Comparison of Single-cod and Dual-cod Trap Nets for Sampling Crappie in Texas Reservoirs

C. Craig Bonds, *Texas Parks and Wildlife Department, 11810 FM 848, Tyler, TX 75707*

Mark Howell, *Texas Parks and Wildlife Department, 409 Chester Avenue, Wichita Falls, TX 76301*

Aaron Jubar, *Texas Parks and Wildlife Department, 2122 Old Henderson Hwy, Tyler, TX 75702*

Richard A. Ott, Jr., *Texas Parks and Wildlife Department, 11810 FM 848, Tyler, TX 75707*

J. Warren Schlechte, *Texas Parks and Wildlife Department, Heart of the Hills Fisheries Science Center, 5103 Junction Hwy, Ingram, TX 78025*

Mandy K. Scott, *Texas Parks and Wildlife Department, 3407-A S. Chadbourne, San Angelo, TX 76904*

Abstract: Shoreline-set single-cod trap nets are the standard gear used by Texas Parks and Wildlife to assess crappie (*Pomoxis* spp) populations. In some reservoirs, standardized trap net catch is too low to provide the desired information. In 2006, we compared offshore-set dual-cod trap nets to shoreline-set single-cod and offshore-set single-cod trap nets in ten Texas reservoirs. Catch rates of shoreline-set single-cod trap nets (13.4 fish per net night; F/NN) were similar to each end of the offshore-set dual-cod trap nets (27.1 F/NN when both cod-ends were summed) and all were statistically greater than offshore-set single-cod trap nets (8.0 F/NN). In 2007, we compared shoreline-set single-cod trap nets to offshore-set dual-cod trap nets for one and three night soak times in eight reservoirs and offshore-set dual-cod trap nets only for one and three night soak times in five reservoirs. Like 2006 results, catch rate per cod-end in 2007 was similar in shoreline-set single-cod trap nets (7.8 F/NN) and offshore-set dual-cod trap nets (25.9 F/NN when both cod-ends were summed). Multiple-night sets did increase overall catch, but did not increase catch rate proportional to soak time. In general, offshore-set dual-cod trap nets tripled the overall catch compared to shoreline-set single-cod trap nets, but catch per cod-end was similar. Personnel time required for multiple-night sets was similar to single night sets, therefore catch can be increased without additional labor cost. Offshore-set dual-cod trap nets and/or multiple-night sets may be effective alternatives for fisheries managers desiring to increase overall catch of crappie.

Key words: crappie sampling, trap net, frame net, catch rate, multiple night

Proc. Annu. Conf. Southeast. Assoc. Fish and Wildl. Agencies 62:125–130

Crappie (*Pomoxis* spp.) are popular sport fish in many parts of the United States (U. S. Department of Interior 2006), attracting over six million anglers. In Texas' freshwaters they are the third most sought-after fish (Bohnsack and Ditton 1999). To manage crappie populations, Texas Parks and Wildlife Department (TPWD) conducts trap net sampling in the fall. Random sites along the shoreline within reservoirs are selected following a standard sampling protocol (TPWD, Inland Fisheries, unpublished manual revised 2005). Unfortunately, the current sampling strategy can produce highly variable catch rates and questionable size distribution data. To avert low and highly variable catch rates, it may be necessary to allocate more sampling effort (net nights) or improve the effectiveness of our sampling by modifying either the gear or the sampling protocol.

Changing to a different gear is unlikely to improve catch rates or reduce the variability. Because trap nets are more effective than other gear types (Colvin and Vasey 1986, Boxrucker and Ploskey 1988, Miranda et al. 1990, Guy et al. 1996), fisheries managers in many states use trap nets to sample for crappies. Modifications to trap nets have proven useful under some scenarios (Miranda et al. 1996, Isaaks and Miranda 1997, Besler et al. 1998). Louisiana fisheries biologists have experimented with a technique for catching crappie which utilizes two hoop nets with facing throats attached to a common lead (Mike Wood, Louisiana Department of Wildlife and Fisheries, personal communication). A review of literature found no available information on the effectiveness of this gear compared to our standard trap nets.

