time of survey and the prior year (at the time of survey execution annual fishing licenses in Louisiana began on June 1). A random, non-stratified, draw of 11,000 license-holders formed our sample population while ensuring duplicate license holders in multiple years were not selected. Of those emails 10,224 were valid addresses and successfully delivered. Survey distribution included a cover letter to assure response anonymity, provided an estimated length of the questionnaire, and detailed that this survey was seeking to obtain public input on alternative management options for spotted seatrout. On May 20, 2020, the survey was distributed to our sample population. Reminder emails were sent to non-responding contacts on May 28 and June 4, 2020, following protocol according to Dillman et al. (2014). The survey was closed on June 30, 2020.

*Open-Access Survey* – Given the high level of interest in spotted seatrout management, a third version of the questionnaire was developed to allow participation from an even broader range of anglers. An open-access version of the survey (identical to the Probability-Based Survey) sampled anyone interested in participating. On June 9, 2020, a URL to the

Open-Access Survey was posted on the LDWF website. Availability of the Open-Access Survey was advertised through electronic and printed media, television, radio, and via direct email messaging of the LDWF eNewsletter. The Open-Access Survey was also closed on June 30, 2020.

To prevent ballot stuffing, responses for each electronic survey were limited to a single response from an Internet Protocol (IP) address of which 59 IP addresses were identified and removed. Furthermore, to prevent dual responses within multiple survey types, IP addresses within both the Probability-Based Survey and Open-Access Survey were identified and removed from the Open-Access Survey. Sixty-three IP addresses were identified and removed.

## *Survey Instrument*

Each survey consisted of three sections characterizing: (1) general angler background, (2) spotted seatrout background, and (3) regulatory preferences. There were few distinctions between surveys presented electronically (Probability-Based Survey and Open-Access Survey) and within the Public Meetings. These distinctions are described in the following section.

*General Angler Background* – The general angler background section began with eliciting respondent motives for angling. Respondents chose between the following motives: *fish to eat, relaxation, enjoy nature*, *build skills*, *socialize*, and *other*. The following question asked anglers to indicate the coastal region they fished most often, splitting coastal Louisiana into the five LDWF coastal management zones of relatively equal size (Figure 2). Essentially, each coastal management zone consists of a major coastal Louisiana estuary. Additionally, a measure of avidity was gathered from respondents by eliciting the average number of coastal angling trips an angler took during a typical year. While this question allowed continuous responses in the electronic surveys, during Public Meetings respondents chose between *none, less than 10*, *10–19*, *20–29*, *30–39*, *40–49*, and *50 or more*. The following question asked respondents to indicate any Louisiana recreational angling licenses they held including *basic fishing license*, *saltwater fishing license*, *senior license*, and *charter license*. This section concluded with asking respondents to elicit their main coastal Louisiana species of target (selecting all that apply) including *spotted seatrout*, *red drum Sciaenops ocellatus*, *black drum Pogonias cromis*, *sheepshead Archosargus probatocephalus*, *southern flounder Paralichthys lethostigma*, *other*, and *anything I can catch*. Finally, the only demographic information gathered by all three survey modes was age. For age, continuous responses were gathered within the electronic surveys and within Public Meetings, respondents chose between *under 20 years*, *20–29*, *30–39*, *40–49*, *50–60*, *Over 60 years*. Within the Probability-Based Survey, we additionally solicited the home ZIP code of each respondent.

*Spotted Seatrout Background* – The spotted seatrout background section asked respondents to indicate the number of spotted seatrout typically harvested during fishing trips ranging from *none*, *1–5 fish*, *6–10 fish*, *11–15 fish*, *16–20 fish*, *21–24 fish*, and *25 fish (limit out)*. This section also asked respondents to indicate whether they have noticed a change in fishing quality over the past five years for spotted seatrout in the coastal region they fish most frequently. Responses included: *yes, it has improved*; *no, it seems the same*; *yes, it has grown worse*; and *I don't know*. After eliciting this response in the electronic surveys, figures were shown displaying declining trends in the fishery for both estimated abundance and

recreational landings (Figure 1) and were accompanied with several bullet points depicting the status of the fishery. During the Public Meetings, these same figures were displayed, and points iterated; however, an LDWF biologist also provided additional information on how these declining trends were estimated. Following this information, respondents were asked to indicate their level of concern for the fishery using a 5-point Likert scale ranging from *not at all concerned* to *extremely concerned.*

