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# A COMPARISON OF SUMMER GILL NETTING AND TRAP NETTING TO FALL TRAP NETTING FOR SAMPLING CRAPPIE POPULATIONS IN MINNESOTA LAKES[1]

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*Abstract.*--Summer (June through August) gill netting and trap netting for sampling black crappie *Pomoxis nigromaculatus* and white crappie *P. annularis* was compared to fall trap netting in Minnesota lakes. No clear advantage for evaluating abundance and size structure of crappie populations was evident in 40 lakes netted during both summer and fall. Catch-per-unit-effort (CPUE) of black crappie in gill nets was significantly lower than CPUE in trap nets for 2,811 surveys from the statewide data base, but white crappie CPUE in gill nets was significantly higher than CPUE in trap nets. Significantly smaller individuals of both species were captured in gill nets. Black crappie CPUE in gill nets was more precise, while black crappie CPUE in trap nets was better correlated with angler catch per hour and harvest per hectare. White crappie CPUE in gill nets was also more precise, but neither CPUE in gill nets nor in trap nets was significantly correlated with angler catch indices. A negative correlation existed between net catch length frequencies and angler harvest length frequencies. Catch distributions of black crappie in gill nets was less positively skewed than catch distributions in trap nets in summer or fall. Skewness of catch distributions and coefficient of variation of black crappie CPUE in trap nets were significantly affected by the number of locations sampled. Trap net catches in lakes where less than seven locations were sampled appeared not to be representative of the true population. Length-frequency distributions of black crappie differed significantly between gear in 42% of the sampled lakes, and length-frequency distributions of white crappie differed significantly in 70% of the lakes. Fall trap netting caught a larger range of lengths than summer gill netting or trap netting, and crappie > 254 mm or <76 mm were more likely to be caught. Fall trap netting should be considered in large deep lakes when the summer survey catch is inadequate.

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## Introduction

Populations of black crappie *Pomoxis nigromaculatus* and white crappie *P. annularis* in Minnesota lakes have been sampled during standard lake surveys with experimental gill nets since 1935 and trap nets since 1951 (Schupp 1992). Most lake surveys have been done during summer (June through August) because net catches were thought to be less variable than net catches during spring or fall (Scidmore 1970). Many species move less in summer and age 0-fish would not reach sizes susceptible to capture (Scidmore 1970).

Studies elsewhere have shown that catch-per-unit-effort (CPUE) of black crappie and white crappie in trap and gill nets varied among months sampled. CPUE of both crappie species in gill nets and trap nets in Iowa impoundments varied substantially among months, however, seasonal trends were not observed (McWilliams et al. 1974). Kelley (1953) reported that black crappie CPUE in trap nets set in the backwaters of Pool 8 of the Mississippi River was significantly higher in spring and fall than in summer, but white crappie CPUE did not differ significantly among seasons. CPUE of stock-sized black crappie in trap nets in a natural South Dakota lake was also significantly higher in spring and fall than during summer (Guy and Willis 1991).

Spring or fall trap netting accurately reflected age and size structures, and densities of black and white crappie caught by angling in some impoundments. Black crappie CPUE during spring and fall were significantly correlated with catch rates of black crappie by anglers during the same seasons (McInerny 1988). Length frequencies of black crappie caught in 19 mm bar mesh trap nets and by anglers in spring, and in 25 mm mesh trap nets and by anglers in fall did not significantly differ (McInerny 1988). White crappie CPUE in fall or spring trap netting were significantly correlated with angler harvest in Missouri and Mississippi reservoirs (Colvin and Vasey 1986; Colvin 1991; Miranda 1990). Boxrucker and Ploskey (1988) reported that fall trap netting provided higher catch and better estimates of age and size structure of white crappie populations in Oklahoma reservoirs than spring trap netting, spring or fall electrofishing, or fall gill netting. Effectiveness of summer gill and trap netting to estimate abundance and size structure of black and white crappie populations in natural Minnesota lakes has not been determined.

Study objectives were to determine how well summer gill and trap netting reflected abundance and size structure of black and white crappie populations in Minnesota lakes, and to compare summer net catches to fall trap net catches.

## Methods

### *Data Collection*

Three data sets were used to evaluate summer gill and trap netting of black and white crappie. Data on CPUE and mean weight (total pounds/total number of crappie caught per lake) in experimental gill and trap nets set during summer (June through August) were acquired from the statewide data base. This data base contained records from standard lake surveys and assessments conducted in Minnesota lakes between 1951 and 1989 (Schupp 1992). Black crappie were caught in 2,811 surveys and white crappie in 280 surveys.

Black and white crappie populations in 40 lakes (21 to 442 hectares; 1.2 to 33 m deep) were sampled with trap nets during fall 1989, 1990, or 1991 (Table 1). Fifteen locations equidistant from each other within each lake were netted. All captured crappie were identified, and total lengths were measured to the nearest mm. Scales from five individuals from each 1-cm length group were removed and aged. Age-0 crappie were identified by aging scale impressions made on acetate strips.