Site selection may play a large role in the capture efficiency of trap nets. Factors that could influence the effectiveness of trap nets for sampling for crappie include water depth (O'Brien et al. 1984), bank slope, water temperature, and orientation of the net to shore (Schorr and Miranda 1995, Hubert 1996). Because trap nets are a passive gear, spatial distribution and movement of crappie may be expected to influence capture efficiency. Recent research on the seasonal movement of crappie suggest they use off-shore habitat during the fall (Bonds and Schlechte 2007). Prior to our study, we contacted other state biologists throughout the southeastern United States to ascertain their crappie sampling techniques. Consequently, we learned deeper-water sets might have some utility. They also suggested that fixed-site sampling was routinely used.

Changing from random to subjectively-chosen, fixed sites might reduce catch variability, but the use of nonprobabilistic sampling could diminish the utility of our data (Cochran 1977, Wilde and Fisher 1996).

Texas Parks and Wildlife Department typically sets nets overnight for one night per location. With passive gears, soak-time can affect the number of animals caught (Webb and Ott 1992, Hubert 1996, Zhou and Shirley 1997). Factors such as rate of entry and exit and likelihood of encounter are temporal in nature, suggesting the catch, and potentially catch rate, may increase if nets are fished longer. Lobster and crab fisheries routinely fish multiple nights (Zhou and Shirley 1997, Saila et al. 2002), trying to maximize not only catch, but profit (Miller 1983). For other species, biologists and fishers routinely set nets for multiple nights (Walker et al. 1994, Hansen et al. 1998). However, for crappie nets soak time may be for only a single night (Gablehouse 1984, Pugh and Schramm 1998, Hurley and Jackson 2002), may be fished multiple nights, but retrieved daily (Maceina and Stimpert 1998, St. John and Black 2004, Boxrucker et al. 2005), or they might be fished multiple nights and only retrieved on the final day (Yeh 1977, Webb and Ott 1992). We have not found a completed study which determined which strategy might be preferred. However, Webb and Ott (1992) reported improved precision for catch rate estimates of stock-sized and quality-sized crappie using 3-night sets.

In this paper we examine whether modest changes in how crappie are collected can significantly improve the fisheries information we obtain. Specifically, we examined how three changes in the protocols could address our catch concern: 1) a change from a single-cod net to a dual-cod net, 2) a change from shoreline-only sets to shoreline and offshore sets, and 3) a change from 1-night sets to 3-night sets.

Methods

Reservoirs sampled ranged in size from 81 to 46,337 ha and were distributed throughout Texas, representing a wide variety of habitats (Table 1). All sampling was conducted October through December, when water temperature was 9.5–26.5 C. Reservoirs were sampled once within a given year. We selected sample sites within reservoirs by generating random coordinate-pairs from digitized reservoir polygons using the Random Point Generator tool in Arcview 3.x (Jenness 2005). All nets were fished in water free of obstructions (e.g., brush, dense aquatic vegetation, and rapid changes in bottom contour), with depths sufficient to cover the entire net (>1 m), but not exceeding 12 m for dual-cod trap nets or 5 m for standard trap nets. When the random selection placed a station in unsuitable water, stations were randomly moved to the nearest suitable location (i.e., left or right when facing the nearest shoreline).

Table 1. Year sampled, physical characteristics, turbidity, and historic trap net catch rate of study reservoirs.

