

# Evaluation of an Entanglement Gear Fishery in an East Texas Mainstream Reservoir

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*Abstract:* A creel survey was conducted from 1 September 1990 through 31 August 1991 to estimate fishing pressure and catch rates, initial mortality, and value of fishes captured in an entanglement gear fishery at Wright Patman Reservoir, Texas. Mean daily net fishing pressure ranged from 3,508 m/day (fall) to 763 m/day (summer). Commercial nets accounted for 85% of the annual netting pressure. Catch rates of sport and commercial fishes declined as bar mesh size increased from 76 to 102 mm. Smallmouth buffalo (*Ictiobus bubalus*) was the dominant species represented in entanglement gear, comprising 70% of all fish and 84% of the rough fish/catfish captured. By-catch of sport fishes in nets was highest during winter months (12.7 fish/1,000 m of net) and represented 41% of that season's catch. Crappies (*Pomoxis* spp.) were the dominant sport species represented in nets, comprising 55% of the sport fish and 8% of all species captured. Most sport fishes captured in entanglement gear were legal-sized adults. Annual initial netting mortality of sport fishes was 14.6%; largemouth bass (*Micropterus salmoides*) experienced the highest rate (37.5%). The estimated monetary cost to the resource from netting was \$72,402; of that, \$48,116 represented potential commercial value. Monetary loss of sport fishes as a result of netting-induced mortalities was \$24,286, translating into a cost of \$1.00 to the recreational fishery for every \$2.00 of commercial value of rough fish/catfish.

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A controversial topic in fisheries management during the past several decades has been the issue of commercial net fishing (Houser 1957, Seidensticker 1976, Heitman and Van Den Avyle 1978, Bronte and Johnson 1983, Timmons et al. 1989). Proponents argue that the harvest of unexploited stocks of commercially important fishes provides income to commercial fishermen and helps control rough fish populations, thereby enhancing sport fisheries. Opponents of commercial fishing cite concerns related to negative impacts of commercial fishing activity on non-target sport fish populations.

There have been numerous studies conducted to evaluate by-catch and mortality of sport fishes captured in entanglement gear. Generally, studies have shown catch rates of non-target species are low in entanglement gear (Seidensticker 1976, Heitman and Van Den Avyle 1978, Bronte and Johnson 1983, Timmons et al. 1989). Although by-catch is usually low, initial mortality of sport fishes captured in entanglement gear maybe relatively high. Bronte and Johnson (1983) reported 35% of the sport fishes captured in commercial nets suffered initial mortalities at Lake Barkley and Kentucky Lake; initial mortality rates for sauger (*Stizostedion canadense*) and white crappie (*Pomoxis annularis*) were 67% and 45%, respectively. Total mortality (initial and delayed) of crappies (*Pomoxis* spp.) and largemouth bass (*Micropterus salmoides*) removed from commercial gill nets at Whitney and Rayburn Reservoirs, Texas were 100% and 88%, respectively (Seidensticker 1976).

Commercial and sport net fishing were legal methods of harvesting rough fishes and catfishes as defined in Texas Parks and Wildlife Laws (Texas Parks and Wildl. Dep. 1984) in 32 of the 254 counties in Texas until 1 September 1991. The minimum length limit for channel catfish (*Ictalurus punctatus*) and blue catfish (*I. furcatus*) was 229 mm with a bag limit of 25 fish per day in the aggregate. Flat-head catfish (*Pylodictis olivaris*) was considered a sport fish and could not be retained by net fishermen. No limits applied to rough fishes.

Under existing regulations, commercial and sport fishermen could legally use entanglement gear (gill, trammel, and flag nets) and entrapment gear (hoop nets) having  $\geq 76$ -mm bar mesh. Entanglement gear was the principal gear type utilized by net fishermen in Texas reservoirs. There were no restrictions on the number of nets fishermen could set, but entanglement gear could not exceed 549 m/set. Entanglement gear was required to be fished at the surface, with one float attached for each 1.8 m of line. All nets were also required to have tags affixed at each end showing the owner's name, address, and date the net was set.