Data from standard lake surveys or assessments done in the same 40 lakes during the summer (June, July, or August) of the same year were obtained from management. Data included number of gill and trap net sets, number of black and white crappie per gill and trap net lift, and length-frequency distributions (13 mm length groups if $<$ 304 mm; 25 mm length groups if $\geq$ 304 mm) of each crappie species in gill and trap nets. Two to 12 locations within each lake were sampled with experimental gill

Table 1. Maximum depth (m) and surface area (hectares) of 40 Minnesota lakes sampled for black and white crappie during 1989, 1990, or 1991.

| Lake | County | Year sampled | Maximum depth | Surface Area |
|---|---|---|---|---|
| Crystal | Blue Earth | 1991 | 3.0 | 154 |
| Duck | Blue Earth | 1990 | 7.6 | 117 |
| George | Blue Earth | 1990 | 8.5 | 32 |
| Loon | Blue Earth | 1991 | 2.1 | 305 |
| Mountain | Cottonwood | 1990 | 2.4 | 88 |
| Andrew | Douglas | 1991 | 24.4 | 393 |
| Blackwell | Douglas | 1990 | 12.5 | 113 |
| Freeborn | Douglas | 1990 | 5.5 | 98 |
| Maple | Douglas | 1991 | 23.8 | 330 |
| Oscar | Douglas | 1990 | 5.8 | 255 |
| Pocket | Douglas | 1990 | 10.7 | 111 |
| Clear | Jackson | 1990 | 2.7 | 183 |
| Fish | Jackson | 1990 | 8.2 | 116 |
| Round | Jackson | 1990 | 2.7 | 414 |
| Andrew | Kandiyohi | 1990 | 7.9 | 329 |
| Carrie | Kandiyohi | 1989 | 7.9 | 33 |
| Elizabeth | Kandiyohi | 1991 | 2.7 | 427 |
| Florida | Kandiyohi | 1991 | 12.2 | 273 |
| Games | Kandiyohi | 1991 | 12.8 | 208 |
| Henderson | Kandiyohi | 1991 | 12.8 | 30 |
| Little Bass | Kandiyohi | 1989 | 9.1 | 21 |
| Long | Kandiyohi | 1990 | 13.7 | 116 |
| Emily | Lesueur | 1990 | 11.3 | 110 |
| Rays | Lesueur | 1990 | 9.8 | 63 |
| Big Swan | Meeker | 1989 | 9.8 | 254 |
| Betsy | Meeker | 1989 | 8.8 | 60 |
| Dunn | Meeker | 1991 | 6.1 | 57 |
| Long | Meeker | 1989 | 8.5 | 66 |
| Richardson | Meeker | 1989,1991 | 14.3 | 45 |
| Union | Meeker | 1989 | 10.6 | 36 |
| First Fulda | Murray | 1989 | 2.7 | 48 |
| Sarah | Murray | 1989 | 1.2 | 442 |
| Scandinavian | Pope | 1991 | 14.9 | 160 |
| Fox | Rice | 1991 | 14.3 | 125 |
| Horseshoe | Stearns | 1990 | 17.4 | 223 |
| Cedar | Wright | 1991 | 32.9 | 339 |
| French | Wright | 1990 | 15.2 | 134 |
| Granite | Wright | 1991 | 10.4 | 137 |
| Ida | Wright | 1990 | 7.9 | 32 |
| Pleasant | Wright | 1991 | 22.6 | 206 |

nets and 3 to 14 locations with trap nets. Generally, more locations were sampled in larger lakes.

Summer gill and trap netting was also done in conjunction with creel surveys on 32 lakes. Most creel surveys were conducted between mid-May and late September-early October. Fishing pressure was estimated from angler counts. Numbers of harvested black and white crappie were estimated from angler interviews (Malvestuto 1983). Madison Lake, Blue Earth County, was the only lake where sufficient numbers of black and white crappie were measured during a creel survey, and where both species were captured in trap and gill nets.

Experimental gill nets used in this study were 76 m long by 1.8 m deep, and consisted of five 15.2 m panels of 38, 51, 64, 76, and 102 mm mesh stretch. Trap nets consisted of a single 0.9 x 12.2 m lead attached to a double 0.9 x 1.8 m frame with a codend consisting of five 0.8 m diameter hoops. Mesh size of all trap nets was 19 mm bar mesh. Gill nets were set on the bottom, off shore, and at or above the thermocline. Leads of trap nets were usually secured to the shore, and nets were stretched perpendicular to the shoreline. Trap nets were set off shore when water depths were too shallow to immerse the net throat or when aquatic macrophytes along the shore were so dense that the lead line of the net lead did not contact the lake bottom. All gill and trap nets were set during the day and lifted the following day.