Reservoir	Study year	Surface area (ha)	SDF[a]	Mean depth (m)	Secchi depth (m)	Historic trap net catch rate[b]
Aquilla	2006	957	1.5	3.1	0.3 – 0.6	moderate
Arrowhead	2006, 2007	6,058	6.4	5.5	0.3 – 0.7	high
Belton	2006	5,012	8.8	3.7	1.2 – 1.8	low
Buchanan	2007	8,988	5.8	13.1	0.6 – 1.8	low
Fork	2007	11,033	13.5	3.7	1.2 – 1.8	low
Graham	2006	970	5.7	4.1	0.7 – 1.1	low
Grapevine	2007	2,789	6.4	8.6	0.6 – 0.8	high
J. B. Thomas	2007	3,165	6.1	4.0	0.2	high
Jacksonville	2007	489	4.9	7.1	1.2 – 1.8	low
Leon	2006	643	2.8	3.0	0.4 – 0.6	high
L.B.J.	2007	2,609	17.9	6.7	0.6 – 1.8	low
Nasworthy	2006	558	7.0	4.0	0.6	high
O. H. Ivie	2007	7,770	10.6	9.3	1.3 – 2.7	moderate
Oak Creek	2006	961	4.7	1.5	1.1	moderate
Palestine	2006	9,483	6.1	6.8	1.1 – 1.4	moderate
Sam Rayburn	2006	46,337	16.3	1.9	0.6 – 1.2	low
San Augustine	2006	81	2.8	3.5	0.6 – 1.2	low
Timpson	2007	90	3.8	2.4	0.6 – 1.2	n/a
Travis	2007	7,536	18.3	20.7	2.0	low
Twin Buttes	2007	3,675	3.3	3.7	0.3 – 0.6	high
Tyler East	2007	921	5.0	4.9	1.2 – 1.8	moderate
Tyler West	2007	899	3.7	5.5	1.2 – 1.8	low

a. SDF is the shoreline development factor calculated from the formula SDF = lake perimeter / (2*(√pi*lake area)). Increasing values indicate greater irregularity of the lake shoreline.

b. Historic trap net catch rate is based on data collected from 1997–2006. "Low", "moderate", and "high" catch rate refers to CPUE < 7, CPUE = 7 – 15, and CPUE > 15, respectively. For Timpson Reservoir, "n/a" means data were not available to calculate a historic catch rate.

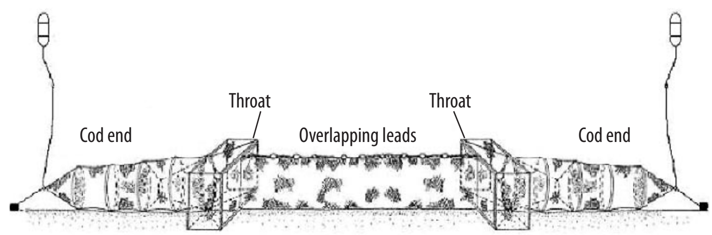

Figure 1. Dual-cod trap net constructed of two standard trap nets with leads completely overlapping and attached together along the float lines and lead lines. The throats of each net face each other.

Standard trap nets (0.9- x 1.8-m frames, 18.3-m leads, and 13-mm bar mesh) were similar in design to those described by Webb and Ott (1992). Shoreline-set standard trap nets were deployed perpendicular to the shore, with the lead attached to a solid structure on the shore. Dual-cod trap nets were constructed of two standard trap nets with leads completely overlapping and attached together along the float lines and lead lines; the throats of each net faced each other (Figure 1). The offshore-set standard trap net was the same as the standard trap net, except the lead was attached to a staging rope and float and the weighted line attached to a weight. Dual-cod nets and offshore-set standard nets were oriented perpendicular to the shoreline, with a weight and a float attached at both ends.

2006 Study

We sampled ten reservoirs to compare dual-cod trap nets to standard trap nets and shoreline sets to offshore sets. Nets were set during daylight hours and retrieved the following day. We sampled six stations within each reservoir. At each station we deployed one shoreline-set standard trap net, one offshore-set standard trap net, and one offshore-set dual-cod trap net. We set the dual-cod trap net at the station coordinates. We set the shoreline-set standard trap net to the shoreward side of the dual-cod nets, and we randomly deployed the offshore-set standard trap net 100–200 m upstream or downstream of the dual-cod net. Nets were set once per sampling station.

