LOUISIANA FISHERIES FORWARD

BLACK DRUM & SHEEPSHEAD

Trotline Bycatch Report*

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**Due to COVID-19 limitations in 2020, the hurricanes of 2020 and 2021, and the warm conditions in 2021, trawl data is not included in this report.*

ABSTRACT

The Black Drum *Pogonias cromis* and Sheepshead *Archosargus probatocephalus* fishery in Louisiana comprises one of the largest fisheries by volume and in recent years has exceeded $5 million in annual value. The vast majority of Black Drum and Sheepshead are harvested from the baited trotline fishery that operates in state waters. Very little is known about the bycatch from this fishery; however, because of the magnitude of the fishery quantifying any bycatch has become a knowledge gap in the management of this resource.

We observed 59 baited trotline sets on 13 different dates spanning two years of sampling (2020–2021). Total bycatch (*n* = 1392) was similar in number to the harvest of the target species (*n* = 1265); However, most bycatch species were nongame fishes and released alive. Of all the bycatch caught, only 4% was dead and the majority of that 4% (47 out of 57 fish) were Gafftopsail Catfish and Hardhead Catfish, both species for which there is little fishery and no known issues with the populations. We also found that catch rates of bycatch did not vary by season or between the two areas fished. The catch rate of bycatch did not increase as the catch rate of target species increased; although as expected, bycatch mortality did significantly increase as water temperature increased. Overall, the baited trotline fishery for Black Drum and Sheepshead catches about one individual of bycatch for one target individual; however, the overall extremely low bycatch mortality suggests that this fishery operates with little impact on non-target species.

BACKGROUND to the STUDY

This research project was requested as part of Louisiana Fisheries Forward (LFF) in 2020 as an independent investigation on the bycatch associated with commercial landings of Black Drum and in the coastal waters of Louisiana. Together, Black Drum and Sheepshead comprise one of the top commercial finfish fisheries in Louisiana (and western Gulf of Mexico). Both species have exhibited varying levels of harvest among coastal estuaries as well as over time. Black Drum (Drum) and Sheepshead are both assessed and managed at the state level. Although the species are similar in many ways, Black Drum tend to dominate the landings; from 2015 to 2020 approximately 3.5 million pounds of Black Drum were annually landed in Louisiana, compared to about 1.5 million pounds of Sheepshead. (Fig. 1). Like other fisheries, the number of commercial fishermen for Black Drum has been in decline from over 900 in 2000 to 306 in 2017 (Adriance et al. 2019).

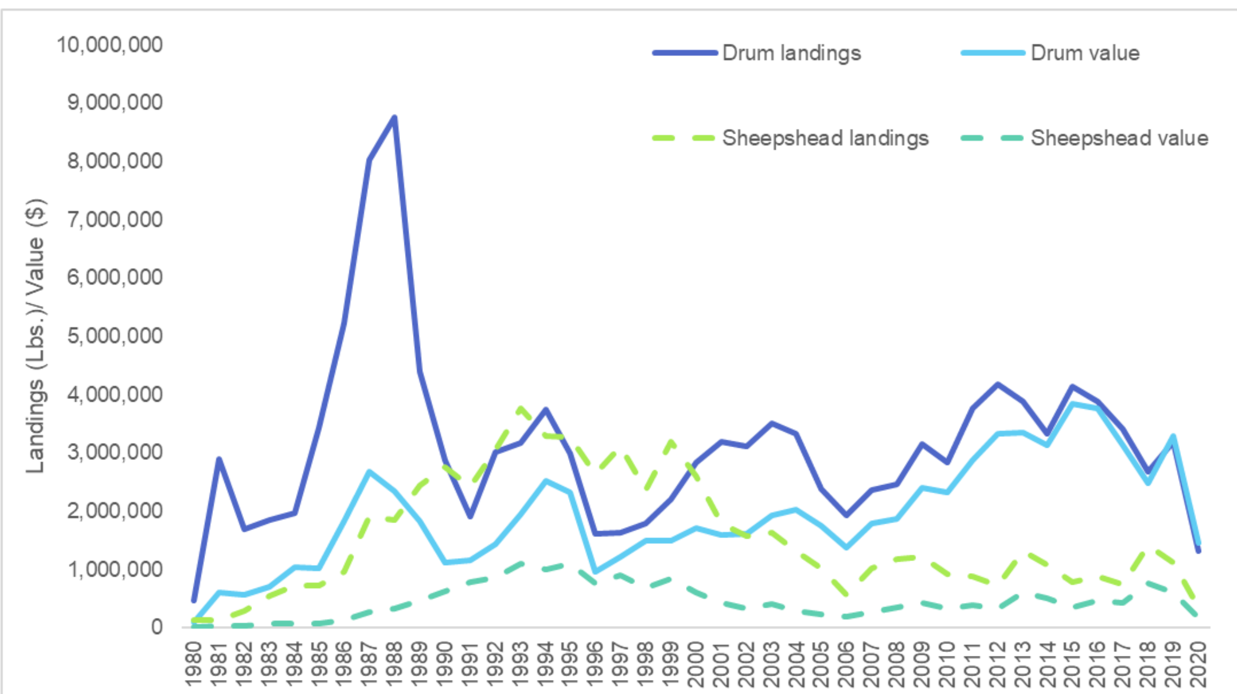

Figure 1. Statewide landings and value of Black Drum and Sheepshead from 1980 to 2020. Data source: NOAA Fisheries.