*Data Analyses*

Kruskal-Wallis tests (H) were used to determine if CPUE or mean weight per lift of black crappie and white crappie differed significantly ($P \leq 0.05$) between gill and trap nets from the statewide data base (Zar 1974). Spearman's rank correlations were used to determine if associations between CPUE in gill and trap nets were significant (Zar 1974).

Mean CPUE of black and white crappie in summer gill nets, summer trap nets, and fall trap nets were calculated for each of the 40 sampled lakes. Coefficient of variation (CV) of CPUE, skewness coefficients of the catch distribution, and range of catch of each species by gear type were also calculated for each lake. Total lengths, measured in fall, were converted to English units, and grouped into 0.5-in length groups if < 12 in and into 1.0-in groups if ≥ 12 in for comparisons with standard lake survey data. Numbers of 0.5-in and 1.0-in length groups of black and white crappie in summer gill nets, summer trap nets, and fall trap nets for each lake were determined.

One way ANOVA or Kruskal-Wallis tests were used to determine if mean CPUE, mean CV of CPUE (when CPUE ≥ 1/lift), mean skewness coefficients, mean range of catch, and mean range of 0.5- and 1.0-in length groups among lakes differed significantly among gear-season combinations (Zar 1974). Chi-square contingency tests were used to determine if length-frequency distributions of each crappie species in summer gill and trap nets, and angler catch were significantly different. Associations among selected variables were analyzed with Spearman's rank correlations.

Influences of individual net catches on CPUE of black and white crappie were also analyzed. Effects of the high and low net catch on the variation of CPUE among lakes were determined by regression analyses. Coefficients of variation of CPUE, excluding the net with the highest catch, were compared with CV of CPUE including all catches for each netting at each lake. Analysis of variance or Kruskal-Wallis tests were used to determine if CV (when CPUE ≥ 1/lift) including and excluding the highest net catch among lakes significantly differed. The highest net catch was interpreted to affect CV of CPUE if CV including the highest net catch differed significantly from CV excluding the highest net catch.

## Results

### *Summer Gill Netting Vs Summer Trap Netting*

*Statewide Database*.--Gill nets caught significantly fewer and smaller black crappie, but caught significantly more and smaller white crappie than summer trap net sets (Tables 2 and 3). CPUE of black crappie in gill nets was significantly correlated with CPUE of black crappie in trap nets, and CPUE of white crappie in gill nets was significantly correlated with CPUE of white crappie in trap nets (Table 4).

### *Summer Surveys and Assessments, 1989-1991*

Black crappie were caught in gill nets in 36 lakes and in trap nets in 39 of the 40 sampled lakes (Table 5). White crappie were caught in gill nets in 10 lakes and in trap nets in 11 lakes (Table 6).

Gill nets also caught fewer black and white crappie than summer trap nets in the 40 sampled lakes, but the differences were not significant (Tables 2 and 3). CPUE in gill nets was significantly correlated with CPUE in trap nets for black crappie (Table 4). The correlation for white crappie was not significant.

Variation in net catches within lakes was inversely related to CPUE. Rank correlations between CPUE and CV of CPUE ranged from - 0.61 to -0.84 (all significant, $P < 0.05$) for the four combinations of species and netting.

Relative variation was lower among lakes with high CPUE than among lakes with low CPUE for both gears. Coefficients of variation of black and white crappie CPUE in gill and trap nets were frequently below 100 when CPUE was ≥ 1/lift, but almost always above 100 when CPUE was < 1/lift (Tables 5 and 6).

Mean CV of black crappie CPUE in gill nets among lakes was lower, but did not differ significantly from mean CV in trap nets when CPUE of both gears was ≥ 1/lift (Table 2). Mean CV of white crappie CPUE in gill nets, however, was significantly lower than mean CV of white crappie CPUE in summer trap nets among lakes when both CPUEs were ≥ 1/lift (Table 3).

Catch ranges of black and white crappie in gill and trap nets were often wide (> 50), and distributions of net catches of each species in each gear were usually positively skewed (Tables 5 and 6). Mean ranges of black crappie catch in gill and trap nets among lakes did not differ significantly (Table 2). The mean range of white crappie catch in gill nets among lakes was significantly lower than the mean range of catch in trap nets (Table 3). Catch distributions of black crappie in gill nets among lakes were significantly less skewed than catch distributions in trap nets (Table 2). Skewness of white crappie catch distributions between gill and trap nets did not differ significantly among lakes (Table 3).

