Simulation of a Commercial Saltwater Trotline Fishery

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Abstract: The commercial trotline fishery in the Laguna Madre, Texas, was simulated using fishery-independent sampling data to estimate landings of black drum (*Pogonias cromis*). Simulation of a commercial fishery can provide landings estimates and more precise estimates of confidence intervals. It can also provide information (i.e., by-catch) not available through self-reported systems.

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Knowledge of commercial catch and landings is needed to effectively manage fishery resources. Fishery managers usually rely on self-reported commercial information. Self-reporting programs generally do not provide reliable information to adequately assess a commercial fishery (Matlock 1982, Green and Thompson 1981). Biases in commercial catch and landings may be reduced if fishery-independent sampling can be used to mimic the commercial fishery.

The relatively small, localized commercial trotline fishery in the Laguna Madre is the most important bay commercial finfish fishery in Texas. The Laguna Madre has historically accounted for a majority of Texas' self-reported commercial finfish landings (Hamilton and Saul 1984). Trotlines have been the mainstay of the fishery since the early 1930s (Breuer 1973, 1974, 1975).

Previous Texas Parks and Wildlife Department (TPWD) studies demonstrated TPWD trotlines and commercial trotlines have similar catch rates and species composition when lines are identically fished (McEachron et al. 1986). The objective of the present study was to determine if an independent sampling program can mimic

the commercial trotline fishery in the Laguna Madre so that catch and landings can be estimated.

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Methods

TPWD mimicked the commercial trotline fishery using six 100-hook trotlines in both the upper and lower Laguna Madre during February 1985 through January 1986. Trotlines and fishing techniques were similar to those used by commercial fishermen (McEachron et al. 1987). TPWD trotlines were set only in areas where active commercial trotline operations were occurring; fishermen were contacted by telephone prior to each trotline set. Trotlines were set overnight 3 times each month in each of upper and lower Laguna Madre. Prior to sample initiation, the upper and lower Laguna Madre were divided into 1-minute latitude by 1-minute longitude grids for sampling purposes. On the morning TPWD trotlines were retrieved, all commercial trotlines in the sample grid and all contiguous grids were counted to identify total commercial activity. Up to 5 commercial trotlines were checked to obtain information on number of hooks used/trotline and number of fish caught by species/trotline.

The simulation used to estimate the total number of commercial trotlines fished per day in both upper and lower Laguna Madre was based on data from only those grids in which commercial trotlines were actually counted; the 2 bays were simulated separately. There were 18 and 25 such grids in upper and lower Laguna Madre, respectively, and the number of trotlines counted in a grid ranged from 0 to 18. The number of days any given grid was surveyed varied and ranged from 1 to 14. The number of commercial trotlines fished, in a day in each grid, was simulated by randomly selecting a number from the set of trotline numbers counted in different survey days for that grid. All random assignments in the simulations were based on random number function RANUNI from SAS (SAS Inst. 1985). The total number of commercial trotline sets/day for each bay system was the sum of the random assignments across all grids in each bay. The simulation was repeated 1,000 times.

TPWD crews counted the number of hooks on 66 commercial trotlines in the upper Laguna Madre (range 28–142 hooks/trotline) and on 70 in lower Laguna Madre (range 43–125). Each simulated trotline was randomly assigned a commercial trotline hook number. For each bay, catch data were available from 162 TPWD trotline sets. Each of these catches were randomly assigned to a commercial trotline. Since TPWD trotlines were standardized at 100 hooks/trotline, the catch on simulated commercial trotlines was adjusted to the catch of commercial hooks (TPWD catch

× commercial hooks/100). Trotline catches were summed for each simulation; 1,000 commercial trotline catches/day were simulated for each bay.

There were 194 legal fishing days during the study year; only trotlines fished on weekdays were legal. Summer (Jun–Aug) was excluded from simulation because no commercial trotline activity occurred during this period. A yearly total trotline catch was estimated by randomly choosing 194 catches out of 1,000 summing the daily estimates. This simulation was also repeated 1,000 times.

Mean and variance of total fish caught/year/bay for the 1,000 commercial trotline simulations were calculated for black drum, spotted seatrout (*Cynoscion nebulosus*), red drum (*Sciaenops ocellatus*), and all other species combined. Results of the simulation were compared to the mean of total fish caught/year/bay (Y) independently derived using the following equation (equation 1)

$$Y = T \times H \times C \times 194$$

where T = mean total number of commercial trotline sets/day/bay, H = mean hook number/100/commercial trotline, and C = mean catch/TPWD trotline set.

Using the whole weight-total length relationship developed by Harrington et al. (1979), the mean and variance of the weight (kg) of black drum were estimated so comparisons with commercial reported landings could be made. Total weight of fish caught/year was estimated by multiplying these values by the total catch. The variance (V) of total weight was estimated based on Goodman (1960) (equation 2)

$$V = (\text{mean total catch})^2 \times (\text{V of mean weight/fish}) + (\text{mean weight/fish})^2 \times (\text{V of mean total catch}) - (\text{V of mean weight/fish}) \times (\text{V of mean total catch}).$$

Results and Discussion

Results from the simulation showed the annual mean commercial trotline catch (±2 SE) in the Laguna Madre was 241,042 (±5,802) fishes during February 1985 through January 1986, including 24,313 (±813) black drum, 58,445 (±1,999) red drum, 6,868 (±250) spotted seatrout, and 151,416 (±5,380) other fishes. Simulated weight of black drum caught in upper and lower Laguna Madre was 71,560 ± 6,920 kg. The simulated catch was only 37% of the 192,902 kg reported bought by seafood dealers from Laguna Madre fishermen. This discrepancy could be due to 1) values used for simulation not representative of the commercial trotline fishery, or 2) landings from gears other than trotlines.

Apparently, commercial fishing gear other than trotlines fished on weekdays was the primary source of fish caught in the Laguna Madre. Illegal nets or trotlines and legal otter trawls were major gears used. For example, no trotline activity was reported during summer by commercial trotliners, coastal law enforcement personnel, or TPWD staff; however, commercial fishermen reported landing about 13,900 kg of black drum, mostly from upper Laguna Madre (Osburn et al. 1986). Our simulations also excluded weekends because trotlining was not allowed. But illegal trotlines were confiscated on weekends (TPWD, unpubl. data). Illegal netting

was widespread during the study period, and fishermen probably reported illegal gill net catches of black drum as legal trotline catches (Hal Osburn, pers. commun.). Additionally, there was an otter trawl fishery in upper Laguna Madre from which at least 50,000 kg of black drum were legally harvested (Marvin Tamez, pers. commun.). Therefore, we believe our estimates accurately reflect legal commercial trotline catches and landings.

Our results show that an independent sampling program mimicking commercial gear and methodology can be used to estimate commercial catch. This approach, using simulation, provides an estimate of mean catch and, more importantly, a less biased and more precise estimate of the variance and confidence intervals (approximated by 2 SE). Estimated mean catch derived from the simulation approximated the mean catch calculated from equation 1 indicating correct simulation algorithm (<1% difference).

Several items must be considered by fishery managers when considering estimating catches in a commercial fishery by simulation. Cost estimates probably require most concern. In our study about 4,000 field man-hours were expended with an additional $4,500 being spent on equipment, maintenance, and travel. The simulation generated information not available from self-reported landings such as catch rates and unretained or illegally landed by-catch. Based on the results of the present study, fishery managers should consider simulation if required commercial data cannot be obtained through other methods and if costs are not prohibitive.

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