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ARTICLE

# Economic Values of Potential Regulation Changes for the Southern Flounder Fishery in Louisiana

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***Abstract***
**Population declines of Southern Flounder *Paralichthys lethostigma* have reached levels that present management concerns in Louisiana waters. As the need for regulatory change in this fishery approaches, we conducted a survey to better characterize the Southern Flounder fishery in Louisiana, with two primary goals: (1) determining a value for the economic welfare provided by the fishery and (2) evaluating how this value might change in response to hypothetical regulation scenarios. Based on total travel cost estimates, the aggregate economic value of the Southern Flounder fishery among coastal Louisiana anglers reached an estimated US$119.7 million; however, this value primarily stems from anglers targeting multiple species during their coastal angling trips, as the value of the Southern Flounder fishery while only accounting for anglers that solely targeted this species amounted to an estimated $8.4 million. Respondents revealed strong levels of supportiveness for all regulation scenarios that increased limitations on allowable harvest for Southern Flounder. None of the hypothetical regulation scenarios led to significant behavioral responses in the expected number of coastal angling trips taken, leaving the economic value of coastal Louisiana fisheries unchanged. The results of our study illustrate the relatively inconsequential nature of Southern Flounder regulations upon the behavior of coastal Louisiana anglers. The information gathered by this survey can be used to guide the decision-making process in developing a sustainable management strategy that is supported by stakeholders and that keeps the strong economic values of coastal Louisiana fisheries intact.**

In recent years, numerous state management agencies have recognized Southern Flounder *Paralichthys lethostigma* populations as a declining fish stock throughout much of the Gulf of Mexico and the U.S. southeast Atlantic (Froeschke et al. 2011; Powers et al. 2018; Flowers et al. 2019; West et al. 2020; Erickson et al. 2021). In response to these declines, significant regulatory changes have been implemented for Southern Flounder fisheries in

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multiple states. Although no regulatory changes have been made in Louisiana for Southern Flounder, the most recent stock assessment by the Louisiana Department of Wildlife and Fisheries (LDWF) stated that management actions will be necessary in order to recover the depleted stock (West et al. 2020).

As the need for regulatory change in this Louisiana fishery approaches, informed policy decisions should also consider stakeholder input and economic implications. Ignoring the attitudes and preferences of stakeholders can attenuate new management strategies (Arlinghaus et al. 2007; Raemaekers and Britz 2009). While a fishery regulation may be biologically sound, management success ultimately relies upon the behavior of anglers (Arlinghaus et al. 2013; Hunt et al. 2013; Ward et al. 2016; Murphy et al. 2019). Identifying stakeholder support for current and proposed regulation scenarios in the Louisiana Southern Flounder fishery is a primary goal of this study. Another goal of this study is to evaluate the economic welfare impacts of altering regulations in the fishery as an equally important component of strategic viability (Liese and Carter 2017). Changes in economic value resulting from potential regulation changes of the Southern Flounder fishery in Louisiana are difficult to infer, as no baseline economic value exists for this recreational fishery. Consequently, our study quantifies the current economic value of the Southern Flounder fishery in Louisiana while evaluating how that value might change under proposed regulatory strategies.

To accomplish these objectives, we used both revealed preference (RP) and stated preference (SP) nonmarket valuation approaches as complements to reach a more robust valuation of the resource (Whitehead et al. 2011b; Parsons 2017). Revealed preference methods estimate value through the observation of actual behavior, while SP methods estimate values by surveying individuals and inferring value from hypothetical responses (Whitehead et al. 2011b; Segerson 2017; Lew and Whitehead 2019). We used the travel cost method as our RP approach, which is commonly used to value the economic welfare of recreational angling (Pollack et al. 1994). The SP method applied in this study was contingent behavior (CB), as we wanted to characterize the behavioral response regarding angler effort based on regulatory changes in the Southern Flounder fishery (Parsons 2017).

## Previous Research

Several fisheries studies have used a combination of RP–SP approaches to value various aspects of fisheries. Gillig et al. (2003) used data from the Gulf of Mexico fishery for Red Snapper *Lutjanus campechanus* to estimate changes to creel limits and indicated that the total cost to anglers for a one-fish reduction in allowable harvest would reach US$11.27 million. Ready et al. (2005) compared historic fishing license sales data to SP survey data to evaluate the relationship between stocking levels and angler participation, finding a much stronger relationship between stocking and participation among survey respondents when compared to the actual behavior of anglers as indicated by license sales. Rolfe and Prayaga (2007) estimated the value of recreational fishing for three major freshwater impoundments in Australia and specified how marginal benefits to recreational anglers diminished with increased catch rates, indicating that the extent of improving a fishing experience may be limited. Cha and Melstrom (2018) modeled the effects of catch-and-release regulations within the Paddlefish *Polyodon spathula* fishery in Oklahoma and determined that if catch-and-release regulations were applied to that fishery, angling trips in the fishery would fall by nearly one-third. Although varied in their examples, the application of SP–RP approaches plays an important, if not underutilized, role in the valuation of recreational fisheries.

There have been relatively few applications of RP–SP approaches valuing fisheries in coastal Louisiana. Bergstrom et al. (2004) estimated changes in angling effort related to catch rates of Spotted Seatrout *Cynoscion nebulosus* and Red Drum *Sciaenops ocellatus* in the lower Atchafalaya River basin along the Louisiana coast, finding that changes in catch rates had a relatively minor effect on effort per angler; however, these effects were noteworthy when aggregated across total angler participation. Wang et al. (2019) modeled preferences for surf and marsh recreational fishing locations on the Louisiana coast and found that the closure of the most used recreational beach fishing sites in coastal Louisiana would lead to average welfare losses ranging from $592 to $2,101 per traveler per year.

Fisheries studies implementing RP–SP approaches and specifically utilizing the CB method have been applied to understand how catch rates affect angler effort in Italy (Alberini et al. 2007), Australia (Prayaga et al. 2010), and Ireland (Deely et al. 2019). Both Alberini et al. (2007) and Prayaga et al. (2010) found that altered fishing trip conditions (e.g., increased catch rates and optimal site conditions) did not lead to significant changes in angling participation. Deely et al. (2019) found that a 50% increased catch rate in fish quantity corresponded to significant increases in angler participation, leading utility estimates of the resource to nearly double in value. Loomis (2002) applied CB to compare existing recreational activity in reservoirs along the lower Snake River in the northwestern USA with the potential recreational activity in riverine environments that could be restored by dam removal. Their study determined that the additional benefits provided by river recreation would exceed the losses from reservoir recreation. These aforementioned studies showcase how regulatory effects on a fishery can be measured by environmental changes (e.g., catch rates and river restoration) using CB. Only one other fisheries study was found that applied CB to directly elicit behavior related to potential changes in regulations. Whitehead et al. (2011a) explored how anglers would react to a decrease in snapper–grouper creel limits from 15 to 7 fish; they estimated that the number of charter boat fishing trips would decrease by 25%, resulting in an estimated annual reduction of $24 million in the aggregate value for the North Carolina charter boat fishery.

