Precision of White Crappie Population Parameters Under Single-night and Multiple-night Frame-net Sampling Regimes

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Abstract: White crappie (*Pomoxis annularis*) stock structure and catch rate estimates and their associated variances were compared between 1-night and 3-night frame-net sets. We set paired frame nets at each of 5 stations on 3 reservoirs in fall and early winter 1990. We ran 1 net of each pair the morning after it was set; the second net of each pair was allowed to fish for 3 nights continuously. PSD and RSD_p estimates from each sampling regime were similar. Three night sets significantly increased precision of PSD estimates. Both 1-night and 3-night sets yielded similar estimates of $CPUE_s$, $CPUE_q$, and $CPUE_p$. Precision surrounding catch rate esimates for stock-size and quality-size fish increased significantly using 3-night sets.

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Many methods have been used to collect crappie (*Pomoxis* spp.) for population estimates, food habits, and/or growth analysis. Of all the gears used, frame nets are the most cost effective (have the highest catch rate per man hour), catch the widest size range of fish, have the lowest variation in catch rate by station, and appear to adequately represent density and year class strength (Boxrucker and Ploskey 1988, McInerny 1989). In addition, age and size structure of black crappie (*P. nigromaculatus*) caught in frame nets are similar to those harvested by anglers in the same season (McInerny 1989), and may be used to predict angler success in later seasons (Miranda et al. 1992). Data collected by frame netting have also been used to propose a qualitative rating system for white crappie (*P. annularis*) populations (Colvin and Vasey 1986).

The Texas Parks and Wildlife Department (TPWD), Inland Fisheries Branch, incorporated fall frame-netting into standardized sampling methodology in 1985 using 1-night sets. Results of white crappie population data collected by frame net from 3 large Texas reservoirs (Webb and Ott 1992) led to establishment of Texas' statewide 254-mm minimum-length, 25-fish/day limits in September 1990. During analysis of data leading to this regulation change, we found that although variance of frame-net data between stations is lower than variance from other gears used to sample crappie, it is still high enough to make statistical detection of subtle population changes difficult. The objectives of our study were to determine 1) if white crappie stock-structure and/or catch-rate estimates derived from 1-night and 3-night sets would remain similar and 2) if precision surrounding these estimates could be improved using 3-night sets.

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Methods

We conducted frame netting for this study on 3 large reservoirs in Texas. Lake Palestine, on the Neches River, was impounded in 1962 for municipal and industrial water supply. At conservation pool the reservoir covers 10,320 ha; maximum depth is 18.1 m, and average depth is 5.0 m. The reservoir is clear and slightly acidic and experiences 0.7-m annual water level fluctuation. Lake Somerville, on Yegua Creek (a tributary of the Brazos River), was impounded in 1967 for municipal and industrial water supply. At conservation pool the reservoir covers 4,638 ha; maximum depth is 15.4 m, and average depth is 4.5 m. The reservoir is turbid and alkaline and experiences 0.6-m annual water level fluctuations. Lake Wright Patman, on the Sulfur River, was impounded in 1956 to provide flood control and water conservation. At conservation pool the reservoir covers 8,215 ha; maximum depth is 12.5 m, and average depth is 2.4 m. The reservoir is turbid and slightly acidic and undergoes 5.5-m annual water level fluctuation. Lake Palestine has been under a 254-mm minimum-length, 25-fish daily bag limit for crappie since September 1985. Lakes Somerville and Wright Patman had no crappie length-limit until September 1990 when a statewide 254-mm minimum-length, 25-fish daily bag-limit regulation was imposed.

Our frame nets were constructed of 2 0.9-m high x 1.8-m wide frames and 4 0.8-m diameter hoops made from 0.8-cm steel covered in 1.3-cm bar-mesh knotless-nylon webbing. Frames were spaced 76 cm apart with the first hoop 81 cm from the second frame. Remaining hoops were spaced 61 cm apart. The first frame had a 15-cm throat; the second frame had a 31-cm throat. A 0.9-m deep, 20-m long leader extended outward from the first frame. The leader was constructed of 1.3-cm square knotless-nylon webbing.

We conducted our sampling in November and December 1990 when water temperatures were 10°–13° C. At each reservoir we selected 5 stations where we felt white crappie catch would be maximized. This occurred where points approached the river channel as identified with topographical maps or depth locators. We set 2 nets at each station, 1 on each side of the point and a minimum of 100 m apart to prevent interference. Nets were set with the leads extending outward from shore. After setting the net pairs we determined, at random, which net would follow each regime. One of each net-pair was run the following morning (1-night). The other net was left set for 3 nights continuously (3-night) and allowed to fish undisturbed. The 1-night set was intended to simulate our TPWD Inland Fisheries Branch standardized frame-net surveys for comparison with the 3-night set. All white crappie collected were separated into 2.54-cm total-length groups and counted by net. The resulting values were divided by the number of nights the net fished; therefore, catch per unit effort (CPUE) is presented as catch per net-night.