Crappie were identified to species and counted. We calculated catch-per-unit-effort (CPUE), expressed as catch/cod end-night. Net types were defined as shoreline-set standard trap net, offshore-set standard trap net, nearshore dual-cod trap net end, and offshore dual-cod trap net end. Because of inherent differences in reservoir size, morphology, habitat, and other factors which may affect crappie catch rates, we blocked the analysis by station within reservoir using a GLM procedure in SAS (SAS 2000). Since sampling occurred over a three month time period and variation in water temperatures may influence catch rates in our passive gears, we included temperature as a covariate in our model. In order to account for heteroscedasticity in our CPUE data, we used a log(x + 0.5) transformation. Pairwise comparisons of all net ends were conducted using a Tukey's studentized range test (*alpha* = 0.05) on the transformed CPUE data.

2007 Study

We sampled eight reservoirs to compare offshore-set dual-cod trap nets with shoreline-set standard trap nets, for single-night and three-night soak times. Nets were set during daylight hours, and retrieved the following day (single-night treatment), or on the day following the third night (three-night treatment). We sampled eight stations per reservoir. At each randomly-selected station we set one shoreline-set standard trap net and one offshore dual-cod net. Four stations were single-night sets and four different stations were three-night sets, with soak times randomly assigned. An additional five reservoirs were sampled using only offshore-set dual-cod trap nets comparing single-night and three-night soak times. Single and three-night sets were paired at four randomly selected stations.

Crappie were processed as in the 2006 study. We used a mixed model to test if CPUE varied as a function of net type, soak time (one or three night sets), water temperature, and their interaction. As opposed to 2006, net types were defined as shoreline-set standard trap nets and offshore-set dual-cod trap nets (catch pooled for dual-cod net ends). The analyses were performed using the MIXED procedure in SAS (SAS 2000). We included variables in our models when $P < 0.05$. In order to meet our model's distributional assumptions, we used a log(x + 0.5) transformation of our CPUE data.

Results

2006 Study

Water temperature did not significantly influence catch rates and was removed from the analysis. We detected significant differences in crappie CPUE as a function of net type (Proc GLM, $F_{3, 127} = 7.45$ $P < 0.0001$) (Table 2). Based on the pairwise comparisons, offshore-set standard trap net CPUE was significantly lower than all other net ends. We found no significant differences in CPUE among comparisons of all other net ends. The blocking variables of station and waterbody were useful in reducing the error variance (Proc GLM, $F_{55, 127} = 2.63$ $P < 0.0001$).

2007 Study

Offshore-set standard trap nets performed poorly in the 2006 study and were dropped from the evaluation. Because the 2006 results detected no difference in crappie CPUE between the nearshore and offshore ends of dual-cod trap nets, we combined the catch from both cod-ends for our 2007 analyses. A second comparison was made between single-night and three-night sets for both offshore-set dual-cod trap nets and shoreline-set standard trap nets (Table 3).

The 2007 final model included net type and soak time as vari-

Table 2. Mean CPUE for each net end for each reservoir during the 2006 study period. Standard errors are in parentheses. Average values for net types with different letters are significantly different.