Our study contributes in several novel ways to the existing literature. Estimates of recruitment and population size for the Louisiana Southern Flounder fishery have declined to remarkably low levels in recent years. The decline in this fishery has led to a need for management reform based on several biological indices of the population's viability (West et al. 2020). The biological importance behind the potential regulatory decisions we have evaluated is significant. Moreover, we explore from an economic perspective an undercharacterized fishery that lacks information profiling welfare values and stakeholder interest. Our study quantifies angler interest and avidity as well as the economic welfare provided by the Southern Flounder fishery. The present work also provides another case study of CB within the literature pertaining directly to fishery regulations, which has rarely occurred apart from the Whitehead et al. (2011a) study. The joint framework built by this study, through combining the travel cost method with CB, can assess potential regulatory strategies for a diversity of natural resource management applications.

## METHODS

### Survey Development and Distribution

To understand angler trip behavior for Southern Flounder, we relied on a survey containing five sections to characterize (1) avidity; (2) angling effort; (3) angling expenditures; (4) Southern Flounder interest, familiarity, and regulation-based behavior; and (5) demographics. As Southern Flounder are rarely the primary target of Louisiana anglers (LDWF recreational angler harvest survey [referred to as "LA Creel"], unpublished data), a survey framed around Southern Flounder would likely generate little interest from this population. Instead, to keep respondents engaged, the survey was framed broadly, gathering information on Spotted Seatrout and Red Drum, the two major coastal fisheries in Louisiana alongside Southern Flounder.

Before delivery of the survey, we administered a draft survey to a sample of LDWF biologists, Louisiana Sea Grant marine extension agents, and Louisiana State University graduate students to refine our survey instrument. By testing the survey with this panel, we found that the survey took approximately 10–15 min to complete and we received substantial feedback from constituents who were intimately connected to coastal recreational angling in Louisiana.

All survey actions were completed using the survey software Qualtrics with Louisiana State University Institutional Review Board approval (Institutional Review Board Number E11895). The survey sample population was gathered from Louisiana license holders with recreational saltwater fishing privileges between June 1, 2017, and November 13, 2019. A random draw of 10,000 license holders that provided e-mail addresses formed our sample population. The total population of Louisiana license holders with saltwater privileges in 2019 was 373,120 anglers. Potential response biases exist from only including anglers that provided e-mail addresses within our sample population (Duda and Nobile 2010); however, several factors led to our decision in using this form of contact. The proportion of Louisiana saltwater anglers that provided e-mail addresses within fishing license contact information was robust (35.8%), and the proportions of license types (e.g., resident, hunting and fishing combination, lifetime, and senior) within the population that provided e-mail contacts did not substantially differ from the proportions in the general population (LDWF 2018). Additionally, the ease of delivery and breadth of coverage while using e-mail contacts (Dillman 2017) were substantially important factors in choosing our mode of contact. Although potential biases may exist while using e-mail contacts, this method provided the best option to characterize the general Louisiana saltwater angler population.

On November 15, 2019, the survey (see the Supplement available separately online) was distributed via e-mail to our sample population. Of those e-mails, 9,946 were successfully sent. Survey distribution included a cover letter that assured response anonymity, provided an estimated length of the questionnaire, and detailed that this survey was seeking to characterize coastal Louisiana angler behaviors alongside their regulation preferences. Two reminder e-mails were sent to respondents who had not completed the survey on November 19 and 26, 2019, following the protocol presented by Dillman et al. (2014). The survey was closed on November 27, 2019.

### Survey Instrument

*Avidity.*— The survey began with the avidity section, which measured respondent avidity primarily through a question asking respondents to categorize their angling avidity with a selection of *beginner*, *intermediate*, *advanced*, and *expert*. While measuring angling specialization often includes multiple variables (e.g., effort, equipment investment, and skill; Oh and Ditton 2006), evidence suggests that self-classification of avidity may perform just as well as more complex techniques (Needham et al. 2009; Scyphers et al. 2021; Smith et al. 2021b). For these reasons, we opted to characterize avidity in the survey using a self-classification measure. The avidity section also included questions that indicated whether each respondent participated in a range of natural resource recreational activities in Louisiana over the previous 12 months, with a question that specifically indicated participation in coastal angling.

*Angling effort.*— The angling effort section of the survey asked respondents to indicate the number of angling trips taken over the past 12 months while angling within coastal Louisiana. An angling trip was defined as leaving the respondent's residence to participate in recreational angling in coastal Louisiana, with each trip ending upon subsequent return to the respondent's residence. Within the next subsection, anglers indicated the number of trips that occurred while targeting Southern Flounder, Spotted Seatrout, Red Drum, or any other fish species while angling in coastal Louisiana.

*Angling expenditures.*— The angling expenditures section included several questions that sought to detail the typical coastal angling trip. Respondents indicated the average one-way distance traveled from their residence to a coastal angling site and the average amount of money spent on a range of various expenditures during a typical coastal angling trip.

*Southern Flounder.*— The Southern Flounder section began by asking for the level of self-reported interest in catching Southern Flounder in Louisiana using a five-point Likert scale ranging from *strongly uninterested* to *strongly interested*. The next question asked if over the past 5 years the respondent had noticed a change in fishing quality for Southern Flounder in Louisiana, with the following responses: *yes, it has declined*; *no, it has not changed*; *yes, it has improved*; and *I don't know*. The subsequent questions asked whether the respondent was familiar with the current Southern Flounder regulations in Louisiana. Respondents who answered *yes* were then tested on current Louisiana Southern Flounder regulations (creel limit, minimum size limit, and seasonal limitations) to evaluate their true familiarity.

In the CB subsection of the Southern Flounder section, respondents were presented with the current Southern Flounder regulations in Louisiana (hereafter, referred to as "Status Quo") and each of six hypothetical regulation scenarios. The regulation scenarios presented were either an adjustment from current Louisiana regulations in one of the various limitations that fisheries managers typically impose (i.e., minimum size limit, creel limit, and seasonal limitations) or one of the regulation strategies that were present for Southern Flounder in other Gulf of Mexico states at the time of survey execution (Table 1). Respondents first indicated their level of favorability for each regulation scenario using a five-point Likert scale ranging from *strongly oppose* to *strongly support*. These scenarios were also the basis for their CB, stating their expected number of coastal angling trips and Southern Flounder-specific trips over the next 12 months given the adoption of a specific regulation scenario for Southern Flounder in Louisiana. This subsection specified that each regulation scenario was only for Southern Flounder. Respondents were presented with the minimum size limit, creel limit, and seasonal limitation associated with each regulation scenario and how the scenario differed from the Status Quo. To minimize respondent fatigue and potential order effects (Dillman et al. 2014), each respondent was randomly assigned to answer three of the six non-Status Quo regulation scenarios.

*Demographics.*— The final section of the survey included several demographic questions that identified the respondent's gender, age, race, education, employment status, residential zip code, and individual income.