A resident commercial fishing license (\$15.00) was required in order for fishermen to sell their harvest. Commercial fishermen also had to purchase a \$10.50 freshwater commercial fishing boat license. In addition, seine/net tags (\$2.00 each) had to be attached at 30.5-m intervals on entanglement gear. Sport net fishermen who harvested rough fishes and catfishes for personal consumption were required only to possess a resident freshwater fishing license (\$13.00).

As a result of concern by recreational anglers over possible negative impacts to the sport fishery from netting and violation of harvest regulations by net fishermen, the Texas Parks and Wildlife Department (TPWD) Commission acted to ban net fishing in Wright Patman Reservoir and the Sulphur River drainage effective 1 September. This study was conducted prior to implementation of the ban in order to gather supplemental baseline data for use in evaluating effects of net fishing in other fresh water bodies of the state.

The objective of this study was to estimate seasonal and annual net fishing pressure and catch rate, initial mortality, and values of commercial and sport fishes captured in an entanglement gear fishery at Wright Patman Reservoir, a Texas impoundment where entanglement gear was legal.

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## **Methods**

### **Study Area**

Wright Patman Reservoir is located in Northeast Texas in Bowie and Cass counties, approximately 32 km southwest of Texarkana. The mainstream reservoir was constructed on the Sulphur River in 1956 by the U.S. Army Corps of Engineers for flood control and municipal water supply. It covers 8,100 ha (67 m msl) and has a mean depth of 2.3 m. The reservoir is moderately turbid, with Secchi disk transparency ranging from 30 to 61 cm. The drainage area is 8,917 km<sup>2</sup> and the reservoir is subjected to rapid fluctuation in water levels.

### **Sampling Procedures**

A creel survey was conducted from 1 September 1990 through 31 August 1991 to assess net fishing pressure and catch rates of fishes captured in the entanglement gear fishery. Sampling was divided into quarters: fall (September through November); winter (December through February); spring (March through May); and summer (June through August). A total of 9 days (4 weekdays and 5 weekend days) were randomly selected and surveyed each quarter. Surveys began at sunrise when most net fishermen were running their gear and lasted 6 hours.

The reservoir was divided into 9 sections, and roving boat surveys in 2 randomly selected sections were utilized each survey day. Creel clerks inspected each entanglement net observed in assigned sections. The owner's name, mesh size, type of webbing, length, and type of entanglement gear (gill, trammel, flag) was recorded for each net. Length of each net (m) was estimated with a rangefinder (Ranging 500, Ranging, Inc., Rochester, N.Y.). Nets were categorized as commercial, sport, or illegal. Entanglement gear not meeting legal specifications or observed without required identification and/or seine tags was considered illegal.

Net fishing pressure was estimated by tabulating the number of nets and total length of nets from assigned sections and expanding these data to estimate pressure for the entire reservoir. Total length of nets were calculated according to day-type and mesh size and expanded by the number of days of that type per quarter.

Catch in entanglement gear was obtained using 2 methods. The first involved observations made by a creel clerk as commercial fishermen retrieved their nets.

Fishes were measured in 25-mm length groups as they were removed from the net. The second involved inspection of unattended nets as they were encountered by creel clerks during roving creel surveys. Nets were lifted and the captured fish were measured with a meter stick without being removed. Mean weights of each species by 25-mm length group were estimated according to Childress (1989). Number of dead fish observed in all nets were recorded to obtain initial mortality estimates.

Gross values of rough fish/catfish captured in nets were calculated by multiplying the mean weight (kg) of each 25-mm length group of each species by the estimated annual yield (total number of each size of each species) and multiplying the product by the mean wholesale price. The mean wholesale price, procured from local fish markets, was \$0.66/kg for buffalo (*Ictiobus* spp.) and \$1.54/kg for catfishes (*Ictalurus* spp.). Whole weights were utilized to determine value. Market value for other rough fishes was insufficient to generate much interest among commercial fishermen, and non-preferred species were generally not retained. Although commercial netters only retained live fish for sale, dead fish from the nets were also lost from the fishery. Further, it was assumed sport netters behaved like commercial netters. Therefore, monetary values of rough fish/catfish species were based on the estimated total number of fishes captured.

