# Hooking Mortality of Channel Catfish Caught by Trotline

**Richard A. Ott, Jr.**, *Texas Parks and Wildlife Department, Route 10, Box 1043 Tyler, Texas 75707*

**Kevin W. Storey,** *Texas Parks and Wildlife Department, Route 10, Box 1043 Tyler, Texas 75707*

*Abstract:* We assessed trotline hooking mortality of channel catfish (*Ictalurus punctatus*) at Lake Palestine, Texas, from June through September 1989. Our objective was to estimate trotline hooking mortality of channel catfish using 3 hook types and identify factors relating to that mortality. Fish collected by trotline were confined for 72 hours in submerged cages. We examined relations between percent mortality and hook type, water temperature, and oxygen concentration using logistic analysis. A total of 214 channel catfish were collected by trotline; 40 (19%) were dead at the end of the 72-hour confinement period. Oxygen concentration was the only variable significantly related to mortality ($P = 0.002$). Our results indicate channel catfish have >80% chance of survival when caught on trotline and released, even under stressful conditions such as high water temperature, variable oxygen concentration, and confinement.

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Hooking mortality, defined as mortality induced by the catch (hook and line) and handling of a fish subsequent to release, is an important consideration prior to implementation of harvest regulations. If survival of released fish is low, restrictive size and bag limits may not be effective. Although channel catfish (*Ictalurus punctatus*) harvest in Texas is regulated through the use of size and bag limits, little information regarding their hooking mortality is available. Rutledge (1975) estimated channel catfish hooking mortality by rod and reel. However, channel catfish are also efficiently harvested by trotline (White 1962). Because hooked fish often remain on trotlines for a longer time than those caught on rod and reel, potential for stress increases, and results of rod and reel evaluations may not be comparable. Hooking mortality by trotline has been assessed for several marine species (Martin et al. 1987); however, studies involving freshwater species are not readily available. In evaluating trotline hooking mortality, consideration must also be given to hook type. McEachron et al. (1985) reported that Circle-Sea$_{TM}$ hooks, required by law for trotlines on the Texas coast, can reduce the percentage of foul hooking (hooking in areas other than the lip or mouth). The objective of our study was to estimate hooking mortality of channel catfish by trotline, using 3 hook types, and identify factors relating to that mortality.

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## Methods

We assessed trotline hooking mortality of channel catfish in 1989 at Lake Palestine, a 10,320-ha impoundment of the Neches River in East Texas. We set trotlines from June through September when previous creel surveys indicated angling activity for catfish was highest (Texas Parks and Wildl. Dep., unpubl. data). Trotlines were of conventional design, similar to "sets" described by White (1962). Each set consisted of a "main line" with 25 drops (Johnson 1987) and hooks. Main lines were braided nylon (167 kg), 47 m long, anchored at each end, and marked with buoys. Three small anchors and floats positioned the main line approximately 0.6 m off the bottom. Drops were 0.4 m multi-strand nylon (No. 9) with a size 5 black interlock snap on 1 end and the hook on the other. We spaced drops 1.25 m apart, starting 7.8 m from each end of the main line.

We used similar size hooks of 3 types: Limerick, Circle-Sea$_{TM}$, and Kahle$_{TM}$ (Fig. 1). We chose 3/0 Limerick hooks due to their popularity with local trotline anglers. We chose 10/0 Circle-Sea hooks because this hook type is required by law for trotlines in Texas coastal waters (McEachron et al. 1985). We chose 3/0 Kahle hooks because of their increasing use with live bait in other fisheries.

We set trotlines in 2 locations approximately 1 km apart in the central section of the reservoir. We conducted 8 replicates each with the Limerick and Kahle hooks, but only 5 with the Circle-Sea because of delayed availability. Each replicate consisted of 4 25-hook sets with each hook type except for the first Circle-Sea set when only 8 hooks were available. Sets were equally distributed between the 2 sampling areas to reduce bias. All sets were approximately 2.5 m deep. Oxygen

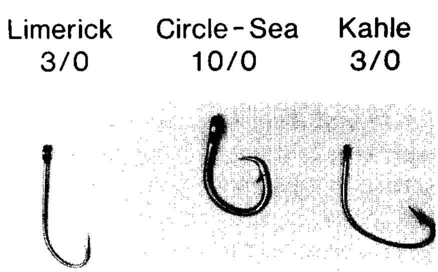


**Figure 1.** Three types of hooks used in assessment of trotline hooking mortality, Lake Palestine, Texas, June–September, 1989. Hooks shown to scale.

concentration and temperature were measured at both sampling areas with a YSI meter each sampling day to insure trotlines were not set below the thermocline. We baited trotlines in the evening with shrimp or liver (chicken, beef, or pork depending on availability), and removed fish the following morning. Bait types were equally distributed between the sampling areas to reduce bias.