## Survey Analysis

*Avidity and angling effort.*— To determine the equity of survey responses between each avidity category, pairwise chi-square tests were run among survey questions with categorical responses and *t*-tests were performed for survey questions with continuous responses ($\alpha = 0.05$). Mean annual angling effort was calculated for total coastal angling trips in Louisiana alongside each species-specific category (Southern Flounder, Spotted Seatrout, Red Drum, and all other species). A significant proportion of respondents indicated taking a sum of trips in the species-specific sections that was greater than the total number of coastal

TABLE 1. Hypothetical Southern Flounder regulation scenarios used in the contingent behavior subsection of the survey.

| Regulation scenario | Minimum size limit (mm) | Creel limit (fish/d) | Seasonal limitations |
|---|---|---|---|
| Current Regulations | None | 10 | None |
| Mississippi–Florida | 305 | 10 | None |
| Creel Reduction | None | 5 | None |
| Texas | 356 | 5 | Creel limit is reduced to 2 from Nov 1 to Dec 15 |
| Alabama | 356 | 5 | No harvest permitted during Nov |
| Season Added | None | 10 | Creel limit is reduced to 2 during Nov |
| Creel Addition | None | 15 | None |

angling trips indicated in the previous section. We found that the best approach was to interpret angling effort to include multispecies trips for each specific target category in which the target of more than one species could occur, as several previous studies have quantified effort for specific fisheries during trips that target multiple species (Beardmore et al. 2011; Melstrom and Lupi 2013; Raynor and Phaneuf 2020; Terashima et al. 2020). An upper bound of multispecies trips was estimated alongside each species-specific trip estimate. The exact value of multispecies trips could not be estimated as information was not available to determine the exact combination of species targeted during multispecies trips and several different combinations could have been targeted during each multispecies trip. Additionally, the mean number of trips that occurred while solely targeting Southern Flounder, Spotted Seatrout, or Red Drum was calculated alongside multispecies trips.

*Angler expenditures.*— Following the methods outlined by Parsons (2017), consumer surplus (CS) was calculated as an estimated nonmarket value for the benefits provided by a typical coastal angling trip in Louisiana through estimating a single-site trip demand function. This function regresses the number of trips taken to a recreational site by the trip cost, which includes the cost to travel to a site, any expenditures included to complete the trip, and a value for time expended in traveling to the recreational site (Parsons 2017).

Our model quantified trip cost by using the following equation:

$$T_i = Fv_i + Ex_i + \mathrm{OC}_i. \tag{1}$$

The term $T_i$ refers to the trip cost value for each angling trip for each respondent $i$; $Fv_i$ refers to the operational cost of vehicle travel; $Ex_i$ refers to the total dollar value of coastal angling expenditures; and $\mathrm{OC}_i$ refers to the opportunity cost of time.

The vehicle operating cost was calculated as

$$Fv_i = M_i \times 0.2444 \times 2. \tag{2}$$

The term $M_i$ is the average one-way vehicle mileage traveled to complete a coastal fishing trip. The constant 0.2444 represents the dollar value of the American Automobile Association's 2019 operating cost per mile for a half-ton, crew-cab pickup (AAA 2019), a commonly used approach among travel cost studies (Hang et al. 2016). The equation is multiplied by 2 to represent the driving mileage to and from the destination.

Total cost of angling expenditures was calculated as

$$\begin{aligned} Ex_i = {} & BoatFuel_i + Rental_i + Hotel_i + Camping_i \\ & + AccessFee_i + Guide_i + Ice_i + LiveBait_i \\ & + DeadBait_i + Tackle_i + Other_i. \end{aligned} \tag{3}$$

The terms in equation (3) refer to the dollar value of expenditures spent on boat fuel and oil ($BoatFuel_i$), boat rentals ($Rental_i$), hotel lodging ($Hotel_i$), camping ($Camping_i$), access fees at boat ramps or piers ($AccessFee_i$), guided or chartered trips ($Guide_i$), ice ($Ice_i$), live bait ($LiveBait_i$), dead bait ($DeadBait_i$), terminal tackle ($Tackle_i$), and any other expenditures ($Other_i$). The most common response within the $Other_i$ category included boat and trailer maintenance and expenses. Log-transformed values of total expenditures greater than three absolute deviations from the median were excluded from analysis as outliers (Leys et al. 2013). Six values were excluded from analysis ranging from \$3,600 to \$72,115 in total expenditures.

The opportunity cost of time was calculated as

$$\mathrm{OC}_i = h_i \times W_i \times 0.33. \tag{4}$$

The term $h_i$ refers to the number of hours spent driving to and from the typical coastal angling site at an assumed average speed of 50 mi/h (80.47 km/h). The term $W_i$ refers to the hourly wage rate based on the respondent's individual income. We used individual income to estimate the opportunity cost of time as most frequently occurs in the travel cost literature (Fezzi et al. 2014; Parsons 2017; Lloyd-Smith et al. 2019), although alternatives exist (Lupi et al. 2020). This study applied a 0.33 fraction to calculate the opportunity cost of time, which is standard within recreation demand studies (Parsons 2017; Lupi et al. 2020; E. English, C. Leggett, and K. McConnell, 2015 memorandum to C. O'Connor, National Oceanic and Atmospheric Administration, on value of travel time and income imputation). Mean replacement was applied to respondents who declined to provide individual income data (i.e., 21.4% of the total travel cost respondents).

The demand curve for coastal angling trips was estimated as

$$Q_i = \beta_0 + \beta_1(T_i) + \epsilon. \tag{5}$$

The term $Q_i$ refers to the quantity of coastal angling trips taken by each respondent 12 months prior to survey distribution, $\beta_0$ refers to the intercept, $T_i$ refers to the trip cost value for each angling trip, and $\epsilon$ refers to the error. Since the $Q_i$ term is expressed as nonnegative count values, we applied a count data model in estimating the demand curve (Creel and Loomis 1990; Lothrop et al. 2014; Gratz 2017; Parsons 2017). Moreover, significant overdispersion was detected in the quantity of annual coastal angling trips due to a small number of anglers that took many trips alongside many anglers that took few trips (Lothrop et al. 2014). As such, we used the negative binomial distribution (Haab and McConnell 2002; Parsons 2017; Greene 2018) as

$$\lambda_i = \exp[\beta_0 + \beta_1(T_i) + \alpha + \epsilon], \tag{6}$$

where $\lambda_i$ refers to the predicted number of annual coastal angling trips ($Q_i$) and $\alpha$ is a parameter that accounts for the degree of dispersion within each prediction. A common issue that can confound the interpretation of survey data is endogenous stratification (Martinez-Espineira and Amoako-Tuffour 2006; Duda and Nobile 2010), with avid anglers more likely to provide survey responses than less-avid anglers. Within our model, we applied a weighting to correct for avidity bias within each observation prior to parameter estimation (Lothrop et al. 2014). Additionally, Cook's distance tests were used to determine outliers in the data set with Cook's distance values greater than $3/n$ (Bollen and Jackman 1990; Gratz 2017). This method of outlier detection removed 19 responses from our demand curve.

Consumer surplus was estimated as

$$\mathrm{CS} = (\widehat{\lambda}/-\widehat{\beta}_1)/\widehat{\lambda} = 1/-\widehat{\beta}_1, \tag{7}$$

where the terms $\widehat{\beta}_1$ and $\widehat{\lambda}$ are derived from equation (6) (Lothrop et al. 2014; Parsons 2017). Consumer surplus per angling trip was calculated by dividing CS by the mean number of annual coastal angling trips (Lothrop et al. 2014; Parsons 2017). The coefficient for trip cost was significant, supporting the calculation of CS (Haab and McConnell 2002; Parsons 2017).