Length-frequency distributions of both crappie species differed between gill and trap nets. Gill nets usually caught smaller crappie than trap nets (Table 7). Length frequencies of black crappie caught in gill and trap nets differed significantly in 42% of the sampled lakes where black crappie were caught in both gear types (Table 8). Length frequencies of black crappie between gears differed significantly in

Table 2. Mean catch-per-unit-of-effort, mean weight per fish, mean coefficient of variation of CPUE (when CPUE ≥ 1/lift), mean skewness coefficients of catch distributions, mean range of net catches (when CPUE ≥ 1/lift), and mean range of 12.7 mm (0.5-in) and 25.4 mm (1.0-in) length groups of black crappie among Minnesota lakes during summer gill netting (SGN) and summer trap netting (STN), summer gill netting and fall trap netting (FTN), and summer trap netting and fall trap netting.

| Variable | Means | | Statistic | df | *P* |
|---|---|---|---|---|---|
| *Summer gill netting versus summer trap netting* | | | | | |
| Catch-per-unit-effort[a] | SGN = 8.1 | STN = 9.6 | $H$ = 6.00 | 1 | 0.0142 |
| Mean weight per fish (lbs)[a] | SGN = 0.30 | STN = 0.35 | $H$ = 171.5 | 1 | <0.0001 |
| Catch-per-unit-effort[b] | SGN = 12.5 | STN = 33.5 | $H$ = 1.78 | 1 | 0.1813 |
| Coefficient of variation | SGN = 80 | STN = 96 | $F$ = 3.58 | 1,52 | 0.0640 |
| Skewness coefficient | SGN = 0.44 | STN = 0.85 | $F$ = 5.48 | 1,66 | 0.0222 |
| Range of net catches | SGN = 25 | STN = 33 | $F$ = 1.25 | 1,52 | 0.2694 |
| Range of length groups (in) | SGN = 3.2 | STN = 3.9 | $F$ = 1.97 | 1,80 | 0.1638 |
| *Summer gill netting versus fall trap netting* | | | | | |
| Catch-per-unit-effort | SGN = 10.8 | FTN = 9.7 | $F$ = 0.12 | 1,80 | 0.7293 |
| Coefficient of variation | SGN = 73 | FTN = 128 | $F$ = 45.10 | 1,46 | <0.0001 |
| Skewness coefficient | SGN = 0.42 | FTN = 1.52 | $F$ = 53.97 | 1,66 | <0.0001 |
| Range of net catches | SGN = 26 | FTN = 61 | $H$ = 5.63 | 1 | 0.0177 |
| Range of length groups (in) | SGN = 3.2 | FTN = 6.0 | $F$ = 32.99 | 1,80 | <0.0001 |
| *Summer trap netting versus fall trap netting* | | | | | |
| Catch-per-unit-effort | STN = 14.4 | FTN = 9.7 | $H$ = 0.50 | 1 | 0.4780 |
| Coefficient of variation | STN = 94 | FTN = 128 | $F$ = 13.10 | 1,46 | 0.0007 |
| Skewness coefficient | STN = 0.91 | FTN = 1.54 | $F$ = 13.34 | 1,72 | 0.0005 |
| Range of net catches | STN = 35 | FTN = 57 | $H$ = 1.26 | 1 | 0.2609 |
| Range of length groups (in) | STN = 3.9 | FTN = 6.0 | $F$ = 18.62 | 1,80 | <0.0001 |

[a] Statewide lake survey data base [b] Forty lakes, 1989-1991

Table 3. Mean catch-per-unit-of-effort, mean weight per fish, mean coefficient of variation of CPUE (when CPUE ≥ 1/lift), mean skewness coefficients of catch distributions, mean range of net catches (when CPUE ≥ 1/lift), and mean range of 12.7 mm (0.5-in) and 25.4 mm (1.0-in) length groups of white crappie among Minnesota lakes during summer gill netting (SGN) and summer trap netting (STN), summer gill netting and fall trap netting (FTN), and summer trap netting and fall trap netting.