Both species are open for commercial fishing year-round in Louisiana with relatively stable landings most of the year except for a spike in January (Fig. 2). This increase is likely related to the gear available for catch.

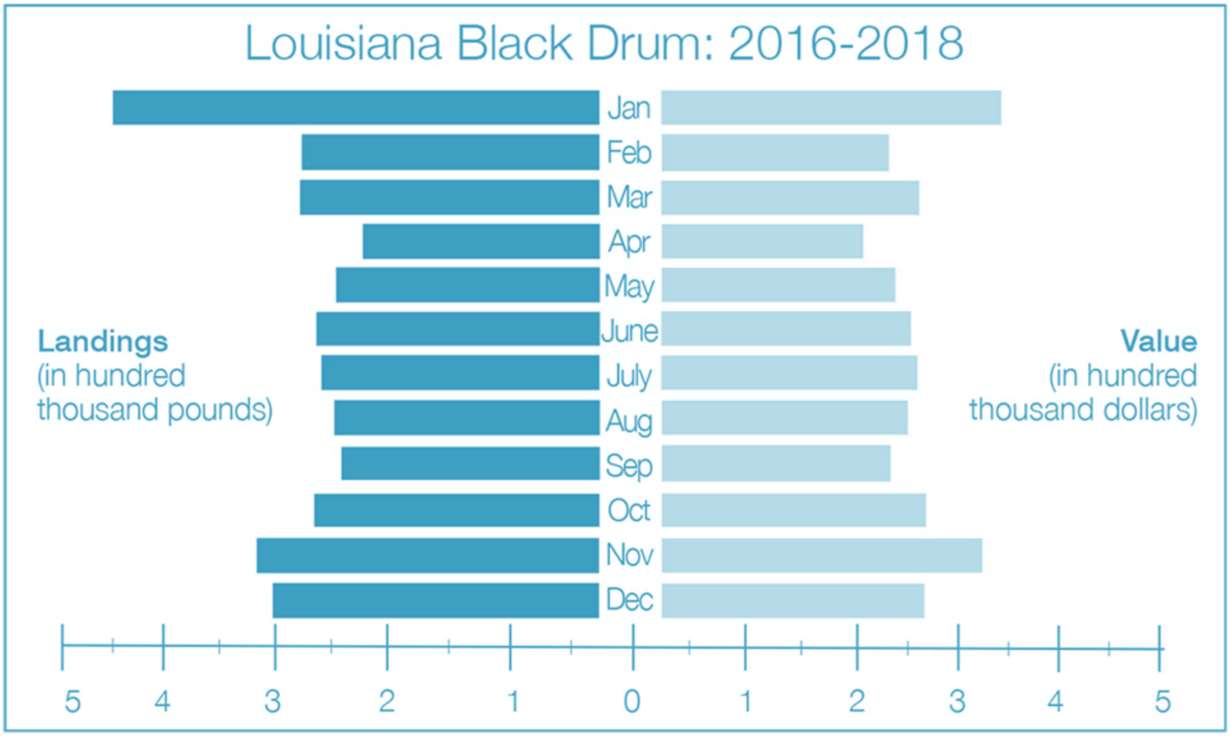

Figure 2. Average catch of Black Drum per month (2016-2018). Source: LDWF trip tickets.

Baited trotlines are now the dominant fishing gear for Black Drum in state waters (Adriance et al. 2019). They are anecdotally reported to have relatively low bycatch, and other studies have reported on low bycatch mortality related to hooking duration (Steffenson et al. 2013), but to date no scientific study has documented bycatch rates and fates for the Black Drum and Sheepshead trotline fishery.

The objectives of this study were part descriptive and part analytical. Without knowing what species would be observed as bycatch, the first part of the study was intended to provide descriptive results about the species, catch rate, and timing of bycatch associated with commercial trotline fishing. The analytical part of the study was intended to explore catch rates over space and time for Black Drum and Sheepshead (because it was assumed these species would be captured in the trotline fishery that targets them), and then use the bycatch data to quantify how bycatch related to catch rates of target species. Finally, we wanted to examine available environmental factors that might account for the probability of dead discards.