Each individual fishery's travel cost values were calculated as

$$\mathrm{TC}_h = \mathrm{CS} \times TRIPS\overline{x}_h \times 0.762 \times Population. \tag{8}$$

The term $\mathrm{TC}_h$ refers to the total travel cost value for each target category $h$. There were five target categories: (1) Southern Flounder, (2) Red Drum, (3) Spotted Seatrout, (4) other coastal fish species, and (5) total Louisiana coastal angling trips. Within each of the target categories for specific fish species, responses accounted for multispecies trips, in which several species could be targeted under the same trip. In addition to estimates that included multispecies trips, travel cost value estimates were also made for angling trips that occurred while solely targeting one species: Southern Flounder, Red Drum, or Spotted Seatrout. The term CS refers to the per-trip CS value. The term $TRIPS\overline{x}_h$ refers to the average number of trips that were indicated to have occurred for each target category. The fraction 0.762 is the proportion of respondents who indicated that they had participated in coastal angling over the past 12 months within the avidity section of the survey. The term *Population* refers to the 373,120 anglers that had saltwater privileges in Louisiana in 2019. We calculated 90% CIs for CS and $TRIPS\overline{x}_h$ to place upper and lower bounds on the estimated value of coastal angling for each individual fishery in coastal Louisiana.

*Southern Flounder.*— Equality of support among each regulation scenario was determined using an ordered logit model in which the dependent variable was the Likert scale favorability responses (1 = *strongly oppose*; 5 = *strongly support*), with a vector of six indicator variables corresponding to each regulation scenario. The regulation scenario corresponding to the response was coded as 1, and all other regulation scenarios were coded as 0. The Likert scale support responses for the Status Quo were used as the reference category for each indicator variable so that the significance of each indicator variable indicated each regulation scenario's relationship with the Status Quo. As an additional directional measure of support, net preferences were calculated as the combined percentage of *strongly support* and *moderately support* minus the combined percentage of *strongly oppose* and *moderately oppose*.

Trip change was calculated for each regulation scenario as

$$TRIPS\Delta_{rhi} = REGTRIPS_{rhi} - BASETRIPS_{hi}. \tag{9}$$

The term $TRIPS\Delta_{rhi}$ refers to the expected trip change from the Status Quo to a specific regulation scenario. The term $BASETRIPS_{hi}$ refers to the number of coastal angling trips that each respondent $i$ expected to take over the next 12 months under the Status Quo for each type of angling trip $h$. The CB subsection featured two types of angling trips (total coastal angling trips and Southern Flounder-specific angling trips). The term $REGTRIPS_{rhi}$ refers to the number of coastal angling trips that each respondent indicated taking over the next 12 months under a specific regulation scenario $r$.

Although every respondent was shown the Status Quo ($BASETRIPS_{hi}$), each respondent answered only half of the possible six regulation scenarios, leading to a different composition of each group and attenuating direct comparisons. This is demonstrated by the significantly different ($\alpha = 0.05$ using pairwise $t$-tests) number of Status Quo angling trips within each group for four regulation scenarios: Creel Addition, Alabama, Texas, and Creel Reduction. Therefore, traditional tests of equality would not provide a true measure of the impact of each regulation since each regulation is confounded by underlying differences in the mean number of Status Quo trips taken by each cohort. One way to account for these base-level differences across cohorts is to use a difference-in-difference (DiD) regression (Meyer et al. 1995; Cameron and Trivedi 2005; Greene 2018), shown below as

$$TRIPS_{rhi} = \beta_0 + \beta_1(\boldsymbol{REG_{rhi}}) + \beta_2(\boldsymbol{Policy_{rhi}}) + \delta(\boldsymbol{REG_{rhi}} \times \boldsymbol{Policy_{rhi}}) + \epsilon. \quad (10)$$

The term $TRIPS_{rhi}$ refers to the number of trips that were indicated to occur (including both $REGTRIPS_{rhi}$ and $BASETRIPS_{hi}$) for each regulation scenario $r$ and each individual $i$. The term $\boldsymbol{REG_{rhi}}$ refers to a vector of indicator variables for each regulation scenario, where 1 is coded for the specific regulation scenario to which $TRIPS_{rhi}$ are connected and 0 is coded for all regulation scenarios that are not connected to the $TRIPS_{rhi}$ term. The term $\boldsymbol{Policy_{rhi}}$ refers to a vector of indicator variables for whether the term $TRIPS_{rhi}$ was for $REGTRIPS_{rhi}$ (coded as 1) or for $BASETRIPS_{hi}$ (coded as 0). Within this DiD regression, the significance of the δ term displays the effect of each policy on the number of trips taken while controlling for the initial difference in the number of Status Quo trips. The DiD regression was run once for each type of angling trip $h$ (total coastal angling trips and Southern Flounder-specific angling trips). The $P$-values produced by the δ term of coefficients in this model were used to determine the equality of $BASETRIPS_{hi}$ versus $REGTRIPS_{rhi}$ ($\alpha = 0.05$). Wald tests were run to determine whether the interactions of coefficients significantly differed among each regulation scenario ($\alpha = 0.05$). To account for the multiple, correlated responses per respondent, a term was added to the DiD regression that calculated clustered SEs for each regulation scenario (Greene 2018). Clustered robust 90% CIs were calculated for each $VALUE_r$ variable (defined below) using the clustered SEs.

The economic value of each regulatory change was calculated as

$$VALUE_r = TRIPS\Delta\bar{x}_r \times \text{CS} \times 0.762 \times Population \times P_r. \quad (11)$$

The term $VALUE_r$ refers to the dollar value for each regulation scenario $r$. The term $TRIPS\Delta\bar{x}_r$ accounts for the change in coastal angling trips based on each regulatory scenario. The term CS refers to the per-trip CS value. Most respondents only answered the multiple-choice Likert scale question indicating their level of support or opposition for the regulation scenario and left the section that indicated their behavioral effort response blank. With this encountered gap between partial and full responses to the CB subsection, we calculated value changes only to reflect a value for the proportion that answered the CB subsection of the survey in the term $P_r$, which refers to the proportion of usable CB responses within each regulation scenario.

## RESULTS

The survey generated partial usable responses from 1,137 respondents, for an 11.4% partial response rate. All partial responses were recorded and included within the analysis. Of these, 265 surveys were fully completed, for a 2.7% completed response rate. The completed response rate is low largely due to a significant proportion of respondents skipping the portion of the survey that elicited the expected number of trips to be taken over the next 12 months based on each regulation scenario. Excluding this section of the survey, our completed response rate was 8.9%. This sample will be referenced hereafter as the partially complete sample. All summary statistics refer to the partially complete sample unless mentioned otherwise. Respondents were predominately white (94.8%) and male (87.2%), with an average age of 52 (Table 2). Survey responses were focused around the Louisiana population centers of New Orleans, Baton Rouge, and Lafayette.

For the typical coastal angling trip, respondents traveled an average of 85.7 mi (137.9 km) one way. Total angling expenditures averaged \$242 per respondent. The most frequently listed expenditures indicated during coastal fishing trips were for boat fuel, terminal tackle, and ice, with 80.3, 71.1, and 67.4% of respondents indicating expenditures in these categories, respectively (Table 3). When adjusted for inflation, our expenditure estimates were nearly identical to per-trip expenditures for Louisiana marine recreational anglers estimated by Lovell et al. (2013; \$223). The mean trip cost value per respondent was \$331 for the average coastal angling trip in Louisiana, and the per-trip CS value was \$327. Based on travel cost calculations (equation 8), the Southern Flounder fishery produced an estimated \$119.7 million in economic value, the Red Drum fishery produced an estimated \$498.1 million in value, the Spotted Seatrout fishery produced an estimated \$598.4 million in value, all other coastal fisheries produced an estimated \$177.1 million in value, and the statewide estimate for all coastal angling trips produced an estimated \$932.5 million in annual travel cost value (Table 4). These outcomes also hold relatively near to recent recreational economic estimates of \$1.6 billion spent on durable goods and trip-related expenditures connected to Louisiana saltwater recreational angling in 2016, which included both coastal and offshore angling (NMFS 2018).