Reservoir	Shoreline-set standard trap net end	Offshore-set standard trap net end	Nearshore dual-cod trap net end	Offshore dual-cod trap net end
Aquilla	4.7 (2.1)	6.4 (2.9)	5.6 (1.8)	11.3 (3.9)
Arrowhead	27.8 (8.5)	20.8 (7.3)	30.7 (8.0)	56.2 (14.3)
Belton	2.3 (0.7)	0.8 (0.7)	1.8 (0.7)	0.3 (0.2)
Graham	6.0 (2.8)	3.3 (2.2)	7.5 (2.2)	9.5 (3.1)
Leon	43.0 (15.3)	18.8 (5.7)	21.5 (9.6)	18.3 (6.2)
Nasworthy	29.2 (6.8)	17.3 (2.7)	27.2 (5.4)	28.0 (7.7)
Oak Creek	11.0 (4.4)	0.5 (0.2)	6.3 (2.5)	11.8 (3.8)
Palestine	7.2 (2.3)	6.3 (2.1)	8.8 (2.7)	7.3 (2.8)
Sam Rayburn	0 (n/a)	0.3 (0.3)	6.8 (6.4)	2.7 (1.2)
San Augustine	7.0 (2.5)	6.8 (4.3)	9.5 (2.2)	10.0 (3.1)
Average	13.4^{A} (2.4)	8.0^{B} (1.4)	12.2^{A} (1.8)	14.9^{A} (2.5)

Table 3. Mean CPUE for standard and dual-cod nets and net nights for each reservoir during the 2007 study period. Standard errors are in parentheses. Catch-per-unit-effort is defined as number of fish per net-night. Catch from both cod ends of dual-cod nets were combined. Shoreline trap nets were not deployed at Buchanan, O. H. Ivie, J. B. Thomas, L. B. J., and Travis reservoirs. Average values for soak times with different letters are significantly different.

	Mean CPUE			
	One night set		Three night set	
Reservoir	Standard net	Dual-cod net	Standard net	Dual-cod net
Arrowhead	46.3 (23.1)	41.5 (9.0)	16.3 (5.7)	52.3 (32.0)
Buchanan	n/a	12.0 (12.0)	n/a	0.3 (0.3)
Fork	3.0 (2.7)	17.0 (8.1)	0.4 (0.4)	2.4 (1.9)
Grapevine	0.8 (0.5)	2.8 (2.7)	1.8 (1.3)	9.8 (6.3)
O. H. Ivie	n/a	6.3 (3.8)	n/a	8.8 (4.0)
J. B. Thomas	n/a	316.0 (79.4)	n/a	83.1 (30.4)
Jacksonville	0.3 (0.3)	0.3 (0.3)	0	0
L. B. J.	n/a	1.3 (0.9)	n/a	0.4 (0.4)
Timpson	33.0 (27.7)	34.8 (30.4)	6.8 (2.7)	25.0 (8.24)
Travis	n/a	11.3 (8.7)	n/a	4.9 (2.9)
Twin Buttes	11.0 (6.9)	18.8 (13.3)	2.0 (1.8)	9.9 (8.9)
Tyler East	1.8 (1.2)	4.8 (1.9)	0.5 (0.3)	2.5 (0.9)
Tyler West	0.3 (0.2)	5.5 (3.2)	0.7 (0.2)	1.8 (0.7)
Average	12.0^{A} (5.0)	36.7^{C} (13.1)	3.6^{B} (1.2)	15.4^{D} (4.6)

ables, but not water temperature which did not significantly influence catch rates. Similar to our 2006 results, crappie CPUE in 2007 varied as a function of net type (Proc Mixed, $F_{1, 81} = 14.96$ $P = 0.0002$). As expected, pooling catch from both (nearshore and offshore) ends of a dual-cod net resulted in higher catch rate (CPUE = 25.9, SE = 6.9), which was more than triple that of a shoreline-set standard trap net (CPUE = 7.8, SE = 2.6). For shoreline-set standard trap nets, increasing the soak time of the nets did not increase overall catch, and catch rates declined ($P = 0.0022$) between the one-night sets (CPUE = 12.0, SE = 5.0) and the three-night sets (CPUE = 3.6, SE = 1.2). Unlike shoreline-set standard trap nets, offshore-set dual-cod trap nets did show an increase in overall crappie catch when allowed to soak for multiple nights, but catch rate declined ($P < 0.0001$) with soak time (one night set CPUE = 36.7, SE = 13.1; three-night set CPUE = 15.4, SE = 4.6).