*Regulation Preferences* – Before eliciting preferences for each of the specific regulation scenarios, respondents were asked their general preference for regulatory change within the Louisiana spotted seatrout fishery using four of the commonly applied management tools by fishery managers to reduce harvest, including *Decreasing the Creel Limit, Increasing the Minimum Length Limit, Implementing a Slot Limit*, and *Implementing a Seasonal Closure.* Preferences were gathered using a 5-point Likert scale ranging from *strongly oppose* to *strongly support.* Within the following subsection eliciting specific regulatory preferences, a preamble stated that each of these scenarios were based on a 20% harvest reduction and a five-year stock recovery. Preferences were elicited for each of the specific regulatory scenarios listed in Table 1 using the same 5-point Likert scale for general preferences.

### Survey Analysis

As our analyses revolved around categorical variables, we followed methods outlined by Agresti (2002). Specifically, we used ordered logit models to evaluate ordinal responses and multinomial logit models to evaluate nominal responses (Agresti, 2002). We assessed the following ordinal responses in ordered logit models in avidity (i.e., average number of coastal angling trips taken during a typical year), typical number of spotted seatrout harvested, concern for the fishery (5-point Likert scale), perception of the fishery (*improving, stable, declining*), general regulatory preferences (each of the four options; 5-point Likert scale), and specific regulatory preferences (5-point Likert scale; each of the five options). Additionally, the following nominal responses were applied within multinomial logit models in the coastal zone most frequently fished, age, and motive for coastal angling. With this framework, our focus was centered around determining the significance of the predictor variable survey mode (i.e., Probability-Based Survey, Open-Access Survey, Public Meetings). In addition, each of the following were included within each model as predictors to depict the heterogeneity of survey respondents: avidity, license type, species of target, motive, and basin most frequently fished. Likelihood ratio tests were conducted to determine the equality of predictor variables in the model ($\alpha = 0.05$) in relation to each response (Agresti, 2002). In models where the predictor variable for survey mode was significant, pairwise likelihood ratio tests followed with data subset for each unique pairing of mode. All analyses were conducted within the R programing language (R Core Team, 2020) using the package *VGAM* (Yee, 2022).

Equality of support among specific regulation scenarios was determined using a Kruskal–Wallis *H* test with the ordered response variable as the Likert scale preference responses (1 = *strongly oppose*; 5 = *strongly support*) for every regulation scenario. A post-hoc Dunn test (Midway et al., 2020) was implemented to determine the significance ($\alpha = 05$) of preference responses for each scenario in reference to the *Size and Creel III* scenario, as this regulation scenario received the highest level of support and lowest level of opposition. As an additional measure of directionality and strength, net preferences were calculated for

general management tools and specific regulation scenarios as the combined percentage of respondents that indicated *strongly support* and *slightly support* subtracted by the combined percentage of *strongly oppose* and *slightly oppose*.

## Results

The Probability-Based Survey generated useable responses from 1,238 respondents for a 12.1% response rate, the Open-Access Survey generated useable responses from 1,511 respondents, and the Public Meetings generated useable responses from 643 respondents. Aggregating all three sampling modes yielded a total of 3,392 respondents (Table 2).

Respondents from each survey mode did not differ significantly by their motives for coastal angling ($p > .35$). Respondents from each survey type differed significantly by the coastal zone most frequently fished ($p < .01$); however, the coastal zones selected among the Public Meetings and Open-Access Survey pairing did not differ significantly ($p > .16$). Respondents within each survey type most frequently targeted spotted seatrout (range: 69–85%), followed by red drum (range: 60–69%), and southern flounder (range: 24–27%). Age was significantly different by survey mode ($p < .01$) due to the older mean age of public meeting respondents (59 years) compared to Open-Access Survey (48 years) and Probability-Based Survey (52 years) respondents. Pairwise comparisons revealed that ages among the Open-Access Survey and Probability-Based Survey did not differ significantly ($p > .12$).