| Variable | Means | | Statistic | df | *P* |
|---|---|---|---|---|---|
| *Summer gill netting versus summer trap netting* | | | | | |
| Catch-per-unit-effort[a] | SGN = 10.8 | STN = 10.1 | $H$ = 4.21 | 1 | 0.0402 |
| Mean weight per fish (lbs)[a] | SGN = 0.25 | STN = 0.33 | $H$ = 47.5 | 1 | <0.0001 |
| Catch-per-unit-effort[b] | SGN = 10.8 | STN = 14.3 | $H$ = 0.60 | 1 | 0.4358 |
| Coefficient of variation | SGN = 38 | STN = 98 | $F$ = 19.58 | 1,10 | 0.0013 |
| Skewness coefficient | SGN = 0.50 | STN = 0.83 | $H$ = 1.03 | 1 | 0.3099 |
| Range of net catches | SGN = 25 | STN = 157 | $H$ = 6.59 | 1 | 0.0103 |
| Range of length groups (in) | SGN = 2.3 | STN = 2.3 | $F$ = 0.00 | 1,24 | 0.9599 |
| *Summer gill netting versus fall trap netting* | | | | | |
| Catch-per-unit-effort | SGN = 12.5 | FTN = 4.4 | $H$ = 0.01 | 1 | 0.9181 |
| Coefficient of variation | SGN = 38 | FTN = 100 | $F$ = 11.49 | 1,10 | 0.0069 |
| Skewness coefficient | SGN = 0.63 | FTN = 1.28 | $F$ = 2.33 | 1,18 | 0.1445 |
| Range of net catches | SGN = 25 | FTN = 29 | $F$ = 0.06 | 1,10 | 0.8081 |
| Range of length groups (in) | SGN = 2.3 | FTN = 5.0 | $F$ = 7.40 | 1,24 | 0.0119 |
| *Summer trap netting versus fall trap netting* | | | | | |
| Catch-per-unit-effort | STN = 33.4 | FTN = 4.4 | $H$ = 1.71 | 1 | 0.1908 |
| Coefficient of variation | STN = 113 | FTN = 106 | $F$ = 0.11 | 1,14 | 0.7424 |
| Skewness coefficient | STN = 0.86 | FTN = 1.36 | $H$ = 1.40 | 1 | 0.2371 |
| Range of net catches | STN = 125 | FTN = 23 | $H$ = 4.88 | 1 | 0.0272 |
| Range of length groups (in) | STN = 2.3 | FTN = 5.0 | $F$ = 8.94 | 1,24 | 0.0064 |

[a] Statewide lake survey data base [b] Forty lakes, 1989-1991

Table 4. Spearman's rank correlation coefficients (by crappie species) for comparisons of CPUE among summer gill netting, summer trap netting and fall trap netting, and for comparisons between CPUE determined during summer netting and angler catch per hour, and harvest per acre in Minnesota lakes.

| Comparison | *r* | df | *P* |
|---|---|---|---|
| | **BLACK CRAPPIE** | | |
| Summer gill netting vs summer trap netting[a] | 0.51 | 2,809 | <0.01 |
| Summer gill netting vs summer trap netting[b] | 0.47 | 39 | <0.01 |
| Summer gill netting vs fall trap netting | 0.43 | 39 | <0.01 |
| Summer trap netting vs fall trap netting | 0.53 | 39 | <0.01 |
| Summer gill netting vs angler catch per hour | 0.36 | 32 | <0.05 |
| Summer gill netting vs angler harvest per acre | 0.48 | 32 | <0.01 |
| Summer trap netting vs angler catch per hour | 0.51 | 24 | <0.01 |
| Summer trap netting vs angler harvest per acre | 0.61 | 24 | <0.01 |
| | **WHITE CRAPPIE** | | |
| Summer gill netting vs summer trap netting[a] | 0.42 | 278 | <0.01 |
| Summer gill netting vs summer trap netting[b] | 0.52 | 11 | >0.05 |
| Summer gill netting vs fall trap netting | 0.74 | 11 | <0.01 |
| Summer trap netting vs fall trap netting | 0.85 | 11 | <0.01 |
| Summer gill netting vs angler catch per hour | 0.17 | 7 | >0.05 |
| Summer gill netting vs angler harvest per acre | 0.18 | 7 | >0.05 |
| Summer trap netting vs angler catch per hour | 0.53 | 7 | >0.05 |
| Summer trap netting vs angler harvest per acre | 0.58 | 7 | >0.05 |

[a] Statewide lake survey data base [b] Forty lakes, 1989-1991

29% of June, 35% of July, and 75% of the August samples (Table 8). Length frequencies of white crappie in gill and trap nets differed significantly in 70% of the sampled lakes, but no seasonal trend was evident (Table 8).

*Summer Netting Vs Fall Trap Netting*

Mean CPUE, CV of CPUE, and ranges of net catches of both crappie species in fall trap nets varied considerably among lakes (Tables 5 and 6). Catch distributions of black and white crappie in fall trap nets within each lake were all positively skewed (Tables 5 and 6).

CPUE of each crappie species in summer gill and trap nets were similar to CPUE in fall trap nets. Mean black crappie CPUE in summer gill or trap nets among lakes did not differ significantly from mean black crappie CPUE in fall trap nets (Table 2). Mean CPUE of white crappie in summer gill and trap nets among lakes were higher than CPUE of white crappie in fall trap nets, however, differences were not significant (Table 3). CPUE among each gear-season combination for both species were positively correlated and significant (Table 4).

Two notable exceptions were observed where substantially more black crappie were caught by fall trap netting than by summer netting. Fifteen total crappie were caught from both Andrew and Maple lakes in Douglas County during summer net surveys. Mean CPUE in fall trap nets was 38.6 at Andrew Lake and 8.5 at Maple Lake (Table 5). Both lakes are larger than 315 hectares and maximum depths exceed 23 m (Table 1). Net catches from Cedar Lake in Wright County were highest during summer surveys (Table 5). Cedar Lake was the deepest (32.9 m) lake netted and exceeds 315 hectares (Table 1).