Discussion

We tested whether we could increase catch of crappie in trap nets by adding an additional cod end to a standard trap net and deploying it offshore. We also tested the performance of an offshore-set standard trap net. Lastly, we determined if increasing soak time of dual-cod and single-cod trap nets could improve our ability to capture greater numbers of crappie.

Although dual-cod trap nets merit consideration as an alternative sampling gear, we hoped to observe more than a doubling in crappie catch compared to standard trap nets. Catch rates in dual-cod trap nets less than twice that of standard trap nets would equate to an inefficient use of available trap nets. When dual-cod trap nets were treated as single sampling units (pooling catch from both cod ends), they generally caught crappie at two to three times the rate of shoreline-set standard trap nets. However, dual-cod trap net performance compared to shoreline-set standard trap nets varied among reservoirs. It was at low- to moderate-catch reservoirs where we anticipated offshore-set dual cod trap nets to offer the greatest catch advantage. For five reservoirs (San Augustine, Fork, Grapevine, Tyler East, and Tyler West), dual-cod trap nets caught crappie at up to five times the rate of shoreline-set standard trap nets. With the exception of Grapevine, these reservoirs historically exhibited low (<7 fish per net-night; F/NN) or moderate (7–15 F/NN) catch rates for crappie in shoreline-set standard trap nets (Table 1). Dual-cod trap nets were the only nets that captured crappie at Sam Rayburn Reservoir with any regularity. At Sam Rayburn Reservoir, shoreline-set standard trap nets have historically performed poorly despite anglers harvesting an estimated 226,160 crappie at a rate of 2.4/hour in a one-year period (Driscoll and Ashe 2007). With the abundant shoreline vegetation at Sam Rayburn Reservoir, the offshore-set dual cod trap nets may be the only reliable method to sample crappie. Dual-cod trap nets generally collected crappie at less than twice the rate of shoreline-set standard trap nets in the remaining nine reservoirs. Six of the nine could be classified as low- or moderate-catch reservoirs, exemplifying the difficulty in predicting the performance of dual-cod nets.

Increasing soak time from one- to three-night sets allowed us to catch greater overall numbers of crappie in offshore-set dual-cod trap nets, but not in shoreline-set standard trap nets. Catch rates for both net types declined at the longer soak time. Our catch-rate results do not support findings from a prior soak-time experiment utilizing trap nets. Webb and Ott (1992) reported similar catch rates of stock-size crappie using standard trap nets soaked for one and three nights in three Texas reservoirs. We included sub-stock-length crappie in our analyses which could explain the disparate findings between the studies. They argued that converting to three-night sets would allow continuation of long-term data trend analysis, but with the benefit of increasing crappie sample size. We suggest increasing soak time from one to three nights may make direct catch rate comparisons between the two inappropriate but may increase the number of crappie caught, at least for offshore-set dual-cod trap nets. Hansen et al. (1998) concluded that gill-net catches of lake trout in Lake Superior did not increase in direct proportion to the number of nights fished, and he derived a means for correcting gill-net CPUE for various soak times to a common base of one night. Increasing trap net soak time may benefit fisheries managers more interested in obtaining a larger crappie sample for growth, recruitment, and mortality analyses without increases in labor or travel cost. Fisheries managers desiring to maintain long-term crappie CPUE trend databases may need to develop soak-time correction factors if trap-net deployment strategy shifts to multiple-night sets.

Offshore-set standard trap nets performed poorly in our study despite research indicating crappie often frequent offshore locations in the fall (Bonds and Schlechte 2007). The float line of a shoreline-set standard trap net was tied securely to a shoreline object; however, the offshore-set standard trap net's float line was attached to a staging line and float. This latter arrangement could have allowed slack in the float line, resulting in partial collapse of the lead. In contrast, the dual-cod trap net, when deployed correctly, kept the lead and float line taut.