The results from this survey clearly demonstrate that Southern Flounder are not a primary target species, confirming prior anecdotal information. In comparison to Spotted Seatrout and Red Drum, the total travel cost value that Southern Flounder provide to coastal Louisiana is less than 25% of each of the major coastal Louisiana fisheries when accounting for multispecies trips. The margin between these economic values grows even wider when only accounting for trips where one species was solely targeted. The proportion of travel cost value provided by anglers solely targeting Southern Flounder in comparison with the travel cost values provided by anglers solely

TABLE 2. Demographic and avidity characteristics of the survey respondents, with statistics derived from the partially complete sample.

| Variable | Description | Response |
|---|---|---|
| Gender | Male | 87.2% |
| Age | Mean (years) | 51.5 |
| Race | Black or African American | 2.9% |
| | American Indian | 0.6% |
| | Asian | 0.5% |
| | White | 94.8% |
| Employment status | Full time | 73.3% |
| | Retired | 20.5% |
| | Unemployed | 0.3% |
| Education | Bachelor's degree or higher | 47.9% |
| Income | Annual individual income < \$80,000 | 37.9% |
| | Mean individual income (US\$) | 114,906 |
| | Annual individual income ≥ \$150,000 | 21.9% |
| Avidity | Participated in *Louisiana natural resource recreation* over the past 12 months | 97.2% |
| | Participated in *Louisiana angling* over the past 12 months | 93.0% |
| | Participated in *coastal Louisiana angling* over the past 12 months | 76.2% |
| Self-rated angling avidity | Expert | 6.2% |
| | Advanced | 49.4% |
| | Intermediate | 38.7% |
| | Beginner | 5.7% |

targeting Red Drum and Spotted Seatrout amounted to only 3.9% and 2.3%, respectively. While 43.9% of respondents indicated being familiar with the Southern Flounder regulations in Louisiana, only 47.1% of those respondents properly identified current regulations when tested. Based on the criteria of correct answers, this amounts to only 20.6% of survey respondents being truly familiar with Louisiana Southern Flounder regulations. Correct answers for each category (i.e., creel limit, seasonal limitation, and minimum size limit) ranged from 29.1% within the section eliciting the daily creel limit to 39.6% within the section eliciting the minimum size limit. Among the respondents that indicated taking at least one Southern Flounder trip, 75.2% indicated that they were familiar with the current Louisiana Southern Flounder regulations; however, nearly one-third of those respondents could not properly identify the current regulations, correcting this percentage to 52.7%. Additionally, over half of respondents (57.3%) indicated that they did not know whether the Southern Flounder fishery has changed or stayed the same over the past 5 years. With the current abundance of Louisiana Southern Flounder at relatively low levels when compared to historic values (West et al. 2020) and the amount of harvest within the recreational fishery declining in recent years (Smith et al. 2021a), the decline over the past 5 years would seemingly be apparent for those targeting Southern Flounder. That this decline has gone unnoticed is likely due to the incidental nature of Southern Flounder targeting behaviors in coastal Louisiana.

With respect to trips taken, 16.5% of survey respondents indicated taking at least one coastal angling trip while targeting Southern Flounder, with 8.6% of the total coastal angling trips specifically indicated as Southern Flounder trips. This estimated participation in the Southern Flounder fishery appears high considering that this species is rarely indicated as a target species by coastal Louisiana anglers during creel surveys (LA Creel,

TABLE 3. Mean expenditures (US\$) for each category during a typical coastal Louisiana angling trip, with SD and the percentage of respondents that indicated expenditures within each category.

| Expenditure | Mean (\$) | SD (\$) | Respondent percentage |
|---|---|---|---|
| Total expenditures | 242.19 | 352.28 | 100.0 |
| Charter fees | 58.32 | 190.08 | 12.0 |
| Boat fuel | 55.50 | 106.86 | 80.3 |
| Hotel | 33.35 | 97.78 | 17.6 |
| Terminal tackle | 26.73 | 86.61 | 71.1 |
| Live bait | 26.52 | 65.90 | 56.6 |
| Access fees | 10.20 | 38.42 | 52.6 |
| Ice | 8.75 | 16.97 | 67.4 |
| Dead bait | 7.75 | 21.60 | 38.0 |
| Other | 7.74 | 52.49 | 6.2 |
| Camping | 5.56 | 38.89 | 3.8 |
| Boat rental | 1.77 | 26.72 | 0.7 |

TABLE 4. Travel cost (TC) calculations for each coastal fishery in Louisiana based on the value of consumer surplus per angling trip (US$327). The population of coastal anglers in Louisiana was calculated using the number of licensed anglers in 2019 with saltwater privileges in Louisiana (373,120) multiplied by the fraction of survey respondents that indicated fishing in coastal Louisiana (0.762). An angling trip was defined as leaving the respondent's residence to participate in recreational angling in coastal Louisiana, with each trip ending upon subsequent return to the respondent's residence. Multispecies trips indicated for each species account for trips in which more than one species of fish was targeted. Sole-target trips are those during which respondents only targeted a specific species.

| Trip type | Mean annual trips | TC total (millions, $) | 90% CI (millions, $) |
|---|---|---|---|
| Coastal angling | 10.04 | 932 | 798–1,077 |
| Southern Flounder (multispecies) | 1.29 | 120 | 84–160 |
| Southern Flounder (sole target) | 0.09 | 8 | 0–28 |
| Red Drum (multispecies) | 5.36 | 498 | 409–595 |
| Red Drum (sole target) | 2.28 | 212 | 137–295 |
| Spotted Seatrout (multispecies) | 6.44 | 598 | 486–721 |
| Spotted Seatrout (sole target) | 3.85 | 358 | 239–490 |
| Other species (multispecies) | 1.91 | 177 | 127–232 |

unpublished data). This is the result of the survey accounting for multiple targeted species during each coastal angling trip. The upper bound for Southern Flounder multispecies trips was estimated at 94.0% of the total Southern Flounder trips. Although each of the mean trip values produced by anglers solely targeting one species was significantly reduced from multispecies trips for each individual species, the proportion of trips made by anglers solely targeting Southern Flounder was considerably lower than anglers solely targeting Spotted Seatrout or Red Drum (Table 4). When accounting for the total trips that were solely targeting one species, only 1.3% of those trips indicated targeting Southern Flounder, an estimate comparable to LA Creel estimates. Comparatively, 52.6% and 31.2% of the total trips that occurred while anglers solely targeted one fish species were targeting Spotted Seatrout and Red Drum, respectively.