GEAR

Black Drum and Sheepshead are caught by a variety of methods including hand lines, otter trawls for fish, shrimp otter trawls, skimmer nets, and trotlines (Fig. 3). The vast majority of fish—77% for the 5-year average (2013–2017)—are caught by trotlines, or long lines, (Fig. 4) with 157 licensed trotline fishermen (Yr-2017; Adriance et al. 2019). However, the winter peak in landings likely relates to shrimping. Some Drum and Sheepshead fishermen also shrimp, reducing effort in the inshore shrimping months. Additionally, as the weather cools and shrimping declines, fishermen will use trawls and skimmers on their nets to essentially target the bycatch of Black Drum and Sheepshead, often with a larger mesh size than normally used for shrimping. Only 14% of landings come from trawl or skimmer nets operated while the shrimp season is still open. The change in gear type also has an impact on the bycatch of the industry. The goal of this study was to characterize the bycatch in the trotline and trawl fishery.

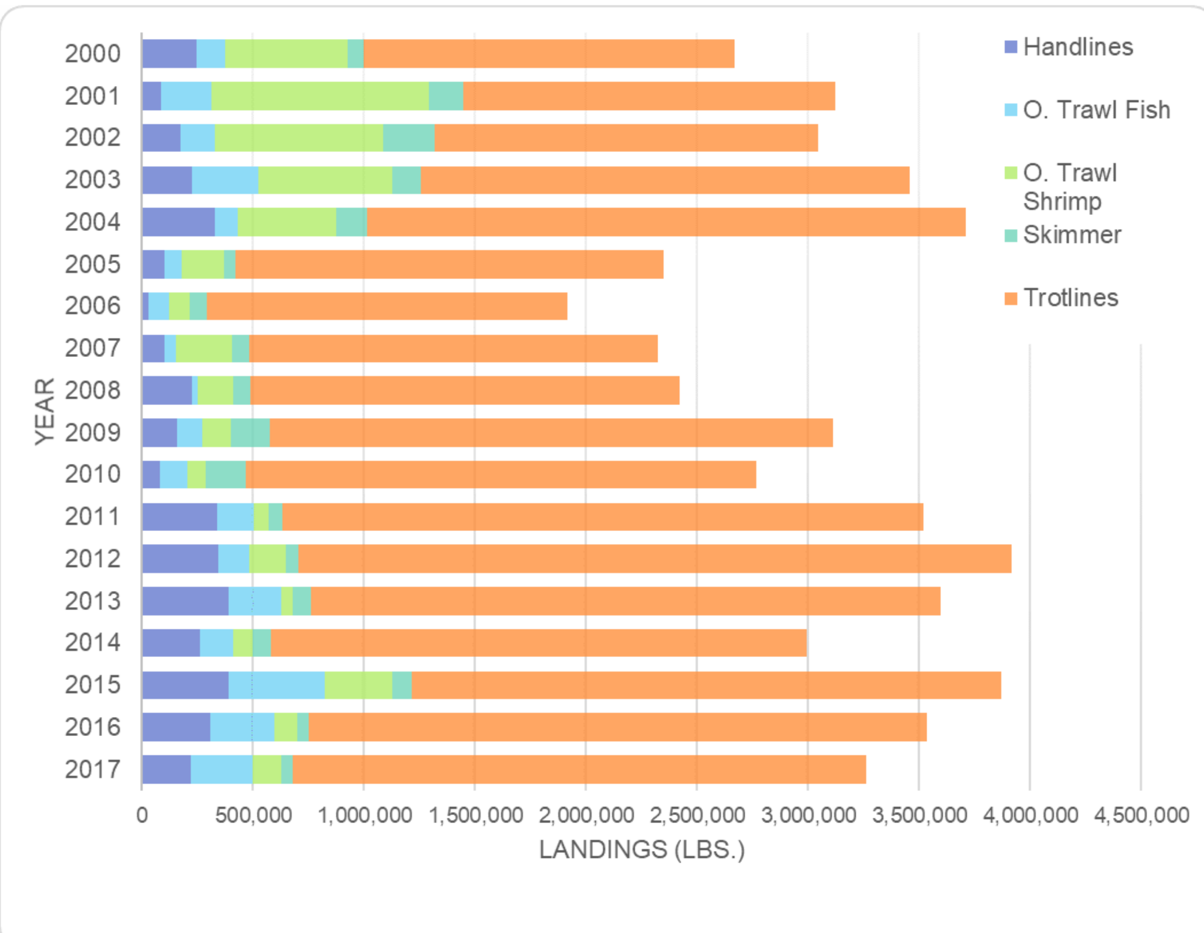

Figure 3. Annual landings of Black Drum (pounds) by most commonly used gear type, 2000-2017. Data source: 2019 Black Drum Fishery Management Plan.

