Gear and Seasonal Biases Associated with Sampling Crappie in Oklahoma[1]

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Abstract: Differences in catch statistics (catch rates, length structure, and age structure) by gear and season were evaluated for white crappie (*Pomoxis annularis*) sampled with trap nets, electrofishing, and gill nets. Catch per man-hour of effort by trap nets was significantly higher than those of other gears tested in spring and fall. Variation in catch per man-hour was less for trapnet samples than for electrofishing or gillnet samples. Within-season variation in length distribution for trapnet samples was consistently less than within-season variation for the other gears tested. Gill nets sampled for the narrowest size range of crappie. Trap nets were the only gear that collected substantial numbers of age-O crappie in fall. Spring trap net and electrofishing samples caught a greater proportion of older crappie than did the respective fall samples. Trap nets collected more fish and provided more precise data on white crappie populations than did the other gears tested.

Catch per man-hour with fall trap nets was higher than the previous spring sample for all sizes of crappie. Fall trapnet samples represented the population age structure better than did respective spring samples. We recommended that Oklahoma incorporate a fall trapnet sampling schedule into a standardized sampling program, with crappie as a target species.

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Scientific management of fishery resources is dependent on the quality of information used to make management decisions. Managers must be confident that sample parameters reflect true population parameters before management recommendations are implemented. Biases associated with sampling are inherent in most gears commonly used to survey fish populations. Capture efficiency is influenced by environmental factors including season, water temperature, water level, water clar-

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ity, conductivity, and currents; by habitat characteristics including lake morphometry, substrate, and cover; and by characteristics of the species targeted for capture including habitat preference, fish size, and behavior (Hubert 1983). Consequently, improvement in sampling techniques is an ongoing priority among management agencies, as reflected in recent literature (Gilliland 1985, Hall 1986, Hubbard and Miranda 1986, Nelson and Little 1986, Reddin 1986, Willis 1987).

Management of crappie populations has not been given the priority its popularity with anglers warrants. We conducted an informal poll of Fisheries Divisions of the member states of the Southeastern Association of Fish and Wildlife Agencies. Crappie ranked first or second as preferred species sought in 11 of 15 states responding; however, only 9 states were routinely using gear designed to collect population data on crappie (Boxrucker, unpubl. data). Crappie rank second in popularity to largemouth bass (*Micropterus salmoides*) among Oklahoma anglers (Summers 1986).

Oklahoma has been collecting standardized population samples since 1977. Management recommendations for the state's crappie populations were made based on spring and fall electrofishing and fall gillnet samples. Samples collected by these 2 gear types quite often yielded conflicting results. Consequently, it was deemed necessary to reevaluate existing sampling methods to upgrade Oklahoma's Standardized Sampling Program (Erickson 1978).

The objective of this study was to compare catch rates, length structure, and age structure of crappie population samples collected by spring and fall trap netting, spring and fall electrofishing, and fall gill netting. This research was funded through Oklahoma's Federal Aid in Fish Restoration Projects F-37-R, Jobs 10 and 13.

Methods

Sampling methods

Data were collected from 4 lakes (Arbuckle, Ft. Supply, Thunderbird, and Waurika) from 1983 through 1986. Spring (April and May) and fall (October and November) trapnet and electrofishing and fall gillnet samples were analyzed (Table 1). Although some black crappie (*Pomoxis nigromaculatus*) were collected, only data on white crappie (*Pomoxis annularis*) were included in the analyses.

Trap nets were set at 8 permanent stations and fished for 4 days (24 net-nights). Each net consisted of 2 1.8 m × 0.9 m steel frames with 4 0.9 m hoops covered with 12.7 mm square mesh nylon net attached to a 19.8 m × 0.9 m lead of 12.7 mm mesh. Nets were set perpendicular to the bank off points in 4 to 6 m depths.

Electrofishing samples were collected using pulsed DC current. Sampling was conducting until a minimum of 100 crappie were sampled. Gillnet samples were collected using experimental monofilament gill nets consisting of 8 panels measuring 1.8 m × 7.6 m with 19.1 mm, 25.4 mm, 38.1 mm, 50.8 mm, 63.5 mm, 76.2 mm, 88.9 mm, and 101.6 mm bar mesh. Effort consisted of 10 net-sets at 5 permanent sampling sites.

Table 1. *Trapnet (TN), electrofishing (EF), and gillnet (GN) samples* by year and month from Arbuckle (A), Ft. Supply (S), Thunderbird (T), and Waurika (W) reservoirs that were included in the statistical analyses.