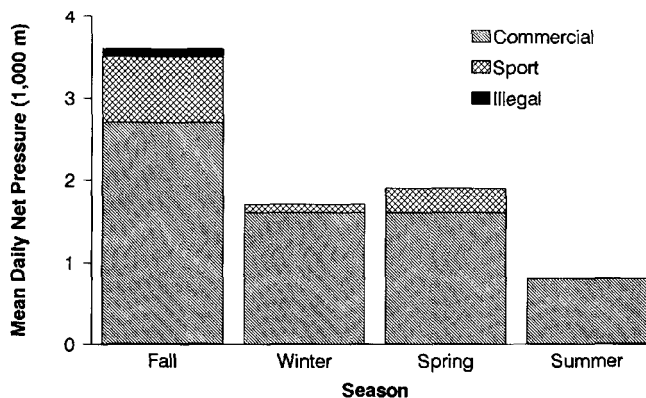
Values of sport fishes lost to netting were estimated similarly using replacement costs listed in Monetary Values of Freshwater Fish (Am. Fish. Soc. 1982). However, since it was illegal to retain sports fishes captured in nets, it was assumed individuals released alive from nets were not lost from the fishery. Monetary values were calculated based on the product of the estimated annual yield and initial mortality rate for each species. These values were then adjusted to account for inflation and recreational values to determine the total recovery value (Texas Register 1986).

## Results

Mean Daily Netting Pressure (MDNP) was highest during the fall (3,508 m/day) and generally declined thereafter (Fig. 1). Commercial nets comprised 85% of the annual net fishing pressure with MDNP ranging from 2,715 (fall) to 763 (summer) m/day. Illegal nets accounted for only 1.3% of all netting pressure.

Catch rates of rough fish/catfish were higher than those of sport fishes during all seasons (Table 1). Buffalo were the dominant fishes harvested with highest catch rates occurring in spring. Smallmouth buffalo (*I. bubalus*) exhibited the highest seasonal catch rates of all fishes captured in entanglement gear (Table 1). Channel and blue catfishes were the only other species that were consistently retained by net fishermen; however, catch rates were low.

Catch rates of all sport fishes combined ranged from 12.7 fish/1,000 m during winter to 2.6 fish/1,000 m during summer (Table 1). Crappie were the dominant sport fishes represented with higher catch rates occurring in winter and spring. Most sport fishes (95.2%) caught in nets were legal-size adults and within preferred size ranges as described by Gabelhouse (1984).



**Figure 1.** Seasonal mean daily netting pressure by fishermen using entanglement gear, Wright Patman Reservoir, Texas, 1 September 1990–31 August 1991.

Catch rates of almost all species were highest in nets having 76-mm bar mesh webbing (Table 2). Catch rates of sport and rough fishes declined as mesh size increased.

Initial mortality of fishes captured in nets ranged from 0.0 to 41.7% (Table 1). Initial mortalities of sport fishes averaged 14.6%, ranging from 12.3% during the fall to 17.5% during the summer (Fig. 2). Largemouth bass suffered the highest annual rates of initial mortality (37.5%) of all sport fishes captured in entanglement gear.

The estimated annual monetary value of rough and sport fishes caught in entanglement gear on Wright Patman Reservoir was \$72,402 (Table 3). Of that total,

**Table 1.** Summary of catch statistics captured in entanglement gear, Wright Patman Reservoir, Texas, 1 September 1990–31 August 1991.

Species	Catch rate (fish/1,000 m)				Mean length (mm)	Range (mm)	Initial mortality (%) <sup>a</sup>
	Fall	Winter	Spring	Summer			
<b>Commercial fish</b>							
Lognose gar	0.1	0.5	0.4	0.5	991	483–1,372	41.7
Spotted gar	0.7	0.1	0.4	0.5	660	483–787	30.8
Common carp	1.9	0.8	3.7	4.7	610	381–787	2.4
Smallmouth buffalo	46.6	14.0	48.5	37.7	483	356–864	1.0
Bigmouth buffalo	0.4	0.1	0.3	0.9	610	457–813	15.4
Channel catfish	0.1	1.0	1.0	0.5	381	254–559	10.0
Blue catfish	0.0	0.0	0.6	0.2	584	330–711	0.0
Freshwater drum	2.5	0.4	1.6	2.8	356	254–508	16.1
Total rough fish/catfish	52.3	16.9	56.5	47.8			
<b>Sportfish</b>							
Flathead catfish	2.1	0.6	2.3	1.5	610	432–711	2.0
White bass	0.4	2.7	0.6	0.1	381	330–432	17.2
Largemouth bass	0.7	2.1	0.0	0.4	432	279–559	37.5
White crappie	2.5	6.9	6.5	0.6	356	152–406	18.3
Black crappie	0.0	0.4	0.0	0.0	330	330–356	0.0
Total sport fish	5.7	12.7	9.4	2.6			

<sup>a</sup> Actual netting mortality which was not weighted by season.