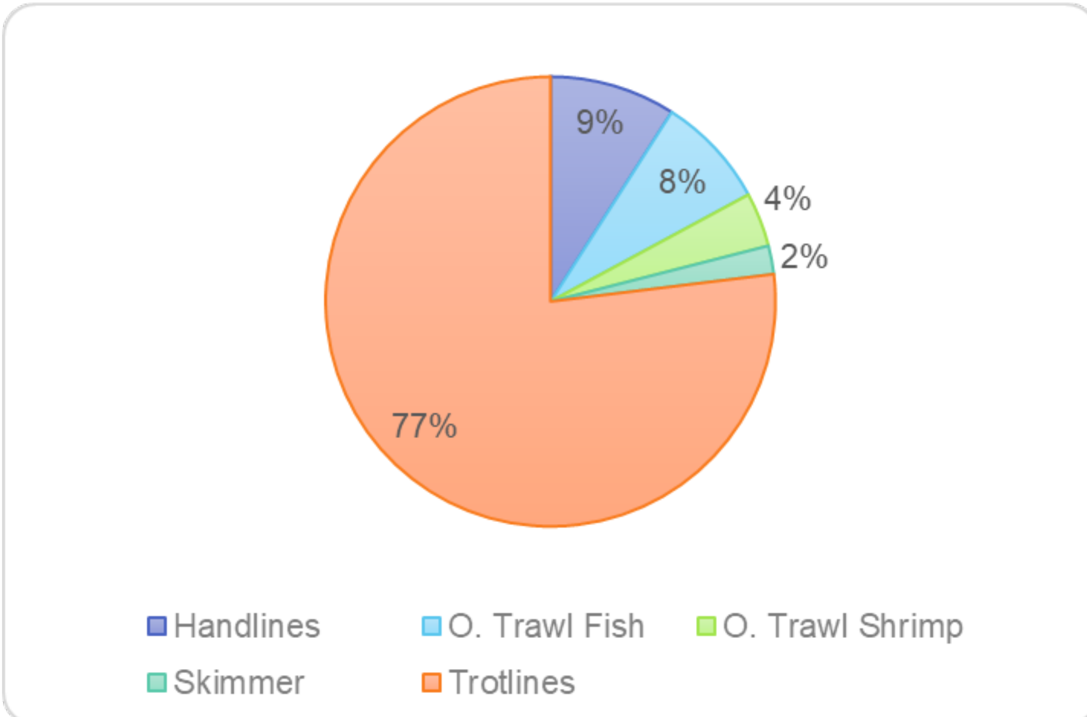

Figure 4. Black Drum landing gear types by percent of total landings (5-year average 2013-2107). Data source: 2019 Black Drum Fishery Management Plan.

METHODS

Through the Louisiana Fisheries Forward program (a joint venture between Louisiana Sea Grant and Louisiana Department of Wildlife and Fisheries [LDWF), we arranged for observers on commercial trotline fishing trips throughout 2020. For each trip, one observer would be aboard a fishing vessel and passively record characteristics (without engaging in fishing activities) about the trotline set and resulting catch. A *set* is the line or lines set out at one time that used between 100–1600 circle hooks at a unique coordinate location; throughout the study we use *set* as the observational unit because sets are spatially unique and take place across seasons. (Note, although state regulations required a maximum of 440 yards and 660 hooks per line set, our definition of *set* includes all lines with a shared coordinate, which is why some of our sets exceed 660 hooks.)

Observers recorded the *date*, *coordinates*, *number of hooks*, and *species* caught for each set. Size bins were based off LDWF size regulations and fish were visually estimated for size and often compared against reference measurements on the boat. Fate of each fish caught was also categorized into *caught* (for fish harvested) or *released* (for those returned to fishing grounds). Released fish were further categorized into *alive* or *dead*. Observers would look for any physical signs of death (missing flesh or body parts, a stiff body, and sunken or cloudy eyes), decomposition, or lack of movement. For signs of movement (alive), observers looked for movement of the gills and if the fish moved under its own power as the hook was removed. Additionally, upon release, swimming away indicated a live fish and floating indicated death. In general, we attempted to follow the Reflex Action Mortality Predictor (RAMP; Davis 2010) guidelines but were limited to gross physical observations.

In addition to the observed data, salinity and water temperature for each set was obtained from historical data from the National Oceanic and Atmospheric Administration (NOAA 2021) and United States Geological Survey (USGS 2021). Finally, we calculated *catch rate* as the number of individuals caught standardized to the number of hooks on a set.

Data Analysis

We used a two-way ANOVA with independent variables of *season* and *region* to test for differences in *target catch rate* and (in a separate ANOVA) *bycatch catch rate*:

$$y_i = \alpha + \beta_j x_{1i} + \delta_k x_{2i} + \varepsilon_i$$

where y_i is the *catch rate* of either target species or bycatch (both modeled but in separate models), α is the overall intercept, β_j is the effect of *season* (with *j* = 4 levels: winter, spring, summer, fall), x_{1i} is the indicator variable for *season*, δ_k is the effect of *region* (with *k* = 2 levels: Lake Calcasieu and Vermilion Bay), x_{2i} is the indicator variable for *region*, and ε_i is the residual error, assumed to be normally distributed with a mean of 0 and variance of σ^2. The subscript *i* is used to index the observation level and applied to observed variables in the model.