Gear	Apr	May	Oct	Nov
1983				
TN	ST	ST	ST	ST
EF	ST	ST	ST	ST
GN			ST	ST
1984				
TN	S		AS	T
EF	A	AS		T
GN			AS	
1985				
TN	AST	T	AT	STW
EF	T	ST	ST	T
GN			SW	
1986				
TN	AS		S	ATW
EF				T
GN			S	

All crappie collected were measured (mm) and weighed (g). Otoliths (sagittae) were removed from 20 crappie from each available 20-mm length group and age structure of the sample was determined by methods described by Ketchen (1950). All crappie age 4 and older were grouped as age 4^+. Data from 42,053 crappie collected with trap nets, 1,532 collected by electrofishing, and 1,224 collected with gill nets were analyzed.

Statistical Design

For comparisons of catch rates among gears, man-hours based on 2-person crews were used as a standardized measure of effort. Effort was measured as total time spent on the water to collect a daily sample and multiplied by 2.

Catch data were not normally distributed and consequently were transformed to common logarithms for analysis. An alpha level ≤ 0.05 was considered to be significant and can be assumed for all tests presented unless otherwise noted. Variability among reservoirs and years was accounted for using a randomized block design. Mean variance in catch per man-hour was calculated for every gear and month, and among gear differences in monthly sample variance were tested with Analysis of Variance using reservoirs and years as replicate samples. Differences in catch per man-hour among gears, months, and seasons also were tested using Analysis of Variance, and Duncan's Multiple Range Tests were used to determine which means differed significantly. Differences in length and age structure were tested using a Chi-square test for independence.

Results

Among Gear Comparisons

Mean catch/man-hour (pooling all samples) of white crappie by trap nets was significantly different from ($P < 0.001$) and approximately 8-fold greater than mean catches by electrofishing or gill nets. Mean electrofishing and gillnetting catches did not differ significantly from one another. Catches of crappie also were significantly greater with trap nets than with other gears in every month sampled (Fig. 1). Trap nets sampled greater numbers in every age class than did either electrofishing or gill nets and trap nets fished in the fall were the only sample that collected substantial numbers of age-0 crappie.

Average among station variance in catch per man-hour by trap nets was significantly less ($P < 0.001$) than the average variance in catch by electrofishing in April, May, and October (Fig 2). No significant differences were found in mean variances of trapnet and gillnet catches in October. Average variance in trapnet catches was higher in November than in other months tested and did not differ significantly from mean gillnet and electrofishing variances in that month (Fig. 2).

Where sufficient data were available to make valid comparisons, length-frequency distributions differed significantly among gears for every lake and month tested (Chi-square; $P < 0.01$). Length frequencies also differed among lakes, years, and seasons within gears. Mean lengths of white crappie sampled by electrofishing also were significantly higher than those of crappie collected in trap nets in every lake and month sampled ($P < 0.01$). Figure 3 provides an example of the difference in the length distribution of a single population sampled in April and May by trap nets and electrofishing. Length frequencies from April electrofishing appeared to overly represent large crappie when compared to April and May trapnets and May

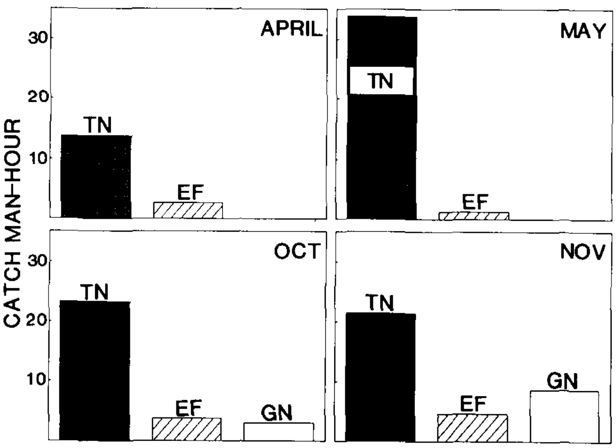

Figure 1. Catch per man-hour by month of white crappie sampled by trap nets (TN), electrofishing (EF), and gill nets (GN) from 4 Oklahoma impoundments, 1983–1986.