In summary, we developed and field tested a dual-cod trap net that typically captures crappie at twice the rate of shoreline-set standard trap nets. The catch advantage can increase up to five times greater at reservoirs with shoreline-set standard trap-net catch rates less than 15 F/NN. Offshore-set standard trap nets did not perform well compared to other net types. Dual-cod trap nets may serve as an alternative to shoreline-set standard trap nets in reservoirs where suitable shoreline sampling locations are largely unavailable (e.g., shorelines containing steeply sloped banks or aquatic/flooded-terrestrial vegetation) or where the latter has a history of low to moderate capture success. Increasing soak time of shoreline-set standard and dual-cod trap nets from one to three nights generally decreased catch rates, but increased overall catch for offshore-set dual-cod nets at a cost commensurate with single-night sets. Although we did not quantify personnel time required to set and retrieve dual-cod, offshore standard, and shoreline standard trap nets, we believe there were no substantial differences between trap-net deployment types.

Acknowledgments

We thank all Texas Parks and Wildlife Department staff assisting with the field component of this study. Funding for this study was provided by the Federal Aid in Sport Fish Restoration Act, Grant F-30-R of TPWD.

Literature Cited

Besler, D.A., S.L. Bryant, and S.L. Van Horn. 1998. Evaluation of crappie catch rates and size distributions obtained from three different trap nets. Proceedings of the Annual Conference of the Southeastern Association of Fish and Wildlife Agencies 52:119–124.

Bohnsack, B.L. and R.B. Ditton. 1999. Demographics, participation, attitudes and management preferences of Texas anglers. Human Dimensions of Fisheries Research Laboratory Report HD-611. Department of Wildlife and Fisheries Sciences, Texas A&M University, College Station.

Bonds, C.C. and J.W. Schlechte. 2007. Can biotelemetry information improve trap-net catch rates of adult white crappie? Proceedings of the Southeastern Association of Fisheries and Wildlife Agencies 60:157–164.

Boxrucker, J. and G. Ploskey. 1988. Gear and seasonal biases associated with sampling crappie in Oklahoma. Proceedings of the Annual Conference of the Southeastern Association of Fish and Wildlife Agencies 42:89–97.

———, G.L. Summers, and E.R. Gilliland. 2005. Effects of the extent and duration of seasonal flood pool inundation on recruitment of threadfin shad, white crappies, and largemouth bass in Hugo Reservoir, Oklahoma. North American Journal Fisheries Management 25(2):709–716.

Cochran, W.G. 1977. Sampling techniques, 3rd edition. Wiley, New York, New York.

Colvin, M.A. and F.W. Vasey. 1986. A method of qualitatively assessing white crappie populations in Missouri reservoirs. Pages 79–85 *in* G.E. Hall and M.J. Van Den Avyle, editors. Reservoir fisheries management: strategies for the 80s. Reservoir Committee Southern Division American Fisheries Society, Bethesda, Maryland.

Driscoll, M.T. and D. Ashe. 2007. Statewide freshwater fisheries monitoring and management program, Sam Rayburn Reservoir, Texas Parks and Wildlife Department, Federal Aid in Sport Fish Restoration, Performance Report, Project F-30-R-32, Job A.

Gablehouse, D.W., Jr. 1984. An assessment of crappie stocks in small Midwestern impoundments. North American Journal of Fisheries Management 4:273–385.

Guy, C.S., D. W. Willis, and R. D. Schultz. 1996. Comparison of catch per unit effort and size structure of white crappies collected with trap nets and gill nets. North American Journal Fisheries Management 16(4):947–951.

Hansen, M.J., R.G. Schorfhaar, and J.H. Selgeby. 1998. Gill-net saturation by Lake Trout in Michigan waters of Lake Superior. North American Journal Fisheries Management 18(4):847–853.

Hubert, W.A. 1996. Passive capture techniques. Pages 157–192 *in* B.R. Murphy and D.W. Willis, editors. Fisheries Techniques, 2nd Edition. American Fisheries Society, Bethesda, Maryland.