**Table 2.** Summary statistics for each mode of contact. Below, random, open, and public correspond to each survey mode in the probability-based survey, open-access survey, and public meetings, respectively. Percentages for fishing license type do not add up to 100% as only a selection of relevant responses for this question are depicted in this table. Respondents could select multiple species of target and hold multiple license types.

| Description | Variable | Random | Open | Public |
|---|---|---|---|---|
| Participation | Respondents | 1,238 | 1,511 | 643 |
| Motivation | % *Fish to eat* | 41 | 43 | 21 |
| | % *Relaxation* | 33 | 30 | 33 |
| | % *Enjoy nature* | 19 | 19 | 23 |
| | % *Socialize* | 4 | 3 | 4 |
| | % *Build skill* | 1 | 3 | 4 |
| | % *Other* | 2 | 2 | 15 |
| Target Species | % *Target spotted seatrout* | 69 | 85 | 83 |
| | % *Target red drum* | 63 | 69 | 60 |
| | % *Target anything* | 22 | 15 | 21 |
| Fishing License Type | % *Basic saltwater license* | 61 | 60 | 42 |
| | % *Senior license* | 20 | 15 | 40 |
| | % *Charter license* | 1 | 2 | 13 |
| Harvest | Mean harvest per trip | 8.1 | 10.9 | 11.9 |
| | % *Limit out (25 fish)* | 4 | 4 | 6 |
| Avidity | Mean annual coastal angling trips | 16 | 27 | 39 |
| Perception of Fishery | % *Declining* | 36 | 49 | 64 |
| | % *Stable* | 31 | 34 | 28 |
| | % *Improving* | 7 | 10 | 4 |
| | % *I don't know* | 26 | 8 | 5 |
| Concern for Fishery | % *Not at all concerned* | 9 | 10 | 5 |
| | % *Slightly concerned* | 15 | 17 | 4 |
| | % *Some what concerned* | 26 | 20 | 14 |
| | % *Moderately concerned* | 25 | 24 | 22 |
| | % *Extremely concerned* | 26 | 29 | 56 |
| Demographics | Mean age of respondents | 52 | 48 | 59 |

Avidity among survey respondents was significantly different by survey mode ($p < .01$), with an average of 15.9 trips per typical year among respondents within the Probability-Based Survey, 26.9 trips among the Open-Access Survey, and 39.1 trips among the Public Meetings. Pairwise comparisons revealed that all unique pairings of survey type held significantly different levels of avidity ($p < .01$). The high level of avidity among the Public Meetings was partially influenced by a meaningful proportion of Public Meetings attendees holding a charter license (13%), of which 92% took at least 40 coastal angling trips during a typical year. Comparatively, among the Probability-Based Survey and Open-Access Survey, less than 2% of respondents held a charter license.

Respondents from each survey type differed significantly by spotted seatrout-based harvest and concern for the fishery ($p < .01$). While typical harvest was significantly lower in the Probability-Based Survey compared to other survey types (Table 2), pairwise comparisons revealed that typical harvest in the Open-Access Survey and Public Meetings did not differ significantly ($p > .08$). Comparably low percentages of anglers among every survey type indicated limiting out (25 fish) during a typical trip (range: 4–6%; Table 2). Concern for the fishery was significantly different ($p < .01$) among each pairwise comparison that included the Public Meetings, with a much greater proportion of respondents indicating higher levels of concern within the Public Meetings compared to the electronic surveys. Pairwise comparisons displayed that the Probability-Based Survey and Open-Access Survey did not significantly differ ($p > .60$) in relation to concern for the fishery. Perceptions of the fishery (*declining, stable, improving*) were significantly different among each survey type ($p < .01$); however, a plurality of respondents perceived the fishery as declining within each survey type (Table 2). Pairwise comparisons displayed that the Probability-Based Survey and Open-Access Survey did not significantly differ ($p > .08$) in relation to perception of the fishery.

Respondents from each survey type did not differ significantly ($p > .05$) by the preferences indicated for the general management tool of *Implementing a Slot Limit*. While significant differences existed among *Increasing the Minimum Length Limit* within all three survey types ($p < .04$), pairwise comparisons revealed that differences between the Open-Access Survey and Probability-Based Survey pairing ($p > .27$), as well as the Open-Access Survey and Public Meetings pairing ($p > .15$) did not differ significantly. Additionally, while in the aggregate, survey type was significantly different for *Implementing a Season Closure*, the pairing of the Open-Access Survey and Public Meetings was not significantly different ($p > .97$). Respondents from every survey type notably supported *Decreasing the Creel Limit*, with at least 62% of respondents supporting this management tool in each survey type and respective net preferences of +43%, +49%, and +53% for the Probability-Based Survey, Open-Access Survey, and Public Meetings (Figure 3). Respondents also notably opposed *Implementing a Seasonal Closure* with at least 51% of respondents opposing the management tool in each survey type and respective net preferences of −20%, −53%, and −49% for the Probability-Based Survey, Open-Access Survey, and Public Meetings (Table 3).