Differences in CPUE of summer netting for black crappie were related to lake size and depth (Table 9). Summer gill net CPUE was significantly higher from lakes $\leq$ 121 hectares than from lakes > 121 hectares regardless of depth. Summer trap net CPUE was significantly higher from lakes $\leq$ 121 hectares with maximum depths > 9 m, but not from shallower lakes. There were no significant differences in CPUE of fall trap nets related to lake size and depth.

Variation in fall trap net catches was inversely related to CPUE for both crappie spe-

Table 5. CPUE of black crappie ≥ age-1 caught in summer gill nets, summer trap nets, and fall trap nets (standard error in parentheses), coefficients of variation (CV) of CPUE, coefficient of variation of CPUE excluding the highest net catch (CVM), range of net catches, skewness coefficients of net catch distributions (Skew), and number of nets set (N) at 40 lakes in Minnesota, 1989-1991.

| | Summer Gill Nets | | | | | Summer Trap Nets | | | | | Fall Trap Nets | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lake | CPUE(SE) | CV(CVM) | Range | Skew | N | CPUE(SE) | CV(CVM) | Range | Skew | N | CPUE(SE) | CV(CVM) | Range | Skew | N |
| Crystal | 0.4(0.2) | 137(200) | 0-1 | 0.41 | 5 | 3.2(1.4) | 112(117) | 0-9 | 0.82 | 6 | 7.5(3.2) | 165(137) | 0-46 | 2.28 | 15 |
| Duck | 17.5(5.0) | 69(51) | 3-39 | 0.82 | 6 | 11.8(3.4) | 58(72) | 2-17 | -0.84 | 4 | 2.6(0.9) | 131(119) | 0-12 | 1.50 | 15 |
| George | 34.2(11.0) | 64(81) | 3-51 | -0.84 | 4 | 2.3(1.3) | 99(0) | 1-5 | 0.71 | 3 | 10.9(2.3) | 81(75) | 0-31 | 0.74 | 15 |
| Loon | 3.8(0.9) | 45(33) | 2-6 | 0.43 | 4 | 23.1(4.3) | 52(47) | 6-44 | 0.34 | 8 | 14.3(3.3) | 90(74) | 0-49 | 1.23 | 15 |
| Mountain | 1.4(0.7) | 108(141) | 0-3 | 0.21 | 5 | 18.5(11.2) | 171(90) | 0-95 | 2.09 | 8 | 4.1(1.2) | 105(104) | 0-13 | 0.91 | 13[a] |
| Andrew (Douglas) | 1.2(0.5) | 91(115) | 0-2 | -0.41 | 5 | 0.4(0.3) | 198(265) | 0-2 | 1.56 | 8 | 38.6(12.4) | 124(133) | 0-126 | 0.84 | 15 |
| Blackwell | 31.8(11.2) | 71(81) | 6-56 | -0.08 | 4 | 5.9(1.8) | 85(90) | 2-13 | 0.66 | 8 | 22.2(10.6) | 185(179) | 1-145 | 2.14 | 15 |
| Freeborn | 0(0) | | | | 3 | 0.2(0.2) | 185(265) | 0-1 | 1.15 | 8 | 0.8(0.4) | 172(191) | 0-4 | 1.40 | 15 |
| Maple | 1.6(0.5) | 71(77) | 0-3 | -0.27 | 5 | 0.7(0.4) | 133(167) | 0-2 | 0.59 | 7 | 8.5(2.7) | 123(124) | 0-32 | 1.01 | 15 |
| Oscar | 5.2(1.2) | 67(70) | 0-10 | 0.17 | 8 | 7.2(2.8) | 143(129) | 0-36 | 1.70 | 14 | 2.5(1.0) | 153(111) | 0-15 | 2.44 | 15 |
| Pocket | 1.3(0.9) | 115(141) | 0-3 | 0.38 | 3 | 14.8(7.2) | 119(129) | 0-44 | 0.79 | 6 | 13.7(4.4) | 123(128) | 0-49 | 0.91 | 15 |
| Fish | 0(0) | | | | 4 | 3.8(1.3) | 102(77) | 0-12 | 1.35 | 8 | 0.9(0.4) | 156(136) | 0-5 | 1.88 | 13[a] |
| Clear | 0.2(0.2) | 200(∞) | 0-1 | 1.16 | 4 | 0.2(0.2) | 282(∞) | 0-2 | 2.27 | 8 | 0.6(0.3) | 203(205) | 0-4 | 2.13 | 14[a] |
| Round | 1.0(0.5) | 122(115) | 0-3 | 0.91 | 5 | 4.9(1.2) | 71(76) | 0-9 | 0.07 | 8 | 2.1(0.6) | 100(96) | 0-7 | 1.05 | 15 |
| Andrew (Kandi.) | 0(0) | | | | 3 | 0.4(0.4) | 283(∞) | 0-3 | 2.27 | 8 | 2.6(1.5) | 225(137) | 0-23 | 3.10 | 15 |
| Carrie | 16.0(3.0) | 26(∞) | 13-19 | 0.00 | 2 | 18.2(7.4) | 91(87) | 0-43 | 0.54 | 5 | 11.8(5.2) | 172(113) | 0-80 | 2.74 | 15 |