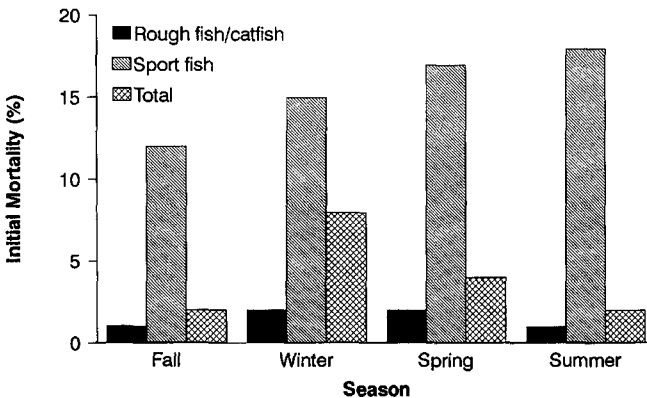
**Table 2.** Catch (*N*/1,000 m) of fishes captured in four mesh sizes of entanglement gear, Wright Patman Reservoir, Texas, 1 September 1990–31 August 1991.

Species	Bar mesh size (mm)			
	76	83	89	102
<b>Rough fish/catfish</b>				
Longnose gar	1.2	0.4	0.3	0.0
Spotted gar	0.0	0.6	0.0	0.7
Common carp	5.6	3.1	1.4	0.0
Smallmouth buffalo	80.8	37.9	25.2	7.8
Bigmouth buffalo	0.0	0.6	0.2	0.0
Blue catfish	0.0	0.2	0.2	0.0
Channel catfish	1.2	0.8	0.0	0.0
Freshwater drum	4.9	1.6	2.3	0.0
Total rough fish/catfish	93.7	45.2	29.6	8.5
<b>Sport fish</b>				
Flathead catfish	3.1	1.7	1.2	0.7
White bass	7.4	0.7	0.3	0.0
Largemouth bass	6.2	0.5	0.7	0.0
White crappie	12.3	4.6	0.5	0.0
Black crappie	0.6	0.1	0.0	0.0
Total sport fish	29.6	7.6	2.7	0.7

the value of sport fish lost to netting was \$24,286, or 33.5%, of the annual monetary estimate.

**Discussion**

Entanglement gear fishing pressure at Wright Patman Reservoir was much lower than anticipated at the beginning of this study. Commercial fishing license



**Figure 2.** Seasonal initial mortalities of fishes captured in entanglement gear, Wright Patman Reservoir, Texas, 1 September 1990–31 August 1991. A listing of species in the rough fish/catfish and sport fish categories can be found in Table 1.

**Table 3.** Estimated economic value<sup>a</sup> (US\$) of fishes captured in entanglement gear, Wright Patman Reservoir, Texas, 1 September 1990–31 August 1991.

Species	N alive	Value <sup>b</sup>	N dead	Value	Species value
Rough fish/catfish <sup>c</sup>					
Smallmouth buffalo	30,282	45,941.00	326	476.00	46,417.00
Bigmouth	277	1,093.00	25	79.00	1,172.00
Channel catfish	379	410.00	42	40.00	450.00
Blue catfish	18	77.00	0	0.00	77.00
Rough fish/catfish total	30,956	47,521.00	393	595.00	48,116.00
Sport fish					
Flathead catfish	1,089		9	337.00	337.00
White bass	565		140	1,400.00	1,400.00
Largemouth bass	392		210	15,227.00	15,227.00
White crappie	2,716		482	7,322.00	7,322.00
Black crappie	65		0	0.00	0.00
Sport fish total	4,827		841	24,286.00	24,286.00

<sup>a</sup> Value of rough fish/catfish = estimated annual yield (kg) × per kg market price; value of sport fish = estimated annual yield, by length group × monetary value × initial mortality rate, adjusted for inflation.