Respondents from every survey type differed significantly ($p < .01$) among four of the five specific regulatory scenarios. Among pairwise comparisons, the Open-Access Survey and Probability-Based Survey did not differ significantly ($p > .48$) among every specific regulation scenario apart from the *Creel Change Only* and *Size Change Only* scenarios ($p < .01$). Aggregate net preferences, including all three survey
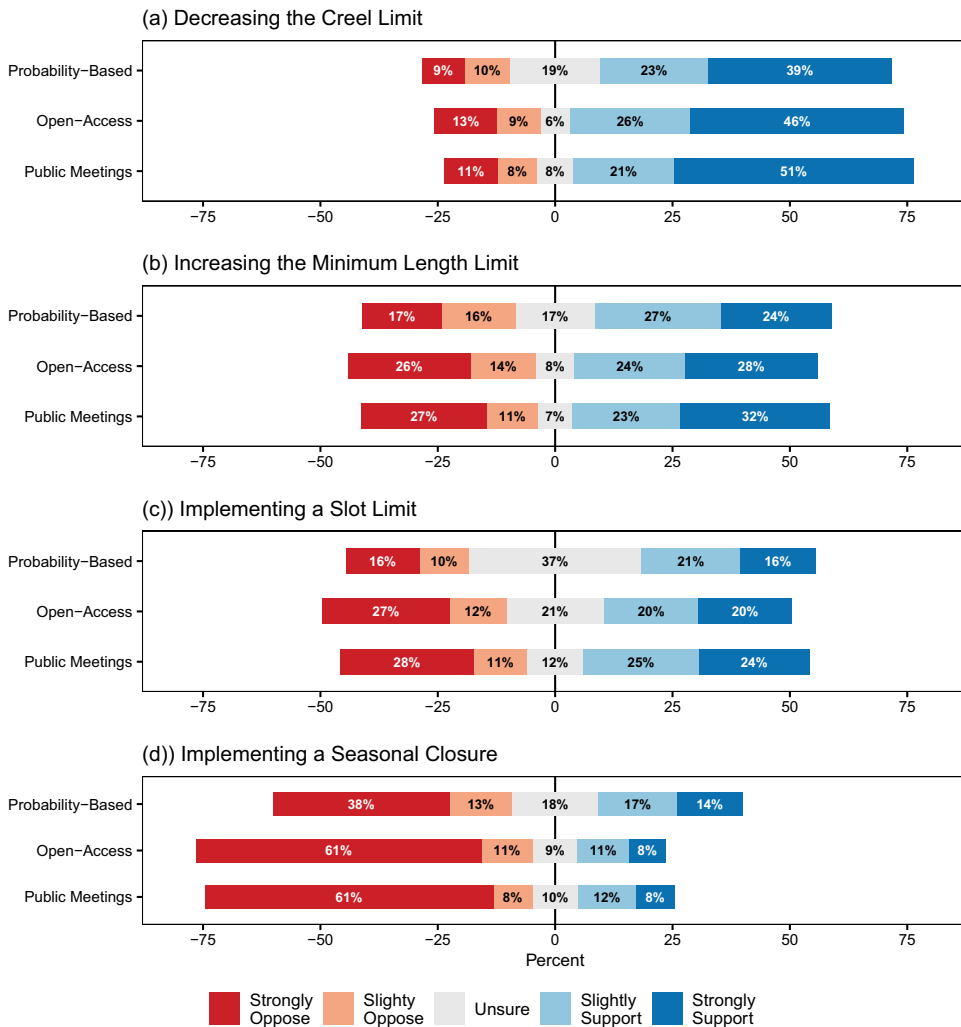
**Figure 3.** Likert scale support for each of the common management tools fishery managers can impose to reduce recreational harvest, specifically in relation to the Louisiana spotted seatrout fishery.

types, were negative for the *Creel Change Only* (−7.0%; Table 3) and *Creel and Size II (Slot)* (−9.8%) scenarios, and positive for the *Size Change Only* (+3.1%), *Creel and Size I* (+7.0%), and *Creel and Size III* (+15.5%) scenarios (Figure 4; Table 3). Every survey type displayed a negative net preference (range: between −2.1% and −26.1%) for the *Creel and Size Change II (Slot)* scenario. Among each of the specific regulation scenarios, respondents most preferred the *Creel and Size III* scenario and equality of combined support among the survey types indicated that respondents significantly preferred this scenario ($p < .01$; Table 3) over every other specific regulation scenario.