Respondent answers regarding Southern Flounder in Louisiana showed increasing participation, interest, and knowledge of the fishery as avidity increased from *beginner* to *expert*. The number of Southern Flounder trips that respondents indicated taking over the past 12 months within Louisiana increased with avidity: the mean numbers of Southern Flounder trips indicated to occur for anglers rated as *beginner*, *intermediate*, *advanced*, and *expert* were 0.4, 0.8, 1.3, and 3.6 trips, respectively. Pairwise $t$-tests indicated significant differences between every avidity group pairing except the *intermediate–beginner* groups and the *expert–advanced* groups. High-avidity anglers were also more familiar with Southern Flounder regulations in Louisiana, as 94.6% of respondents rated as *beginner* indicated that they were not familiar with Southern Flounder regulations, while only 29.0% of respondents rated as *expert* indicated the same unfamiliarity. Correspondingly, the proportion of correct responses when tested on the actual familiarity of those regulations increased with higher avidity. Pairwise chi-square tests indicated significant differences between every avidity group pairing for regulation familiarity. When opinions were elicited on the status of the Southern Flounder fishery in Louisiana over the past 5 years, a significant proportion of responses indicated that the status of this species was unknown for all avidity groups; however, this percentage was lowered as avidity increased. Additionally, as avidity increased, a higher proportion of respondents indicated that the fishery was declining. Pairwise chi-square tests indicated significant differences between every avidity group pairing except *expert–advanced* for responses on the status of the Louisiana Southern Flounder fishery. All survey respondents combined displayed a moderate level of interest in Southern Flounder, as 60.1% of total respondents indicated that they were either *strongly interested* or *moderately interested* in catching Southern Flounder in Louisiana. Levels of interest increased with avidity as 69.3% and 29.1% of respondents rated *expert* and *beginner*, respectively, indicated the same level of interest (Figure 1). Pairwise chi-square tests indicated significant differences between every avidity group pairing except *expert–advanced* for responses on interest in catching Southern Flounder.

Survey results indicate that the effects of the regulations presented in the survey would not significantly alter general angling behaviors or the economic values provided by coastal Louisiana angling. This is demonstrated by the results of the DiD regression (Table 5), which indicated that trip values for coastal angling in general were not significantly altered by each hypothetical regulation scenario. Wald tests indicated that coefficients within this model were not significantly different among regulation scenarios. While the DiD regression indicated that the number of Southern Flounder-specific trips was significantly different from the Status Quo for two of the six regulation scenarios (Season Added and Alabama), the intended trip behavior for total coastal angling trips did not significantly change

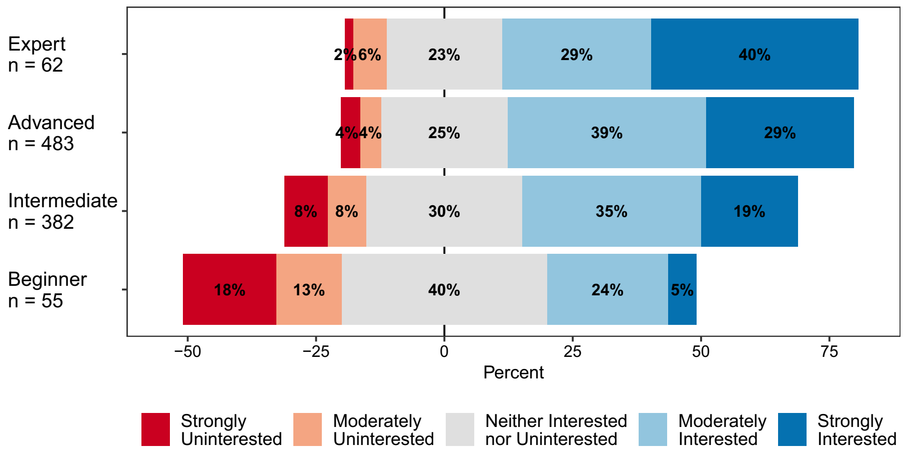


FIGURE 1. Proportion of interest and uninterest (Likert scale) in catching Southern Flounder for each category of avidity among Louisiana anglers who responded to the survey. The *expert* avidity category provided the highest level of interest, while the *beginner* avidity category provided the lowest level of interest.

from the Status Quo within every regulation scenario. Additionally, the percentage of respondents that indicated no change in the number of expected coastal angling trips ranged between 84.1% and 90.5% for all regulation scenarios. The dollar value of regulatory changes in the Southern Flounder fishery ranged in estimated value changes from a reduction of $10.4 million to an addition of $1.6 million, with error indicated by clustered robust 90% CIs within the range of a net-zero effect for every regulation scenario.

TABLE 5. Mean values of trip change ($TRIPS\Delta\overline{x}$), indicating the changes in effort from the number of trips under the Status Quo to the number of trips under each regulation scenario (defined in Table 1). Significance of the changes was indicated by a difference-in-difference regression to account for the base-level differences among each cohort. Significance is denoted by the letter z.

| Regulation scenario | Trip type | $TRIPS\Delta\overline{x}$ | *P*-value |
|---|---|---|---|
| Mississippi–Florida | Coastal angling | −0.35 | 0.32 |
| | Southern Flounder | +0.03 | 0.36 |
| Creel Reduction | Coastal angling | −0.09 | 0.97 |
| | Southern Flounder | −0.11 | 0.20 |
| Texas | Coastal angling | +0.07 | 0.83 |
| | Southern Flounder | −0.19 | 0.20 |
| Alabama | Coastal angling | −0.13 | 0.89 |
| | Southern Flounder | −0.44 | 0.02 z |
| Season Added | Coastal angling | −0.43 | 0.34 |
| | Southern Flounder | −0.23 | 0.04 z |
| Creel Addition | Coastal angling | −0.08 | 0.77 |
| | Southern Flounder | +0.14 | 0.28 |

Our study indicated that there are minor levels of opposition for altering Southern Flounder regulations in Louisiana and even showed that some regulation scenarios achieved levels of support that exceeded the support shown for the Status Quo. Regarding supportiveness toward specific regulation scenarios (Figure 2), anglers most preferred the Mississippi–Florida regulation scenario, with levels of support surpassing that of current Louisiana regulations. The ordered logit model found that support for this regulation scenario did not differ significantly from the support for the Status Quo and presented a positive coefficient, indicating that anglers were even more supportive of this scenario than of the Status Quo (Table 6). Net preferences ranged from +50.6% for the Mississippi–Florida scenario to −12.9% for the Creel Addition scenario (Table 6). Survey respondents opposed the Creel Addition regulation scenario, which proposed relaxing current regulations, as the only scenario with a negative net preference value, and it presented the highest negative coefficient within the ordered logit model. Conversely, there was a net preference of at least +28.9% for every regulation scenario that increased restrictions on allowable harvest, indicating that Louisiana anglers are relatively supportive of altering the current regulations.