We handled fish in a manner similar to that used by anglers. Small fish were lifted aboard by the drops, larger fish were netted. Each fish was grasped behind the head and hooks were removed by hand or with pliers. Fish from each set were placed on a 300-liter non-recirculating holding tank and transported 0.5–1.0 km to 1 of 3 centrally located holding cages according to hook type. No fish remained in the holding tank for more than 30 minutes and water was changed between each set. Holding cages were 16.8 $m^3$ with 1.2-$cm^2$ polyethylene mesh covering a 1.9-cm PVC-pipe frame, similar to those described by Masser (1988) for channel catfish cage-culture. We tied holding cages to inundated timber 2 m below the surface and approximately 50 m apart. Dissolved oxygen concentration and temperature at the cages were recorded for each repetition after the first fish were placed in the cages. Fish were confined for 72 hours, beginning when the first fish was placed in the cages. At the end of 72 hours, we measured each specimen to the nearest mm (TL) and determined if they were alive or dead as indicated by opercular movement. We defined mortality rate for each hook type as number dead after 72 hours divided by number caught by that hook type. Fish that were dead when removed from trotlines were included in the 72-hour mortality estimates.

We partitioned data in multiway contingency tables using the SAS (1988) Proc Freq procedure. Hook type and life status (alive or dead) were categorical explanatory variables; water temperature, and dissolved oxygen were continuous explanatory variables. Number in each life status at the end of 72 hours was the response variable. We used logistic analysis (Agresti 1990) to model mortality as a function of the predictor variables. Logistic analyses were performed using the SAS Catmod Procedure. We fitted models repeatedly beginning with a model containing all of the explanatory variables and estimable interactions. Explanatory variables and their interactions that did not contribute significantly to the model were systematically eliminated. This process continued until the simplest model still generating predicted values not significantly different from observed values resulted. Our threshold level of statistical significance was set at $P \geq 0.05$.

## Results

We collected a total of 214 channel catfish by trotline. Individual specimens ranged in length from 18 to 53 cm with most in the 27 to 43 cm range (Fig. 2). Total mortality was 19% (Table 1). Mortality rates for individual replicates of the 3 hook types ranged from 0% for all 3 hook types to highs of 31% for Limerick, 20% for Circle-Sea, and 50% for Kahle. However, logistic analysis was unable to detect any significant relationship between mortality and hook type.

Water temperature, recorded at the cages, ranged from a high of 30.0 C in July

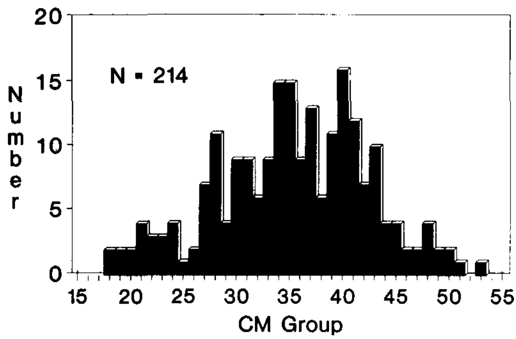


**Figure 2.** Length-frequency of channel catfish collected by trotline, Lake Palestine, Texas, June–September, 1989.

**Table 1.** Results from individual repetitions of channel catfish hooking mortality by trotline conducted at Lake Palestine, Texas. Water temperature and dissolved oxygen recorded when fish were placed in cages. Mortality assessed after 72-hour confinement.

| Date | Water temperature (C) | Dissolved oxygen (mg/ml) | Hook type | Life status Alive (*N*) | Dead (*N*) | Mortality (%) |
|---|---|---|---|---|---|---|
| 27 Jun 1989 | 26.5 | 6.7 | Limerick | 7 | 0 | 0 |
| | | | Circle-Sea | | | |
| | | | Kahle | 4 | 0 | 0 |
| 07 Jul 1989 | 30.0 | 7.1 | Limerick | 7 | 0 | 0 |
| | | | Circle-Sea | | | |
| | | | Kahle | 4 | 0 | 0 |
| 11 Jul 1989 | 29.0 | 6.3 | Limerick | 17 | 4 | 19 |
| | | | Circle-Sea | | | |
| | | | Kahle | 12 | 4 | 25 |
| 14 Jul 1989 | 29.0 | 5.8 | Limerick | 9 | 4 | 31 |
| | | | Circle-Sea | 0 | 0 | |
| | | | Kahle | 8 | 4 | 33 |
| 01 Aug 1989 | 29.5 | 6.8 | Limerick | 28 | 5 | 12 |
| | | | Circle-Sea | 10 | 1 | 9 |
| | | | Kahle | 10 | 2 | 17 |
| 09 Aug 1989 | 28.0 | 5.9 | Limerick | 8 | 3 | 27 |
| | | | Circle-Sea | 4 | 1 | 20 |
| | | | Kahle | 7 | 7 | 50 |
| 22 Sep 1989 | 25.0 | 8.3 | Limerick | 14 | 1 | 7 |
| | | | Circle-Sea | 5 | 0 | 0 |
| | | | Kahle | 4 | 1 | 20 |
| 25 Sep 1989 | 24.5 | 7.0 | Limerick | 8 | 1 | 11 |
| | | | Circle-Sea | 4 | 0 | 0 |
| | | | Kahle | 4 | 2 | 33 |
| | | | Totals | 174 | 40 | 19 |