**Table 3.** Estimates and *p*-values indicate the equality of support for each regulation scenario (defined in Table 1) in relation to the *Creel and Size Change III* scenario, as this scenario received the highest levels of support. Equality of support was calculated via a Kruskal–Wallis H test followed by a post-hoc Dunn test. Net preferences indicate the combined percentage of respondents that indicated *strongly support* and *slightly support* minus the combined percentage of respondents that indicated *strongly oppose* and *slightly oppose* for each regulation scenario. Random, open, and public correspond to each survey mode in the Probability-Based Survey, Open-Access Survey, and Public Meetings, respectively.

| | | Net Preferences | | |
|---|---|---|---|---|
| Regulation Scenario | *p*-value | Random | Open | Public |
| *Creel and Size Change III* | - | +16.7% | +14.5% | - |
| *Creel and Size Change I* | < .001 | +15.2% | +8.1% | −9.3% |
| *Size Change Only* | < .001 | +10.7% | −3.3% | +4.2% |
| *Creel Change Only* | < .001 | +14.6% | −7.8% | −43.2% |
| *Creel and Size Change II (Slot)* | < .001 | −2.1% | −8.2% | −26.1% |

## Discussion

Similar to several prior studies (e.g., Cornicelli & Grund, 2011; Laborde et al., 2014; Sutton, 2006), major differences in avidity (i.e., average annual coastal angling trips during a typical year) were observed among survey types. While avidities within the Public Meetings were partially inflated due to a meaningful proportion of charter boat captains (13% of respondents), avidities among Public Meetings respondents that did not indicate having a charter license remained significantly higher than the other survey types (average annual of 33 trips). Furthermore, while our survey was centered around characterizing trips during a "typical year," it is worth noting that increased levels of angling in relation to the COVID-19 pandemic (Midway et al., 2021) may have influenced survey responses in the electronic survey types. Survey responses for the electronic surveys were gathered in June 2020, while the Public Meetings were conducted prior to these effects in February 2020, placing an even larger emphasis on the disparity between the avidities of the Public Meetings and the electronic survey types.