## DISCUSSION

Our study had two key findings. First, based on total travel cost, the aggregate economic value of the Southern Flounder fishery among coastal Louisiana anglers reached an estimated $119.7 million in 2019. This value is

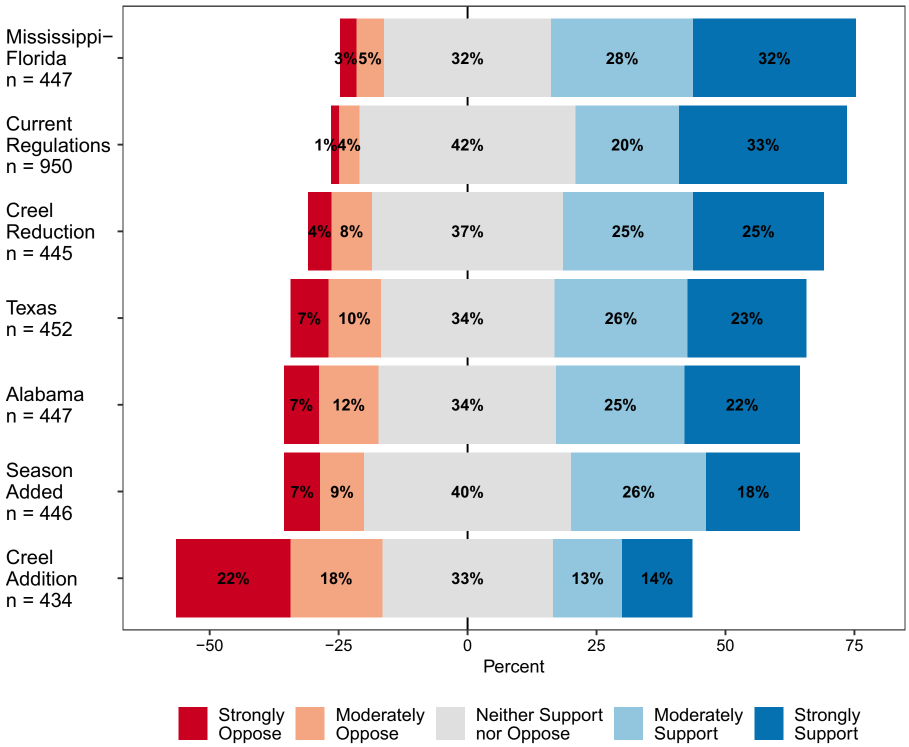


FIGURE 2. Proportion of support and opposition (Likert scale) for each regulation scenario (defined in Table 1) among Louisiana anglers who responded to the survey. The regulation scenario on the top (Mississippi–Florida) had the highest level of support, while the regulation scenario on the bottom (Creel Addition) had the lowest level of support.

TABLE 6. Estimates and *P*-values indicated for the ordered logit model displaying the equality of support responses for regulation scenarios (defined in Table 1) in relation to the current Louisiana regulations (Status Quo). Net preference indicates the combined percentage of *strongly support* and *moderately support* minus the combined percentage of *strongly oppose* and *moderately oppose*. Significance is denoted by the letter z.

| Regulation scenario | Coefficient | *P*-value | Net preference (%) |
|---|---|---|---|
| Mississippi–Florida | 0.07 | 0.249 | +50.6 |
| Creel Reduction | −0.26 | 0.006 z | +38.2 |
| Texas | −0.42 | <0.001 z | +31.4 |
| Alabama | −0.48 | <0.001 z | +28.9 |
| Season Added | −0.55 | <0.001 z | +28.9 |
| Creel Addition | −1.59 | <0.001 z | −12.9 |

relatively small compared to other coastal Louisiana fisheries and primarily stems from anglers who target multiple species during their trips; the value of the Southern Flounder fishery while only accounting for anglers that solely targeted this species amounted to an estimated $8.4 million. Second, the total number of coastal angling trips among Louisiana anglers would not be significantly affected by the adoption of Southern Flounder regulations that are enacted in neighboring Gulf of Mexico states. Although two regulation scenarios indicated that angling behaviors surrounding Southern Flounder-specific trips would significantly differ from the Status Quo (Season Added and Alabama), intended trip behaviors surrounding total coastal angling trips did not significantly differ for each of these scenarios as well as the remaining regulation scenarios. Our results indicate that an increase in regulatory limitations on Southern Flounder angling is unlikely to erode the broader economic value of coastal Louisiana's recreational fisheries while also displaying indications of support from coastal Louisiana anglers. Additionally, our survey confirmed that the Southern Flounder is a secondarily targeted fish species in coastal Louisiana. While there are moderate levels of interest in catching the species (60.1%), very few anglers seek to solely target Southern Flounder (1.3%) compared to more charismatic species, such as Red Drum (31.2%) or Spotted Seatrout (52.6%). Moreover, our survey results identify some concerns for Louisiana fishery managers, as approximately half of anglers that indicated targeting Southern Flounder could not properly identify the current regulations for this species.

There are several examples of survey findings that indicate angler preferences for the liberalization of fishery regulations (Lew and Larson 2012; Goldsmith et al. 2018), and there are also numerous studies that display the negative economic impacts of increasing levels of restriction among fishery regulations (Gilig et al. 2003; Whitehead et al. 2011a; Liese and Carter 2017; Scheld et al. 2020). These study results are contrary to our findings that Southern Flounder regulation increases are supported by anglers and would not affect total participation within Louisiana coastal fisheries. Where these studies diverge from ours is that their focus was on fish species with much more charismatic value than the Southern Flounder provides to Louisiana coastal anglers (e.g., Red Snapper, Cobia *Rachycentron canadum*, and Bluefin Tuna *Thunnus thynnus*). The results of our study are comparable to those of Murphy et al. (2019), who found that the number of days anglers elected to fish did not significantly change after the implementation of alternative regulations in several Atlantic Striped Bass *Morone saxatilis* fisheries; however, an exception to this was seen when catch-and-release regulations were applied to these fisheries and resulted in sharp declines in effort, a finding similar to those of other regulatory studies (Cha and Melstrom 2018).

Moreover, our survey indicated that participation and interest in the Louisiana Southern Flounder fishery increased with angler avidity. While many studies report that increased angler avidity occurs alongside increased catch-and-release behaviors within typical freshwater fisheries (Ditton et al. 1992; Oh and Ditton 2006), there is also evidence in some specialized freshwater fisheries (Dorow et al. 2010) and marine fisheries (Salz et al. 2001) that these attitudes have an inverse relationship, with an increased importance in harvesting fish as avidity increases. Furthermore, there is evidence that as angling avidity increases, the level of angling efficiency increases as well (Ward et al. 2013). Although a small percentage of coastal Louisiana anglers actively target Southern Flounder, these anglers are more likely to maximize landings of Southern Flounder to the highest levels of exploitation allowed by existing regulations.

Given the potential acceptance of regulatory changes in the Louisiana Southern Flounder fishery and the insignificant effect that these regulations appear to have on total coastal angling effort, the biological effectiveness of management actions would appear to be the logical focal point of any regulatory change in the fishery (Johnson and Martinez 1995). The efficacy of a minimum size limit is primarily based on the length at which maturity occurs for a fish species so that mortality risk caused by fishing is minimized prior to first reproduction (Cooke and Cowx 2006; van Poorten et al. 2013). Specifically, Erickson and Midway (2020) identified the percentage of mature female Louisiana Southern Flounder in the population at various lengths. The percentages of mature female Southern Flounder at 305, 330, and 356 mm were 4.8, 19.4, and 52.7%, respectively, showing that even at a 356-mm minimum size limit, only about half of mature females would be protected from harvest risk. Setting a minimum size limit of 356 mm is a biologically defensible measure to improve recruitment levels in the Louisiana Southern Flounder fishery, as this size restriction is approximately the length at maturity for Louisiana Southern Flounder. Additionally, the application of a seasonal limitation within the fishery would also provide a harvest reduction due to the strong seasonality in recreational landings and targeting behaviors of coastal Louisiana anglers (Smith et al. 2021a). Finally, reducing the current creel limit would also provide a reduction in harvest, specifically among more avid anglers, who are more likely to maximize creel limits. The Alabama and Texas regulation scenarios are more restrictive by each regulatory aspect (i.e., minimum size limit, daily creel limit, and seasonal limitations) than the strongest supported regulation scenario (Mississippi–Florida), yet they would be more ambitious in mitigating the potential collapse of the Louisiana Southern Flounder fishery. Furthermore, the net preferences indicated for these regulation scenarios were both strongly positive, with values of +31.4% and +28.9% for the Texas and Alabama scenarios, respectively. These strong preferences provide evidence that anglers are supportive of regulatory strategies that would alter the existing minimum size limit, creel limit, and seasonal limitation. Due to a combination of biological considerations and the results of our survey, the Alabama and Texas regulation scenarios both appear to present potentially viable alterations of Louisiana Southern Flounder recreational regulations.