We used a simple linear regression to test for a relationship between *target catch rate* and *bycatch catch rate*, which would tell us whether bycatch increased, decreased, or was unaffected by target catch rate.

$$y_i = \alpha + \beta x_{1i} + \varepsilon_i$$

where y_i is the *bycatch catch rate* from set *i*, α is the intercept, β is the effect of *target species catch rate*, x_{1i} is the *target species catch rate*, and ε_i is the residual error, assumed to be normally distributed with a mean of 0 and variance of σ^2.

To evaluate environmental variables influencing dead discards, we took all events of any bycatch discards (of which dead discards, if any, are a component) and created a binomial response whereby 1 indicated dead discards present in bycatch and 0 indicate no dead discards present in bycatch. A binomial generalized linear model was used:

$$y_i = \alpha + \beta x_{1i} + \delta x_{2i} + \varepsilon_i$$

where y_i indicates the presence (1) or absence (0) of *dead discards* in the bycatch, α is the overall intercept, β is the effect of *water temperature*, x_{1i} is the *water temperature* in Celsius, δ is the effect of *salinity*, x_{2i} is the *salinity* in parts per thousand, and ε_i is the residual error, assumed to be normally distributed with a mean of 0 and variance of σ^2. The subscript *i* is used to index the observation level and applied to variables in the model. All models were run in R Version 4.2.0 (R Core Team 2022).

RESULTS

A total of 37 trips were originally arranged with commercial fishermen. However, due to COVID-19 restrictions and illness, engine trouble, other injuries, and other boat and weather issues, observations were made on 13 trotline trips (Table 1). Four of the trotline trips occurred in 2020 and 9 in 2021.

Table 1: Type and date of trip identified per fishermen (unique letter)

Season	Trips	Fishermen
Winter	1-24-20	A
Spring	3-6-20	A
Summer	7-29-20	A
Winter	11-4-20	A
Spring	3-16-21	A
Spring	3-17-21	A
Spring	3-30-21	A
Summer	6-4-21	B
Summer	6-17-21	C
Fall	8-25-21	B
Fall	10-6-21	B
Winter	11-12-21	B
Winter	12-10-21	A

A total of 59 trotline sets were observed on 13 different sampling dates ranging from 24 January 2020 to 15 December 2021. The COVID-19 pandemic (from lockdowns, travel restrictions, and temporary reduced markets for fish) both decreased the total number of sampling dates from our original design and extended the work in 2021. Additional sample events were lost due to engine trouble, weather, and other routine challenges common to commercial fishing.

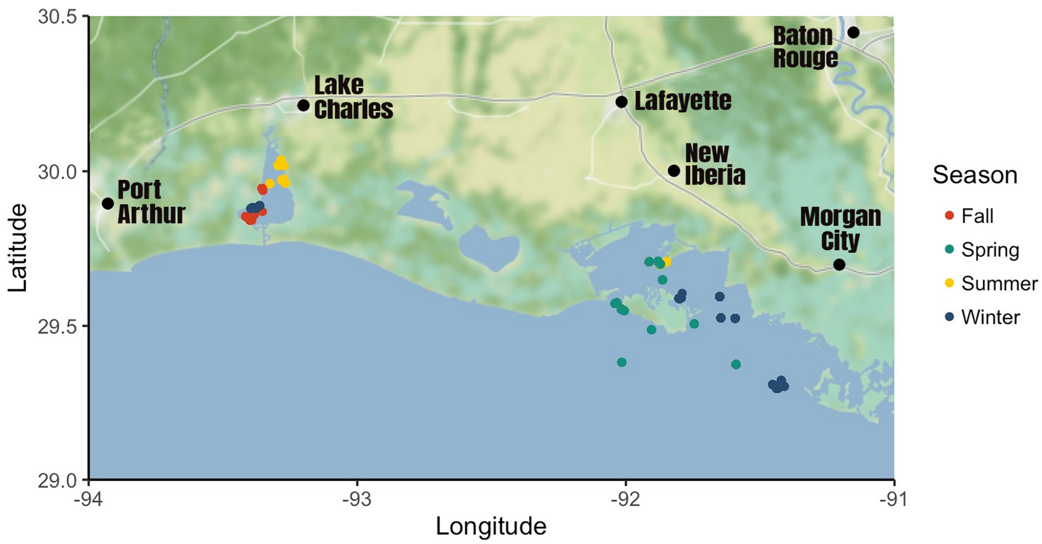

Figure 5. Location of trotline trips per season.

Between 2–8 sets were recorded on a given sampling date and in total 24,100 hooks were fished (ranging between 100 and 1600 hooks per set). Crab was used as bait in the vast majority of sets (86%) and due to its ubiquity, we did not analyze bait.