Several studies have shown that public meeting attendees have higher levels of connection to a resource (e.g., employment directly impacted by angling, elevated levels of avidity) compared to general resource users and this connection can in turn influence perceptions (Bennett et al., 2019; Jones et al., 2022; Sutton, 2006; Sutton & Ditton, 2001). Evidence of higher levels of connection were depicted among Public Meetings respondents in both elevated avidity levels and a significant proportion of respondents holding a charter license (13%) compared to electronic survey types (<2%). When comparing the motivations for angling the Public Meetings sample displayed a higher selection of the response *other* (15%) in comparison to the electronic survey types (<3%); however, differences in motivations across survey types were non-significant after accounting for the heterogeneity of respondents. The frequency of the *other* motivation in the Public Meetings was likely linked to an employment motivation as 73% of respondents with a charter license selected this response. The effects of high levels of resource connection on perceptions were corroborated by our study as a significantly higher percentage of respondents in the Public Meetings viewed the fishery as *declining* (67%) and selected the highest level of concern for the fishery (*extremely concerned*; 55%) compared to electronic survey types (*declining*: 43%; *extremely concerned*: 28%, aggregate online percentages). It is expected that users with a high level of connection
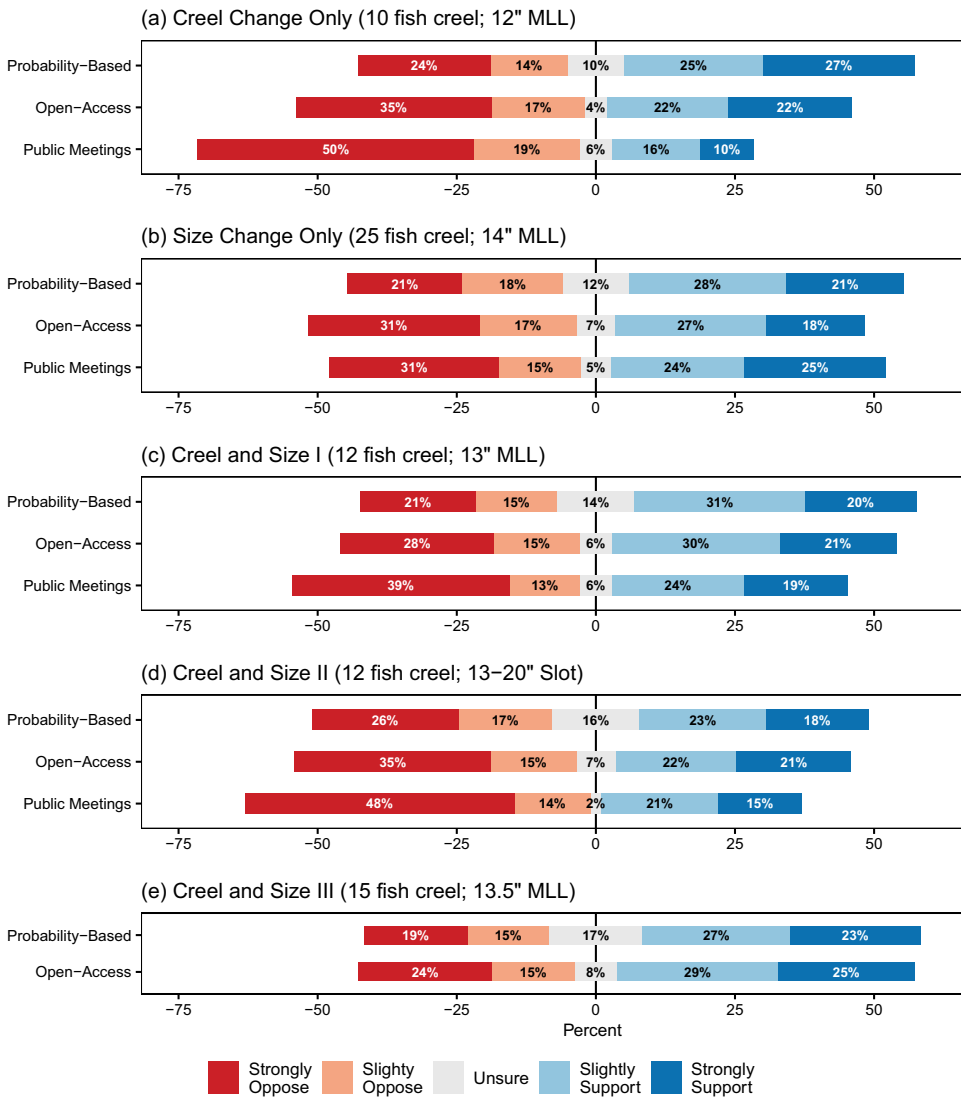
**Figure 4.** Likert scale support for each of the specific regulatory alterations of the Louisiana spotted seatrout fishery. Current regulations for this fishery at the time of survey execution were a creel limit of 25 fish and a minimum length limit (MLL) of 12 inches (305 mm). 13 inches corresponds to 331 mm, 13.5 inches corresponds to 343 mm, and 14 inches corresponds to 356 mm. Each regulatory alteration delivers a 20% reduction in yield, a measure determined to be necessary to recover the stock above the overfished limit within a 5-year window.

to the resource would perceive the fishery as declining as this is in line with statewide recreational trends (West, Zhang, et al., 2019). Further, it is also expected that higher levels of concern would accompany the perception of a declining fishery.

While our results suggest responses were captured from three distinct user groups, the surveys displayed several shared sentiments that can be instrumental in guiding the decision-making process. Spotted seatrout regulations for most of Louisiana at the time of survey execution were a creel limit of 25 fish and a minimum length limit (MLL) of 305

mm (12 inches; the Calcasieu Zone [Figure 2] has a creel limit of 15 fish). These regulations were by far the most liberal throughout the species range (regulation ranges among other U.S. states: 3–15 fish creel limits; 356–483 mm [14–19 inches] MLLs). Numerous respondents noted that current Louisiana regulations stood in contrast to other Gulf of Mexico U.S. states (Caffey et al., 2020). Presumably in response to this contrast, respondents largely displayed support for more restrictive harvest measures within all three survey types. Overall, all three survey types convincingly supported the general management option of *Decreasing the Creel Limit* (aggregate net preference: +48%) and to a lesser degree supported *Increasing the Minimum Length Limit* (aggregate net preference: +15%). Additionally, all three survey types opposed *Implementing a Seasonal Closure* (aggregate net preference: −41%), illustrating that this management option would not be practical for Louisiana fishery managers.