It is critical to consider potential spillover effects from anglers targeting other species as regulations change (Sutton and Ditton 2005; Scheld et al. 2020; Smith et al. 2021b). While we did not precisely test for this, our survey results indicated that angler effort would not significantly change for other coastal Louisiana fisheries since the harvest of Southern Flounder typically occurs alongside several fish species. Moreover, behaviors surrounding Southern Flounder-specific trips did not display significant alterations in effort for four of the six regulation scenarios, suggesting that most of the regulation scenarios presented in this study would not significantly alter the targeting behaviors of anglers in coastal Louisiana.

## Study Limitations

Admittedly, our modeling approach of calculating economic value via travel cost and CB separately does not follow convention, which combines travel cost and CB into a single trip response demand model (e.g., Loomis, 2002; Bergstrom et al. 2004; Whitehead et al. 2011b). Because the results of our study show no behavioral responses that would alter the economic values of coastal Louisiana fisheries, we believe that the main conclusions of our study are qualitatively unchanged by this modeling approach. Furthermore, though we used a single-site travel cost model to estimate CS, Louisiana anglers visit multiple coastal angling sites throughout the state, such that multi-site models are generally preferred to evaluate recreational demand (Parsons 2017). However, such models have much greater information requirements from respondents, thus increasing survey complexity, which can lead to potential respondent fatigue and recall biases (Dillman et al. 2014; Bishop and Boyle 2019). For these reasons, we determined that the best approach was to simplify our survey by only eliciting information that characterized the typical coastal angling trip and analyzing these results using a single-site approach.

While overall participation in our survey was reasonable (8.9%), the lack of fully completed responses for the CB section decreased the usable responses to 2.7%. When designing this survey, a targeted sample size of 384 respondents was calculated (based on the 2019 population of 373,120 anglers) to have a 95% confidence level and a marginal error rate of 5% (Dillman et al. 2014). Respondents that provided usable responses for each regulation scenario ranged from 106 to 125—far below this threshold. This encountered gap is one that we understand exists, and we do not want it to go unreported.

Nevertheless, results of the CB subsection show that the regulation scenarios that do not significantly alter fishing effort may reach this threshold of statistical significance if we assume that the respondents who did not provide a response to this section are also unaffected by Southern Flounder regulations in Louisiana. Potentially, a significant proportion of respondents did not fully comprehend this subsection and left the responses blank to indicate that their effort would not change given the adoption of specific regulation scenarios. A further investigation supports this assumption, with no statistical differences between respondents that skipped the CB subsection and those that answered this subsection based on demographic characteristics (gender, age, education, race, and individual income) and travel cost characteristics (average mileage traveled and the total per-trip expenditures). Respondents that answered the CB subsection took significantly more coastal angling trips, had a higher self-rated avidity, and had a higher interest in catching Southern Flounder than nonparticipants. This information suggests that those most likely to be affected by Southern Flounder regulations provided a response to the CB subsection, yet the results did not indicate a significant behavioral response related to the intended behavior surrounding total coastal angling trips. Finally, the number of respondents that provided answers to regulatory favorability met our threshold of statistical significance (434–452 respondents). With substantially higher levels of support than opposition for each regulation scenario that increased restrictions on allowable harvest, these results provide further evidence that the general behaviors of coastal Louisiana anglers are unlikely to change in response to altering existing Southern Flounder regulations.

The potential for nonresponse bias is a common concern surrounding the analysis of survey results (Groves and Peytcheva 2008; Dillman et al. 2014). The best way to test for nonresponse biases is to conduct a separate follow-up survey, but we were only permitted one contact of survey respondents. Given this limitation, a formal nonresponse follow-up survey was not possible. To evaluate the representativeness of our collected sample, we compared the characteristics of our survey to the general population of Louisiana anglers with saltwater privileges in 2019. The proportions of zip codes within the top-five Louisiana parishes indicated in our survey were compared to the proportions indicated by the general population using two-proportion $Z$-tests. None of the comparisons produced significant differences ($\alpha = 0.05$). Additionally, ages among our survey respondents (mean = 51.5; median = 53; SD = 13.5) did not significantly differ from ages among the general population (mean = 49.3; median = 52; SD = 16.8; LDWF, unpublished data). Moreover, LA Creel access point interviews of coastal Louisiana anglers in 2020 indicated that 44.4, 31.0, and 1.1% of effort were allocated to primarily targeting Spotted Seatrout, Red Drum, and Southern Flounder, respectively (LA Creel, unpublished data). These outcomes display that our estimates of effort for solely targeted trips (52.6, 31.2, and 1.3% for Spotted Seatrout, Red Drum, and Southern Flounder, respectively) only marginally differed from information collected directly from anglers during creel surveys.

The only significant difference that was found in our survey compared to the general population was in gender, as our sample displayed a significantly higher proportion of male respondents (87.2% compared to 76.4%; LDWF, unpublished data). We conducted several tests to evaluate whether gender played a significant role within our estimations of CS and CB, and every test identified the role of gender as nonsignificant ($P > 0.25$). Given evidence displaying that gender did not play a significant role in our economic estimates and given that other demographic and effort estimates only marginally differed from those of the general population, we firmly believe that our economic estimates for specific fisheries in coastal Louisiana are representative of the total population. Although none of these tests truly validates that our study was representative of the total population of Louisiana saltwater anglers, these data offer some evidence that our results may in fact provide an accurate characterization of the general population.

## Conclusions

When considering this study's overall contribution to natural resource management, the framework we have built is one that has a wide range of future applications. The methodology of combining the travel cost method with CB to gather preference data related to specific regulatory strategies provides resource managers with a useful tool that can be used to inform difficult management decisions. Within fisheries, this approach has significant potential in the context of exploring recovery options for other declining fish stocks. When Spotted Seatrout began declining at a rate that warranted management action in coastal Louisiana (West et al. 2019), an opportunity presented itself to apply what was learned in this study to the most desirable coastal fish species in Louisiana. To explore the economic effects of potential regulatory strategies, a survey was developed and executed using the framework built within this study. While results from the survey continue to be analyzed, a preliminary report (Caffey et al. 2020) has been completed that documents an extension of the methods outlined in the present study.

Our study showcases the economic importance of Southern Flounder as a supplementary fishery in coastal Louisiana and indicates that a significant portion of coastal Louisiana anglers support more restrictive regulations within the fishery. Respondents provided ample evidence that the regulation strategies presented by this study would marginally impact the strong economic values provided by coastal Louisiana fisheries. These survey results indicate that moving to restrict the harvest of this species would be both biologically and economically defensible while also being supported by stakeholders who are invested in coastal Louisiana fisheries. Moving forward with possible regulatory adjustments within this fishery, the present results can be used to guide the decision-making process in developing a sustainable management strategy for Southern Flounder in Louisiana.

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## SUPPORTING INFORMATION

Additional supplemental material may be found online in the Supporting Information section at the end of the article.