	Harvest	Release	Dead
Alligator Gar	1	4	0
Blue Crab	0	2	0
Black Drum	1022	458	1
Blacktip Shark	0	5	2
Freshwater Drum	2	5	0
Blue Catfish	48	226	6
Gafftopsail Catfish	5	171	37
Hardhead Catfish	180	318	10
Red Drum	0	183	1
Southern Flounder	0	1	0
Sheepshead	7	1	0
Stingray spp.	0	18	0

Seven species including Black Drum (the primary target species) made up 1265 individual fish that were caught and harvested comprising 81% of the harvest (Figure 6).

Twelve species made up 1392 individual fish that were caught and released, and of the releases only 57 fish (4% of the total bycatch represented by six species; Figure 6) were recorded as dead.

Figure 6. Counts of harvested, released bycatch, and dead bycatch species recorded from 59 trotline from 13 trips spanning January 2020 to December 2021. Counts are presented as numbers in the cells and cell colors correspond to the numbers.

The seasonal breakdown of released bycatch included 10 species, of which only 5 were represented in the dead bycatch (Figure 7). When considering all bycatch species that were released, Blue Catfish, Gafftopsail Catfish, Hardhead Catfish, and Red Drum were the four most commonly caught bycatch with species counts variable across seasons.

Blue Catfish and Hardhead Catfish peaked in abundance in the spring months, whereas not a single Gafftopsail Catfish was recorded in the spring. Red Drum were captured and released nearly uniformly across seasons.

Dead bycatch was rare (4% of total), and Gafftopsail Catfish in summer and fall accounted for the majority (65%) of dead discards.

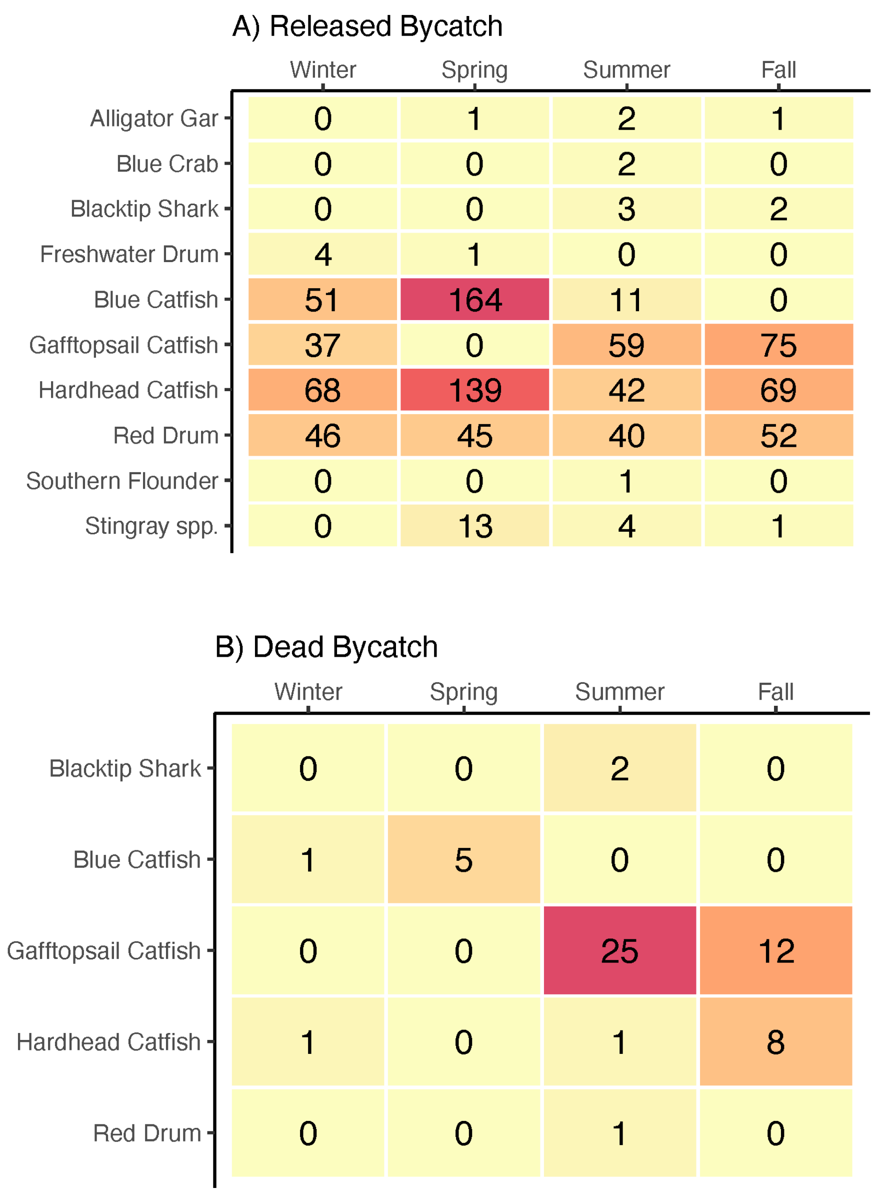

Figure 7. A) Released bycatch and B) dead bycatch species by season recorded from 59 trotline from 13 trips spanning January 2020 to December 2021. Counts are presented as numbers in the cells and cell colors correspond to the numbers (with color ranges endemic to each panel).