Among each survey type, respondents were much more supportive of general management tools (e.g., *Decreasing the Creel Limit*; net preferences of +43%, +49%, and +53% for the Probability-Based Survey, Open-Access Survey, and Public Meetings, respectively) than specific regulation scenarios that implemented these general management tools (e.g., *Creel Change Only*; net preferences of +15%, −8%, −43% for the Probability-Based Survey, Open-Access Survey, and Public Meetings, respectively). While respondents were generally supportive of measures in the broad sense, seeing these measures applied within specific regulation scenarios may have been perceived as more likely to occur, thus leading to higher levels of opposition.

Further, this study delivered insight on anglers with high levels of avidity, although we acknowledge that the public meetings were geared toward high avidity anglers, which may not be the case for all public meetings. Avidity levels among Public Meetings respondents were significantly higher than the Open-Access Survey indicating that this forum is more successful at capturing responses from high-use resource users than open-access web-based surveys. Although avidities were much higher among Public Meetings respondents compared to the Open-Access Survey, average harvest per trip was not significantly different among the non-probabilistic surveys. This non-significant difference suggests an asymptotic relationship with avidity and average harvest, where at the high end of avidities, increasing avidity only marginally increases harvest rates. Additionally, levels of sentiment were highest for specific regulation scenarios among the Probability-Based Survey (net preference range: −2% to +17%) and lowest among the Public Meetings (net preference range: −43% to +4%) suggesting that as avidity levels increase, supportiveness for specific regulation scenarios decreases.

While data were not collected from the Public Meetings surrounding the *Creel and Size III* option, levels of support displayed among electronic survey types were significantly higher than any other specific regulation scenario, with greater than a two-fold increase in net preference compared to the next highest scenario (*Creel and Size III*: +16%; *Creel and Size I*: +7%). While it is not possible to make direct comparisons regarding the *Creel and Size III* option with the Public Meetings, there is ample evidence that this regulation scenario is reflective of a management scenario that accounts for the preferences of all three survey types for a variety of reasons. First, this scenario was developed directly due to the numerous requests for a regulatory scenario with a 15 fish creel limit as the Public Meetings progressed. Review of these comments is what ultimately led to the development of this scenario (Caffey et al., 2020). Secondly, within the Kruskal–Wallis *H* test utilized to

determine the equality of support among survey respondents, we ran an additional test applying identical levels of support from the Public Meetings for the *Creel and Size III* scenario (creel limit of 15 fish; 343 mm MLL) as were observed among the Public Meetings for the *Creel and Size I* scenario (creel limit of 12 fish; 331 mm MLL). Although this scenario displayed a negative net preference (−9%) among Public Meetings respondents, we felt this scenario most closely reflected the creel and size limits applied within the *Creel and Size III* scenario among each of the scenarios presented during the Public Meetings. Even with higher levels of opposition, this additional model revealed that the *Creel and Size III* scenario remained at significantly higher levels of preference compared to any other regulation scenario ($p < .05$).

### Limitations

Alternative methodologies (e.g., rank choice voting, choice experiment) may have provided a more experimentally robust evaluation of regulatory options; however, we chose the methodology utilized to maximize the number of regulatory options presented while maintaining a clear message and minimizing survey fatigue. We acknowledge that there are many caveats in utilizing a Likert scale response to measure support and opposition, but this measure has been implemented with success in other studies evaluating regulatory options (e.g., Laborde et al., 2014). The methodology applied allowed respondents to provide a response while only considering the creel and size limits of one option at a time and the simplicity of the responses solicited allowed for the inclusion of several regulatory scenarios while maintaining a concise survey. The tradeoffs between a more statistically robust methodology and soliciting a clear response, reducing survey fatigue, and allowing for a diverse suite of management scenarios led to applying the methodology utilized.

 With avidity levels significantly higher within the Probability-Based Survey (16 trips per year) compared to a prior statewide survey (10 trips per year; Smith et al., 2022), we examined the representativeness of this sample to evaluate the potential for biases. Among responses in the Probability-Based Survey, we compared demographic responses (ZIP codes and age) of survey respondents in contrast with the general population of Louisiana anglers with saltwater privileges in 2019 (LDWF, unpublished data). Ages in the Probability-Based Survey (mean = 51.8, median = 53, SD = 13.9) were not significantly different from the ages among the general population (mean = 49.3, median = 52, SD = 16.8), suggesting our online sample was not age biased. Additionally, we compared the proportions of ZIP codes within the 10 most popular Louisiana parishes among the general angling population to the Probability-Based Survey using two-proportion $Z$-tests. We found non-significant differences ($p > .05$) in the proportions of respondents among 7 of the 10 parishes; however, a significantly ($p < .01$) greater proportion of Probability-Based Survey respondents were found in three parishes (East Baton Rouge, Jefferson, St. Tammany). Overrepresentation within each of those parishes among the Probability-Based Survey may be a result of avidity bias as each of those parishes were identified as areas with an increased interest in saltwater angling, with well attended Public Meetings (Baton Rouge, Slidell, Metairie) held in each parish.