| Elizabeth | 1.6(1.2) | 163(200) | 0-6 | 1.15 | 5 | 7.2(2.5) | 102(68) | 1-25 | 1.71 | 9 | 0.6(0.3) | 168(190) | 0-3 | 1.51 | 14[a] |
| Florida | 0.5(0.3) | 115(173) | 0-1 | 0.00 | 4 | 0(0) | | | | 10 | 1.1(0.4) | 152(128) | 0-6 | 2.06 | 15 |
| Games | 1.4(0.4) | 81(79) | 0-3 | -0.04 | 5 | 3.0(1.7) | 135(77) | 0-11 | 1.79 | 6 | 15.3(9.3) | 201(126) | 0-105 | 2.55 | 11[a] |
| Henderson | 0(0) | | | | 4 | 10.8(4.6) | 96(67) | 1-28 | 1.00 | 5 | 2.1(0.4) | 79(70) | 0-6 | 0.92 | 15 |
| Little Bass | 1.0(1.0) | 141(∞) | 0-2 | 0.00 | 2 | 1.8(0.9) | 107(82) | 0-5 | 1.02 | 5 | 0.2(0.1) | 280(374) | 0-2 | 2.62 | 15 |
| Long (Kandi.) | 7.3(4.0) | 93(61) | 2-15 | 0.56 | 3 | 9.0(3.9) | 138(154) | 1-33 | 1.46 | 10 | 0.5(0.2) | 172(177) | 0-3 | 1.63 | 15 |
| Emily | 61.3(16.1) | 64(38) | 26-135 | 1.18 | 6 | 114.0(23.4) | 106(22) | 78-158 | 0.35 | 3 | 80.3(29.2) | 141(147) | 0-338 | 1.38 | 15 |
| Rays | 40.0(8.5) | 52(42) | 20-74 | 0.66 | 6 | 13.8(6.3) | 91(123) | 1-25 | -0.05 | 4 | 6.7(2.1) | 121(119) | 0-26 | 1.15 | 15 |
| Big Swan | 18.8(5.1) | 95(101) | 0-46 | 0.24 | 12 | 1.4(0.6) | 129(153) | 0-4 | 0.72 | 8 | 1.9(0.6) | 121(124) | 0-7 | 1.29 | 15 |
| Betsy | 11.3(3.6) | 78(70) | 4-26 | 0.72 | 6 | 5.2(2.3) | 97(47) | 1-14 | 1.27 | 5 | 7.3(2.5) | 134(80) | 0-40 | 2.65 | 15 |
| Dunn | 14.7(3.6) | 59(42) | 5-30 | 0.84 | 6 | 11.2(3.9) | 70(88) | 0-18 | -0.83 | 4 | 5.9(1.5) | 100(91) | 0-21 | 1.35 | 15 |
| Long (Meeker) | 8.5(3.4) | 99(48) | 3-25 | 1.52 | 6 | 4.2(1.4) | 65(75) | 1-7 | -0.19 | 4 | 12.7(4.8) | 146(142) | 0-62 | 1.55 | 15 |
| Richardson(1989) | 60.7(9.4) | 38(31) | 32-97 | 0.40 | 6 | 31.0(14.7) | 95(49) | 11-74 | 0.99 | 4 | 15.3(5.1) | 128(121) | 0-66 | 1.37 | 15 |
| Richardson(1991) | 19.8(5.5) | 68(52) | 9-43 | 0.88 | 6 | 46.5(21.9) | 94(100) | 1-103 | 0.36 | 4 | 6.7(2.2) | 129(135) | 0-25 | 1.26 | 15 |
| Union | 6.5(1.8) | 69(69) | 0-13 | 0.00 | 6 | 1.8(0.9) | 98(100) | 0-4 | 0.43 | 4 | 0.7(0.3) | 146(152) | 0-3 | 1.18 | 15 |
| First Fulda | 10.0 | | | | 2 | 32.8 | | | | 5 | 19.9(3.2) | 63(57) | 1-48 | 0.60 | 15 |
| Sarah | 2.2 | | | | 4 | 14.0 | | | | 5 | 8.3(3.7) | 170(122) | 0-55 | 2.59 | 15 |
| Scandinavian | 1.8(0.5) | 61(67) | 0-3 | -0.87 | 5 | 0.1(0.1) | 283(∞) | 0-1 | 2.27 | 8 | 0.5(0.1) | 111(120) | 0-1 | 0.13 | 15 |
| Fox | 2.0(1.1) | 108(100) | 0-5 | 0.69 | 4 | 0.2(0.2) | 200(∞) | 0-1 | 1.15 | 4 | 0(0) | | | | 15 |
| Horseshoe | 4.0(1.8) | 118(80) | 1-14 | 1.59 | 7 | 21.3(6.1) | 91(78) | 2-64 | 1.18 | 10 | 29.3(5.8) | 77(70) | 4-82 | 0.96 | 15 |
| Cedar | 3.8(1.3) | 95(82) | 0-11 | 1.12 | 8 | 5.0(1.8) | 112(84) | 0-19 | 1.64 | 10 | 0.6(0.32) | 164(176) | 0-3 | 1.33 | 15 |
| French | 22.5(3.2) | 35(24) | 13-36 | 0.69 | 6 | 112.7(16.6) | 36(38) | 58-154 | -0.23 | 6 | 31.2(9.7) | 121(121) | 0-117 | 1.38 | 15 |
| Granite | 14.5(3.0) | 50(52) | 6-23 | 0.00 | 6 | 9.4(3.9) | 109(49) | 2-32 | 1.78 | 7 | 2.9(1.1) | 143(139) | 0-14 | 1.50 | 15 |
| Ida | 13.5(4.0) | 72(60) | 3-30 | 0.68 | 6 | 8.0(1.6) | 41(35) | 4-12 | 0.00 | 4 | 2.5(0.8) | 121(124) | 0-9 | 0.93 | 15 |
| Pleasant | 0.8(0.3) | 90(91) | 0-2 | 0.23 | 6 | 8.5(2.1) | 78(70) | 0-22 | 0.78 | 10 | 0.9(0.5) | 209(232) | 0-6 | 2.01 | 15 |