The effect of water temperature suggested that the probability of dead discards increased as water temperature increased but remained relatively low at only 25% at the warmest (summer) water temperatures.

Unless otherwise noted, we used *set* as the observational unit for statistical models, because a set is a collection of hooks on a trotline (or multiple trotlines if fished at the same coordinates) and represents an independent unit of inference. Although some sets occurred on the same day and therefore date could be considered the observational unit, 1) different sets on the same date were fished in different locations, and 2) an ANOVA looking at the effect of *date* on catch per unit of effort (CPUE) was non-significant and an intraclass correlation coefficient (Nakagawa et al. 2017) added to the linear regression for target vs bycatch catch rates was only 0.3, indicating weak evidence for an effect of *date*.

The two-way ANOVA (with Type II sums of squares) used to examine for effects of *season* and *region* on *target catch rates* reported no significant effect of *season* (F = 1.543 p = 0.214; Figure 2A), but a significant effect of *region* (F = 5.339, p = 0.0247; Figure 2B). Catch rates of Black Drum in Vermilion Bay were significantly higher than catch rates in Calcasieu Lake. The two-way ANOVA (with Type II sums of squares) used to examine for effects of *season* and *region* on *bycatch catch rates* reported no significant effect of *season* (F = 1.423 p = 0.246; Figure 2C) and no significant effect of *region* (F = 0.268, p = 0.607; Figure 2D).

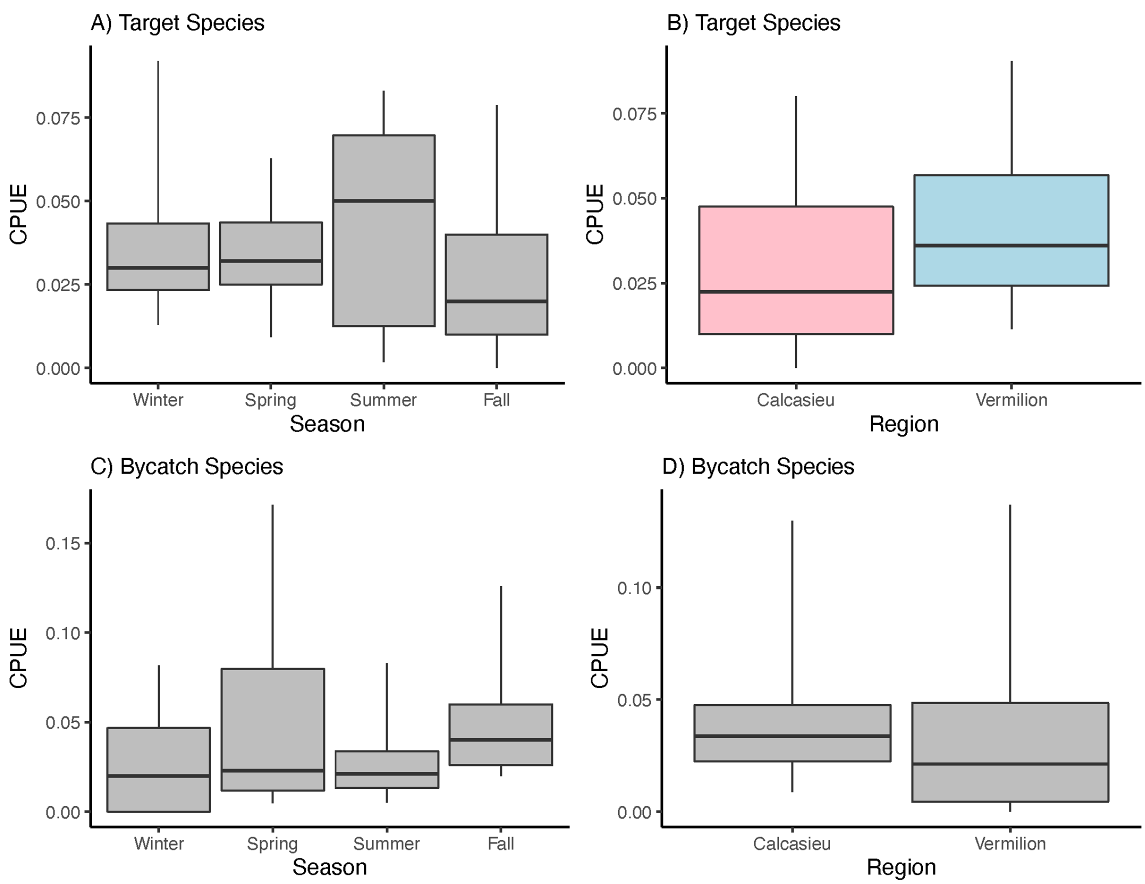

Figure 8. Boxplots of A) target species CPUE by season, B) target species CPUE by region, C) bycatch species CPUE by season, D) bycatch species CPUE by region. Panel B was the only comparison that found a statistically significant difference between groups, which is indicated by the different colors. For all boxplots, the box represents the interquartile range with the median shown by the thick black line within the box. Whiskers extend to the 95% quantiles.