 These comparisons suggest that the Probability-Based Survey was avidity biased, as is commonly seen in angler surveys (e.g., Connelly et al., 2000; Zarauz et al., 2015). While license-holders sampled within the Probability-Based Survey were selected randomly, self-

selection among survey respondents may have led to the avidity bias observed due to a lack of incentive or the electronic mode of contact. Although this sample likely had a degree of self-selection, we find the distinctions between survey types indicate that we indeed gathered information from three distinct angler groups. Further measures accounting for avidity biases (e.g., weighting; Hindsley et al., 2011) may be warranted in future efforts; however, within each ordered logit model, variables accounting for the heterogeneity of respondents, including avidity, were included as independent variables such that significance in each model considered this variable. In the context of our primary objective, in identifying a viable regulatory option for this fishery, these results remain meaningful. Gathering preferences from a relatively avid subset of the population allowed for a management decision to be made considering anglers with a high level of investment in the resource.

### *Management Implications*

Regarding the management of Louisiana spotted seatrout fishery, our study revealed two key findings that may guide the decision-making process. First, spotted seatrout anglers are supportive of measures that restrict the amount of allowable harvest relative to current Louisiana regulations. Secondly, the *Creel and Size III* scenario provides a viable regulatory change for this fishery as this scenario forecasts a potential stock recovery and is supported by anglers of both high and moderate avidities. These insights provide further evidence that management action is warranted and illustrate a feasible scenario to recover the fishery.

When considering this study's contribution to natural resource management, the framework applied is one with a wide array of future applications. The methodology applied can provide managers with a useful tool for guiding management decisions while gathering data from resource users intimately connected to the resource. Furthermore, within this framework, our study provides insight on the types of regulation scenarios resource users are most willing to accept within other modestly regulated fisheries. Other than the *Creel and Size II (Slot)* scenario, which was perceived by respondents as the most restrictive scenario, respondents in the aggregate preferred scenarios which incrementally altered both creel and size limits (aggregate net preference *Creel and Size I*: +7%; *Creel and Size III*: +16%) rather than scenarios that only altered the creel limit (*Creel Change Only*: −7%) or the size limit (*Size Change Only*: +3%). While several studies have displayed the efficacy of conjointly applying restrictions to both creel limits and size limits from a stock assessment perspective (e.g., Moreau & Matthias, 2018; Vaughan & Carmichael, 2002; Woodward & Griffin, 2003), our study provides evidence that these approaches are also viable in maintaining regulatory support from a stakeholder engagement perspective.

While only gathering data from the Probability-Based Survey would have ultimately led to the same management recommendation (*Creel and Size III*), the nuance of gathering information from each distinct segment illustrates some insight when considering the mode of stakeholder engagement. For example, data from only the Probability-Based Survey would have indicated that the *Creel Change Only* management scenario might provide a viable management tool (net preference +15%); however, this was a sentiment that was not shared among the higher avidity user groups (Open-Access Survey net preference: −8%; Public Meetings net preference: −43%). These results illustrate the heterogeneity of regulatory preferences among varying user groups and

demonstrate the utility of incorporating non-probabilistic samples to obtain responses from multiple user groups. Further, the *Creel and Size III* scenario was developed directly in response to interactions from the Public Meetings and without gathering data from this user-group, we would not have even considered this option within the following surveys. While the results of the Public Meetings led to inclusion of this option, this case study highlights the importance of including a component of stakeholder outreach (e.g., focus meetings) in the developmental phase when deciding upon potential management options. Through non-probabilistic means, we were able to gather responses from a segment of stakeholders that a traditional probabilistic approach would have only marginally covered. When considering the import of the management decision our surveys surrounded, seeking input from these segments was crucial in developing a sustainable management strategy and delivered novel insights surrounding the fishery.

## Acknowledgments

## Disclosure statement

## ORCID

David R. Smith  http://orcid.org/0009-0002-7090-0437
Stephen R. Midway  http://orcid.org/0000-0003-0162-1995

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