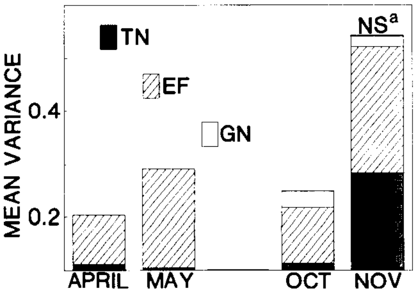

Figure 2. Mean variance of monthly trapnet (TN), electrofishing (EF), and gillnet (GN) samples of white crappie from 4 Oklahoma impoundments, 1983–1986 ([a] nonsignificant differences).

electrofishing samples. Length frequencies based on gillnet catches often contained too few fish to be reliable. Gillnets generally sampled the narrowest length range of the gears tested.

Seasonal biases in trapnet data

Catch per man-hour of trapnetting in October and November did not differ significantly, but catches in April and May were significantly different ($P < 0.01$; Fig. 1). Trapnet catches of age-1 and older white crappie were significantly higher in fall than in spring ($P < 0.02$). Age-0 fish were excluded from this analysis since they are not caught in trap nets in spring.

A greater proportion of age-1 and older crappie were sampled with trap nets in spring than in fall (Fig. 4). However, differences in the proportion of a given age class between the spring and fall samples was only significant for age-1 ($P < 0.05$).

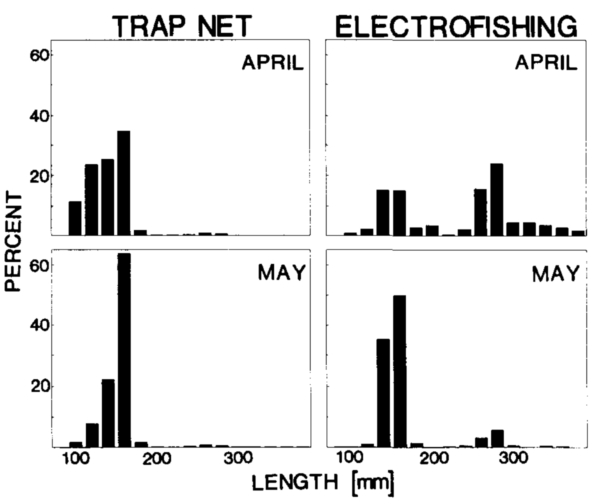

Figure 3. Length frequency of white crappie from Thunderbird Reservoir sampled by trap nets and electrofishing in April and May 1983.

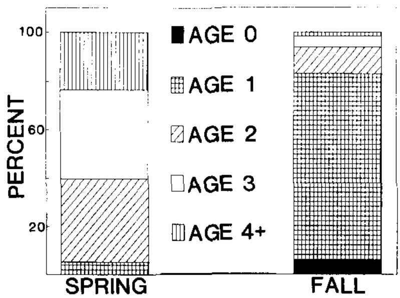

Figure 4. Seasonal age frequency of white crappie sampled by trap nets from 3 Oklahoma impoundments, 1983–1986.

Spring trapnet samples fail to sample age-0 and age-1 crappie in proportion to their abundance in the population as evidenced by the greater proportion of age-2 individuals present than age 1 (Fig. 4). Fall trapnet samples were also biased against age-0 crappie as evidenced by a greater proportion of age 1 in the sample than age-0. By excluding ages 0 and 1 from the seasonal age-frequency comparisons, bias resulting from differences in capture vulnerability by age would be reduced. The age distribution of age-2 and older crappie in the fall samples more closely represented the expected proportionate decline in successive age classes than did the spring samples (Fig. 5).

Discussion

The objective of most population studies or surveys conducted by management agencies is to determine annual trends in population structure. All sampling methods contain some inherent bias; therefore, the challenge facing management agencies is to choose a sampling program that minimizes sampling bias for target species while staying within ever present budget constraints. Among-gear as well as within-gear biases must be recognized to ensure that data are collected by the most precise methods possible.

The efficiency of trap nets in sampling crappie has been known for some time. Bennett and Brown (1968) found that trap nets sampled 38% of the crappie popula-

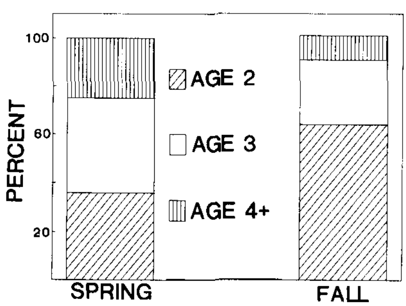

Figure 5. Seasonal age frequency, excluding ages 0 and 1, of white crappie sampled by trap nets from 3 Oklahoma impoundments, 1983–1986.

tion in a small Oklahoma impoundment, while electrofishing and gill nets collected few crappie in the same study. Higher trapnet catches in each month sampled, observed in this study (Fig. 1), indicated that the greater sampling efficiency of trap nets, compared to electrofishing and gillnetting, was not biased by sampling date. The fact that trapnet samples contained more fish of each age class per unit of effort also indicated that the increased efficiency observed was not the result of a select age group biasing the comparisons.