**Table 2.** Results of logistic analysis on channel catfish hooking mortality by trotline data, Lake Palestine, Texas, June–September, 1989.

| Model | Likelihood ratio chi square | df | Probability |
|---|---|---|---|
| Intercept | 5.95 | 1 | 0.0147 |
| Oxygen concentration | 9.55 | 1 | 0.0020 |
| Likelihood ratio | 8.32 | 6 | 0.2159 |

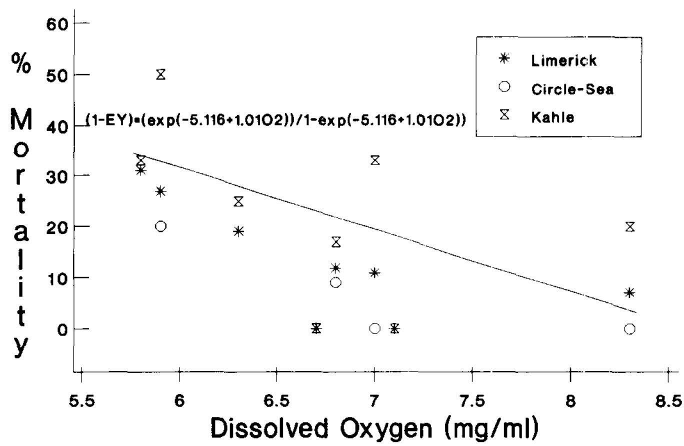


**Figure 3.** Scatter plot and best fit line of hooking mortality against dissolved oxygen, Lake Palestine, Texas, June–September, 1989.

to a low of 24.5 C in September (Table 1). Logistic analysis was unable to detect any significant relationship between water temperature and mortality rate.

Lowest dissolved oxygen (5.8 mg/ml) was recorded in July and highest (8.3 mg/ml) was recorded in September. Mortality was highest in the cages with the lowest dissolved oxygen and this was the only parameter tested that was a significant predictor of mortality rates (Table 2). The best fit model (simplest model that still fits the data) is described by the equation $1 - EY = [\exp(-5.1165 + 1.009609\ O_2)] / [1-\exp(-5.1165 + 1.009609\ O_2)]$ (Fig. 3), where $1 - EY$ is the predicted mortality rate and $O_2$ is oxygen concentration (mg/ml).

## Discussion

Total 72-hour mortality rate for our study (19%) is considerably below the 33% reported by Rutledge (1975) for channel catfish caught by rod and reel. Some of the difference may be due to the longer confinement period for the rod and reel study (144 hours vs. 72 hours). However, the peak daily mortality rate in the 144-hour study did occur on the third day (Rutledge 1975). Klein (1965) reported the same phenomenon with rainbow trout (*Oncorhynchus mykiss*) when most mortality occurred within 3 days of capture.

Estimated hooking mortality of channel catfish by trotline in our study compares favorably with mortality rates reported for largemouth bass (*Micropterus salmoides*) caught by tournament anglers where fish are handled as carefully as possible (Schramm et al. 1985, and Schramm et al. 1987). In addition, hooking mortality in our study was below that reported for other species caught by trotline during summer (33% and 55% for black drum (*Pogonis cromis*) and spotted sea trout (*Cynoscion nebulosis*), respectively) (Martin et al. 1987).

Positive relationships between water temperature and hooking mortality have been reported for salmonids (Klein 1965, Marnell and Hunsacker 1970, Hunsacker et al. 1970, Wydoski et al. 1976, Dotson 1982), centrarchids (May 1972, Welborn and Barkley 1974, Holbrook 1975, Moody 1975, Seidensticker 1975, Rutledge and Prichard 1977, Pelzman 1978, Schramm et al. 1985, Childress 1989), and sciaenids (Hegan et al. 1984, Martin et al. 1987). Previous research with channel catfish indicated a similar relationship (Rutledge 1975). However, we were unable to find any significant relationship in our study. It is possible that other factors contributing to hooking mortality masked the effect of temperature in the limited range we tested.

Although oxygen concentration has been recorded in other hooking mortality studies (Bouck and Ball 1966, Archer and Loyacano 1975; Schramm et al. 1985, Schramm et al. 1987), we were unable to find any in which the relationship between oxygen concentration and mortality rate was defined as significant. Oxygen concentration was the only explanatory variable significantly related to mortality rate in our study. However, the levels we recorded remained above the 5.5 mg/ml level established by the Environmental Protection Agency as a 30-day minimum mean for channel catfish (U.S. Environ. Protection Agency 1986). In reality, if the released fish were free to seek out a preferred oxygen concentration, as would normally be the case, mortality rate may have been lower than we recorded. Hegan et al. (1984) reported, "the hardships encountered by fish during cage studies are far greater than those caused by routine capture and handling by biologists or by recreational fisherman." Matlock and Dailey (1981) speculated "fish released by recreational anglers in the wild may be able to reach less stressful environments".

If harvest regulations are to be an effective tool for fisheries managers, released fish must have a high probability for survival. Results from this study indicate channel catfish have a >80% chance of survival when caught on trotline and released, even under stressful conditions such as high water temperature, variable oxygen concentration, and confinement.

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