Length distributions of white crappie were assessed using Proportional Stock Density (PSD) (Anderson 1978) and Relative Stock Density (RSD_x) (Gabelhouse 1984), defined as the proportion of stock-size white crappie (≥127 mm) that are in some narrower length interval *x*. Three partitions of length distribution were of practical interest: stock-size fish (≥127 mm), denoted *s;* quality-size fish (≥203 mm), denoted *q;* and preferred-size fish (≥254 mm), denoted *p.*

Differences in PSD and RSD_p between 1-night and 3-night sets were determined using 2-way ANOVA in the SAS General Linear Model Procedure with values arcsine square root transformed and weighted by the inverse of their binomial variances. Lakes and nights were treated as independent variables. Values for $CPUE_s$, $CPUE_q$, and $CPUE_p$ were compared between 1-night and 3-night sets using similar analysis except values were log^{10} transformed after the addition of 1.0. Variances for PSD, RSD_p, $CPUE_s$, $CPUE_q$, and $CPUE_p$ from 1-night and 3-night sets were compared using the Kruskal-Wallis nonparametric 1-way analysis in the SAS (Stat. Anal. System 1988) NPAR1WAY procedure. Threshold level of significance was set at $P = 0.1$ for all analyses as recommended by Steele and Torrie (1980).

Results

Catch rates and stock structure indices for Lake Palestine, Lake Somerville, and Lake Wright Patman, Texas are found in Tables 1, 2 and 3, respectively. No significant difference was found for PSD or RSD_p between 1-night and 3-night sets ($P = 0.80$ and 0.72, respectively). A significant difference was detected for variance associated with PSD estimates, indicating an increase in precision using the continuous sets ($P = 0.05$); however, no significant difference was detected for variance associated with RSD_p ($P = 0.51$).

No significant difference was found between 1-night and 3-night estimates of $CPUE_s$, $CPUE_q$, or $CPUE_p$ ($P = 0.24$, 0.36, and 0.71, respectively). Significant differences were detected for variance associated with estimates of $CPUE_s$ and $CPUE_q$ ($P = 0.05$ and 0.05, respectively). No difference was detected for variance associated with $CPUE_p$ ($P = 0.13$).

Table 1. Catch rates[a] and stock structure indices[b] for white crappie collected by frame netting, Lake Palestine, Texas, 1990. Standard errors in parentheses, variance in brackets.

Regime	$CPUE_s$	$CPUE_q$	$CPUE_p$	PSD	RSD_p
1-night	32.0	28.6	17.8	89	55
	(8.75)	(8.78)	(6.29)	[0.06]	[0.09]
3-night	14.9	13.9	8.5	93	57
	(6.70)	(6.15)	(4.66)	[0.01]	[0.08]

[a]CPUE = Catch Per Unit Effort (*N* of fish/net night); s = stock size, q = quality size, p = preferred size (Gabelhouse 1984).

[b]PSD = Proportional Stock Density (Anderson 1978); RSD_p = Relative Stock Density Preferred (Gabelhouse 1984).

Table 2. Catch rates[a] and stock structure indices[b] for white crappie collected by frame netting, Lake Somerville, Texas, 1990. Standard errors in parentheses, variance in brackets.

Regime	$CPUE_s$	$CPUE_q$	$CPUE_p$	PSD	RSD_p
1-night	25.2	14.2	3.0	56	12
	(9.07)	(4.68)	(1.52)	[0.03]	[0.02]
3-night	30.4	15.9	5.0	52	16
	(12.25)	(6.20)	(2.34)	[0.01]	[0.02]

[a]CPUE = Catch Per Unit Effort (*N* of fish/net night); s = stock size, q = quality size, p = preferred size (Gabelhouse 1984).

[b]PSD = Proportional Stock Density (Anderson 1978); RSD_p = Relative Stock Density Preferred (Gabelhouse 1984).

Table 3. Catch rates[a] and stock structure indices[b] for white crappie collected by frame netting, Lake Wright Patman, Texas, 1990. Standard errors in parentheses, variance in brackets.

Regime	$CPUE_s$	$CPUE_q$	$CPUE_p$	PSD	RSD_p
1-night	11.8	7.0	1.8	59	15
	(6.61)	(4.55)	(1.56)	[0.06]	[0.05]
3-night	6.8	4.7	1.5	69	22
	(3.01)	(2.09)	(0.67)	[0.02]	[0.02]

[a]CPUE = Catch Per Unit Effort (*N* of fish/net night); s = stock size, q = quality size, p = preferred size (Gabelhouse 1984).