Hurley, K.L. and J.J. Jackson. 2002. Evaluation of a 254-mm minimum length limit for crappies in two southeast Nebraska reservoirs. North American Journal Fisheries Management 22(4):1369–1375.

Isaaks, L.C. and L.E. Miranda. 1997. Efficiency and selectivity of floating trap nets for sampling crappies. Pages 40–55 *in* Miranda et al., authors. Evaluation of regulations restrictive of crappie harvest. Freshwater Fisheries Report Number 163, F-105. Completion Report. Mississippi Department of Wildlife, Fisheries, and Parks, Jackson.

Jenness, J. 2005. Random point generator (randpts.avx) extension for Arcview 3.x, v. 1.3. Jenness Enterprises. Available at: http://www.jennessent.com/arcview/random_points.htm

Maceina, M.J. and M.R. Stimpert. 1998. Relations between reservoir hydrology and crappie recruitment in Alabama. North American Journal of Fisheries Management 18(1):104–113.

Miller, R.J. 1983. How many traps should a crab fisherman fish? North American Journal of Fisheries Management 3(1):1–8.

Miranda, L.E., J.C. Holder, and M.S. Schorr. 1990. Comparison of methods for estimating relative abundance of white crappie. Proceedings of the Annual Conference of the Southeastern Association of Fish and Wildlife Agencies 44:89–97.

———, M.S. Schorr, M.S. Allen, and K.O. Meals. 1996. Description of a floating trap net for sampling crappies. North American Journal of Fisheries Management 16:457–460.

O'Brien W.J., B. Loveless, and D. Wright. 1984. Feeding ecology of young white crappie in a Kansas Reservoir. North American Journal of Fisheries Management 4:331–349.

Pugh, L.L. and H.L. Schramm, Jr. 1998. Comparison of electrofishing and hoopnetting in lotic habitats of the lower Mississippi River. North American Journal of Fisheries Management 18(3):649–656.

Saila, S.B., D.F. Landers, Jr., and P. Geoghegan. 2002. Model comparisons for estimating the relationship between catch and soak time for the American lobster trap fishery. North American Journal of Fisheries Management 22(3):943–949.

Schorr, M.S. and L.E. Miranda. 1995. Influence of selected physical factors on the catch rate of white crappie in trap nets. Proceedings of the Southeastern Association of Fish and Wildlife Agencies 49:205–215.

St. John, R.T. and W.P. Black. 2004. Methods for predicting age-0 crappie year-class strength in J. Percy Priest Reservoir, Tennessee. North American Journal of Fisheries Management 24(4):1300–1308.

U.S. Department of the Interior, Fish and Wildlife Service, and U.S. Department of Commerce, U.S. Census Bureau. 2006. 2006 National survey of fishing, hunting and wildlife-associated recreation.

Walker, M.R., G. Tilyou, and M.G. McElroy. 1994. Hoop net selectivity and catch rates for channel catfish. Proceedings of the Annual Conference of the Southeastern Association of Fish and Wildlife Agencies 48:542–549.

Webb, M.A. and R.A. Ott, Jr. 1992. Precision of white crappie population parameters under single-night and multiple-night frame-net sampling regimes. Proceedings of the Annual Conference of the Southeastern Association of Fish and Wildlife Agencies 46:314–319.

Wilde, G.R. and W.L. Fisher. 1996. Reservoir fisheries sampling and experimental design. Pages 397–409 *in* L.E. Miranda and D.R. Devries, editors. Multidimensional approaches to reservoir fisheries management. American Fisheries Society, Symposium 16, Bethesda, Maryland.

Yeh, C.F. 1977. Relative selectivity of fishing gear used in a large reservoir in Texas. Transactions of the American Fisheries Society 106(4):309–313.

Zhou, S. and T.C. Shirley. 1997. A model expressing the relationship between catch and soak time for trap fisheries. North American Journal of Fisheries Management 17(2):482–487.