<sup>b</sup> It is illegal to retain sport fishes in nets; it was assumed individuals were released alive and not lost from the fishery.

<sup>c</sup> Other species were also caught, but had no market value.

and seine tag sales were down 33% from the previous year (1990); prior to that, sales had been relatively stable for at least 4 years (L. P. Israel, TPWD, Austin, pers. commun.). Furthermore, based on license sales, commercial fishermen represented <1% of the total fishery resource users in the counties within an 80-km radius of the reservoir (L. P. Israel, pers. commun.). Decline in net fishing activity may have been influenced by several factors. The TPWD Commission ruled in April 1990 to ban netting in the Sulphur River drainage and Wright Patman Reservoir effective 1 September 1991. This decision followed a major undercover law enforcement investigation resulting in the conviction of several commercial fishermen for harvest violations (Capt. B. W. Daniel, TPWD, Mt. Pleasant, pers. commun.). Increased visibility of fisheries personnel conducting sampling at the reservoir in conjunction with this study also may have discouraged many commercial and sport net fishermen from fishing. In any event, the monetary losses due to netting were likely greater in the past than what we estimated here.

Commercially fished nets represented most of the seasonal and total annual netting pressure while illegal nets comprised 1.3% of the total annual net fishing pressure. However, because illegal nets are normally concealed to avoid detection, illegal netting pressure was probably underestimated.

Buffalo and catfishes were the species most frequently captured by netters. Because of their low market value, common carp (*Cyprinus carpio*), freshwater drum (*Aplodinotus grunniens*), and gars (*Lepisosteus* spp.) were usually discarded by commercial fishermen.

Although catch rates of sport fishes in nets were low, by-catch was primarily comprised of relatively large individuals, fishes that likely would be prized by an-

glers. Excluding largemouth bass, initial mortalities of sport fishes remained relatively low. Despite low catch rates and initial mortalities, estimated potential annual monetary losses to the recreational angling fishery exceeded \$24,000. This translated into a cost of \$1.00 to the recreational angling fishery for every \$2.00 of commercial value of rough fish/catfish. However, because initial mortality rates were used to calculate monetary losses, the figure is conservative. If, for example, total mortality rates (initial and delayed) for sport fishes captured in entanglement gear observed by Seidensticker (1976) were used, projected losses to the recreational angling fishery at Wright Patman Reservoir may have exceeded \$103,000. Then the ratio of sport fish losses to commercial value would have been 2.15:1.00. Furthermore, losses were likely higher in years prior to decline in netting activity.

Considering Seidensticker's (1976) estimates for total mortality of sport fishes captured and released from gill nets, crappie and largemouth bass in this study may have suffered significantly higher mortalities than we have reported. Initial mortality of flathead catfish at Wright Patman Reservoir (2%) was less than that reported by Seidensticker (12.7%). However, illegal retention and sale of flathead catfish by net fishermen has been a law enforcement problem at Wright Patman Reservoir (B. W. Daniel, pers. commun.). Consequently, the low rate reported here may well represent an underestimated rate of mortality for this species.

### Management Implications

During the early 1980s, fisheries managers in Texas shifted from commercially-oriented maximum sustained yield philosophies toward recreationally-directed optimum sustained yield strategies to rebuild and maintain fish stocks and improve quality of sport fisheries. Harvest regulations were adjusted accordingly, resulting in higher minimum size limits and lower daily bag limits for many sport fishes in Texas. Implementation of more restrictive harvest regulations and changes in angler attitudes contributed to considerable improvement in most freshwater fisheries in Texas.

While the TPWD does not oppose harvest and sale of commercially important rough fishes, sport fish losses incurred as a result of net fishing conflicted with current management strategies. It is inconsistent for a managing agency to impose stricter harvest regulations on recreational anglers to sustain stocks of quality sizes of sport fishes while allowing other fishing activities that result in losses of these fish to that recreational fishery. Netting-induced sport fish losses at Wright Patman Reservoir were considered excessive and unacceptable and net (entanglement and entrapment) fishing was banned in Texas fresh waters effective 1 September 1993.

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