[b]PSD = Proportional Stock Density (Anderson 1978); RSD_p = Relative Stock Density Preferred (Gabelhouse 1984).

Discussion

Improved precision of any fisheries sampling technique allows managers greater resolution in detecting true changes in fish populations. Our interest in improving precision of our frame-net sampling resulted from perceiving trends in crappie population parameters which were statistically undetectable. Three-day sets, logically, improve the chances that a schooling species will encounter the sampling gear and therefore should increase precision. However, if this increased precision comes at the cost of significant changes to the parameter estimates themselves, any advantage is negated.

Laarman and Ryckman (1982) detected a significant positive relationship between catchability and size of black crappie. They attributed this relationship to higher rates of escapement from trap nets for small fishes than for larger fishes as was reported by Patriarche (1968). Assuming this relationship to be true, 3-night sets would be expected to bias estimates of PSD, and possibly RSD_p, upward as compared to 1-night sets. However, this relationship was not detected in our study. It is possible that the smaller mesh used in our study (1.3-cm bar) allowed less escapement than the 2.4-cm bar mesh used by Laarman and Ryckman (1982).

Variability in frame-net catch rates over time has also been reported. Grinstead (1971) reported the CPUE of 16 commercial species to be inversely related to the interval between trap-net lifts. Conversely, Shorr and Miranda (1991) reported "catch/day of all length groups of white crappie increased sharply with soak time, peaked in 1–3 days, and decreased thereafter." They concluded that "catch could be optimized if nets were run every 2–3 days and that longer soak times could result in the underestimation of small and medium-size fish." Although there seemed to be a trend toward lower catch rates for the 3-night sets as compared to the 1-night sets at lakes Palestine and Wright Patman, it was not apparent at Lake Somerville, and any trend was statistically undetectable. It is possible that by using 3-day sets, the peaks noted by Shorr and Miranda (1991) on days 1 and 2 are balanced by declines on day 3, thereby smoothing the catch curves.

Considering incongruous results between trends in population data found in our study and those found by other authors, more research is needed concerning the relationship between sampling methods and the behavioral patterns of schooling or aggregating fish species. However, data from our study indicate that precision of crappie population parameter estimates can be improved using 3-night sets and that 1-night and 3-night sets offer similar estimates of population parameters, allowing usable trend data for time series analysis from either sampling regime.

Literature Cited

Anderson, R. O. 1978. New approaches to recreational fishery management. Pages 73–78 *in* G. D. Novinger and J. G. Dillard, eds. New approaches to the management of small impoundments. Spec. Publ. 5, North Cent. Div. Am. Fish. Soc.

Boxrucker, J. and G. Ploskey. 1988. Gear and seasonal biases associated with sampling crappie in Oklahoma. Proc. Annu. Conf. Southeast. Assoc. Fish and Wildl. Agencies 42:89–97.

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, eds. Reservoir fisheries management: strategies for the 80's. Reservoir Comm., South. Div., Am. Fish. Soc., Bethesda, Md.

Gabelhouse, D. W., Jr. 1984. A length-categorization system to assess fish stocks. North Am. J. Fish. Manage. 4:273–285.

Grinstead, B. G. 1971. Relationship of interval between lifts and the catch of ten-foot Wisconsin-type trap nets. Proc. Annu. Conf. Southeast. Assoc. Game and Fish Comm. 24:532–545.

Laarman, P. W. and J. R. Ryckman. 1982. Relative size selectivity of trap nets for eight species of fish. North Am. J. Fish. Manage. 2:33–37.

McInerny, M. C. 1989. Evaluation of trapnetting for sampling black crappie. Proc. Annu. Conf. Southeast. Assoc. Fish and Wildl. Agencies 42:98–106.

Miranda, L. E., J. C. Holder, and M. S. Schorr. 1992. Comparison of methods for estimating relative abundance of white crappie. Proc. Annu. Conf. Southeast. Assoc. Fish and Wildl. Agencies 44:89–97.

Patriarche, M. H. 1968. Rates of escape of fish from trap nets. Trans. Am. Fish. Soc. 97:59–61.

SAS (Statistical Analysis System). 1988. SAS/STAT User's Guide, release 6.03 ed. SAS Inst. Inc., Cary, N.C.

Schorr, M. S. and L. E. Miranda. 1991. Catch of white crappie in trap nets in relation to soak time and fish abundance. Proc. Annu. Conf. Southeast. Assoc. Fish and Wildl. Agencies 43:198–205.

Steele, G. D. and J. H. Torrie. 1980. Principals and procedures of statistics, 2nd ed. McGraw-Hill Book Co., New York. 633pp.

Webb, M. A. and R. A. Ott, Jr. 1992. Effects of length and bag limits on population structure and harvest of white crappie in three Texas reservoirs. North Am. J. Fish. Manage. 11:614–622.