DISCUSSION

Although bycatch remains a serious problem in many fisheries across the globe, bycatch is not a universal threat in all fisheries. The baited trotline fishery for Black Drum in Louisiana does encounter a moderate amount of bycatch when looking at the raw counts of fish: 1265 target fish compared to 1392 bycatch fish over 59 trotline sets. However, a closer look at the bycatch should reduce some of the concern.

First, bycatch was comprised of 33% Black Drum (the majority of which were oversized and outside the slot limit), 51% catfishes that have no known population issues, and 13% Red Drum. Second, only 4% of all bycatch was observed as dead—93% of which were catfish species. So, while the bycatch numbers appear relatively high, the bycatch species are commonly encountered and not distinctly different from the fishery; e.g., we did not observe marine mammals, sea turtles, or other species of concern. We acknowledge that bycatch we recorded as alive was based on behavior, which is imperfect data and results in a conservative mortality estimate; no discard survival or mortality was able to be estimated once the fish were released back in the water and we had to make assumptions about health and survival based on established characteristics and behaviors.

Ignoring the Red Drum and oversized Black Drum—both of which had negligible bycatch mortality, catfishes were the only other group that comprised a substantial portion of bycatch.

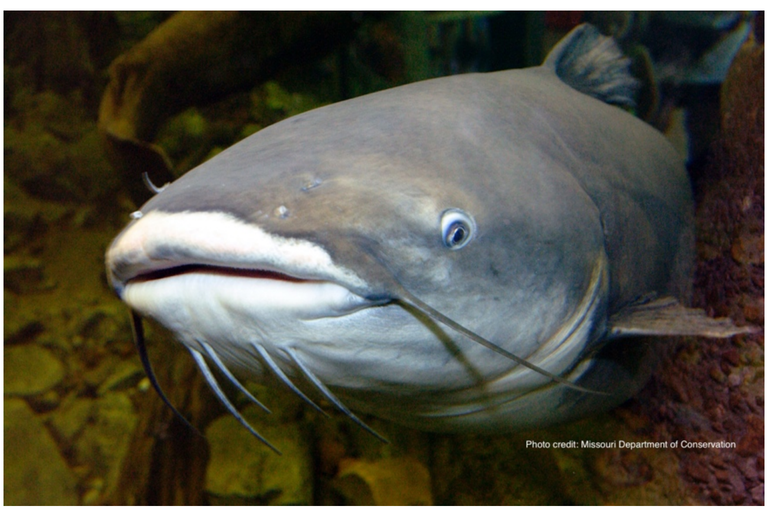
Photo credit: Missouri Department of Conservation

Blue Catfish are typically considered a freshwater catfish but can live in estuarine environments (Nepal and Fabrizio 2019) and are commercially and recreationally targeted. Gafftopsail and Hardhead Catfishes were recently found to have greater longevity than previously assumed (Flinn et al. 2019), yet still grow fast and reproduce relatively early in life (Pensinger et al. 2021). While knowledge of catfish populations in Louisiana waters is imperfect, no state assessments have been done as populations appear stable and no strong fishery exists for any particular catfish species, especially the marine catfishes. The near-complete disappearance of marine catfishes in the US Southeast Atlantic (Ballenger 2018) does serve as a cautionary note that without information even abundant species can quickly decline; however, it would be unwise to draw too many parallels to Atlantic Basin marine catfishes as the causes of the decline remain a mystery.

Although we focused on Black Drum throughout this study, Sheepshead are routinely included as a target species in the trotline fishery. Despite their targeted status, there were relatively few captures of Sheepshead, which have a smaller size limit than Black Drum and no annual harvest limit over a year-round season. Although we may have expected to see a greater proportion of Sheepshead in the landings, recent years have seen Sheepshead landings increase in the recreational sector—in some years the majority of landings are from the recreational fishery (West et al. 2020a).

Recent stock assessment work has concluded that both Sheepshead (West et al. 2020a) and Black Drum (West et al. 2020b) are not overfished with overfishing not occurring. With both species in good condition and some years in which the Black Drum harvest limit is not met, the resulting picture is of a trotline fishery that operates with very low bycatch mortality and no current threat to the target species. Despite the current success of Black Drum and Sheepshead management, future research should consider bycatch across different regions of coastal Louisiana and improving estimates of discard mortality.

ACKNOWLEDGMENTS

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