Estimates of recruitment are essential to evaluating trends in population dynamics. Fall trap nets were the only gear in this study to collect substantial numbers of age-0 crappie. Although trap nets did not collect age-0 crappie in proportion to their abundance in the population (Fig. 4; Colvin and Vasey 1986), fall trap nets gave a relative index of year-class strength among years, which electrofishing and gillnet samples were unable to provide.

Variability in sample data is an important consideration in developing a sampling program. Low variability indicates that fewer samples are required to detect significant population changes with a fixed degree of confidence. Variability in the trapnet catch data was significantly lower than that of the electrofishing and gillnetting catch data in 3 of 4 months sampled (Fig. 2). Increased frequency of unstable weather patterns in Oklahoma in November may impact fish movement patterns and have a subsequent effect on catch efficiency of passive gear types. To reduce bias associated with increased variability in catch rates of trapnet samples, November sampling should be eliminated.

There is a temptation to select sampling methods that catch fair numbers of many species (electrofishing and gill nets) rather than a species-specific method such as trap nets. Only by comparing sample variances for different species can we determine what is sacrificed in terms of management information. In this study, we found that white crappie were poorly sampled with electrofishing and gill netting compared with trapnetting. Future studies need to determine which species are most effectively sampled by which gears. Measures of sampling effectiveness are arbitrary but sample size required to be within ±20% of the true mean or to detect 50% or 100% changes in populations with 80% confidence (Sokal and Rohlf 1969) are starting places.

Length data are one of the frequently used means of evaluating the quality of a sport fish population for angling. Very often, data from different gears are used to make this evaluation without regard for size-related biases in catchability among gear types. Size-related biases in rate of capture have been reported in the literature for trap nets (Laarman and Ryckman 1982, Colvin and Vasey 1986), electrofishing (Reynolds 1983), and gill nets (Crandall et al. 1976). Differences in length frequencies and mean lengths among and within gears by month, season, and year were observed in this study. Within gear differences in the length distribution of a population sample would be expected to change with time given the effects of recruitment, growth, and mortality. However, within gear variability in length data have been reported within a sampling season (Carline et al. 1984) and even between day and night samples collected in the same 24-hour period (Gilliland 1985). Managers must be concerned that the gear used to collect the sample provides as true a picture of the population length structure as possible. Figure 3 illustrates the differences in length distributions provided by trapnetting and electrofishing samples collected at the same time. The April electrofishing sample overly represented large individuals. This sample was collected during the peak of the spawning season when large, sexually-mature crappie were concentrated near shore, thereby increasing their vulnerability to capture. The May electrofishing sample more closely resembled the April and May trapnet samples. The spawning season had subsided in May; consequently large, spawning adult crappie moved offshore and were less vulnerable to capture by electrofishing.

Temporal biases were also evident in the length and age data from the trapnet samples. Greater proportions of larger and older crappie were generally collected in trap nets sampled in spring than in fall (Fig. 4). Angler harvest undoubtedly reduced the number of large crappie available for capture between the spring and fall samples. Increased movement associated with spawning activity would also make the larger sexually-mature crappie more vulnerable to capture by trap nets in the spring.

To reduce short-term temporal biases, trend data should be collected at approximately the same date each year. Given the number of lakes most managers must survey annually, this may not always be practical. Consequently, choosing a sampling gear and season least effected by short-term temporal biases would be preferred. In this study, mean catches in trap nets were similar in October and November, whereas they differed significantly in April and May.

Management Recommendations

Increased sampling efforts aimed at collection of reliable population data on crappie are warranted given their desireability among southern anglers. Fall trapnet samples are recommended for the following reasons:

1. A relative indication of year-class strength was provided by catches of age-0 crappie in the fall.
2. A lower amount of sampling effort was required to collect reproducible data on catch rates.
3. Age structure appeared to better approximate expected age frequencies.
4. Managers would have more reliable information on which to base predictions of numbers and sizes of crappie available to the anglers.

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