[a] Nets vandalized or tipped by high winds were not reset.

Table 6. CPUE of white crappie ≥ age-1 in summer gill nets, summer trap nets, and fall trap nets (standard error in parentheses), coefficient of variation (CV) of CPUE, coefficient of variation of CPUE excluding highest net catch (CVM), range of net catches, skewness coefficients of net catch distributions (Skew), and number of nets set (N) at 40 lakes in Minnesota.

| | Summer gill nets | | | | | Summer trap nets | | | | | Fall trap nets | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lake | CPUE(SE) | CV(CVM) | Range | Skew | N | CPUE(SE) | CV(CVM) | Range | Skew | N | CPUE(SE) | CV(CVM) | Range | Skew | N |
| Duck | 43.8(13.6) | 76(38) | 16-108 | 1.40 | 6 | 84.0(46.0) | 110(121) | 8-208 | 0.57 | 4 | 1.9(0.4) | 88(78) | 0-6 | 0.82 | 15 |
| Mountain | 0.4(0.2) | 137(200) | 0-1 | 0.41 | 5 | 11.5(5.2) | 128(127) | 0-41 | 1.14 | 8 | 1.7(0.6) | 122(125) | 0-6 | 0.91 | 13[a] |
| Round | 0(0) | | | | 5 | 0.2(0.2) | 185(265) | 0-1 | 1.15 | 8 | 0.7(0.6) | 146(152) | 0-3 | 1.18 | 15 |
| Carrie | 65.0(6.0) | 13(∞) | 59-71 | 0.00 | 2 | 5.6(3.1) | 124(116) | 0-17 | 0.94 | 5 | 4.7(1.2) | 103(97) | 0-16 | 1.07 | 15 |
| Elizabeth | 0.4(0.4) | 224(∞) | 0-2 | 1.50 | 5 | 3.7(2.3) | 189(213) | 0-20 | 1.73 | 9 | 1.0(0.3) | 131(132) | 0-4 | 0.87 | 14[a] |
| Emily | 0.2(0.2) | 245(∞) | 0-1) | 1.79 | 6 | 0(0) | | | | 3 | 0.3(0.2) | 185(199) | 0-2 | 1.61 | 15 |
| Big Swan | 0.2(0.2) | 249(332) | 0-2 | 2.22 | 12 | 0.6(0.3) | 147(184) | 0-2 | 0.80 | 8 | 0.4(0.3) | 264(254) | 0-4 | 2.91 | 15 |
| Dunn | 10.5(1.5) | 36(35) | 6-15 | 0.30 | 6 | 146.3(86.7) | 119(85) | 15-398 | 0.95 | 4 | 8.1(1.4) | 66(65) | 0-18 | 0.42 | 15 |
| Long (Meeker) | 0(0) | | | | 6 | 1.0(0.7) | 141(173) | 0-3 | 0.82 | 4 | 0.2(0.1) | 280(374) | 0-2 | 2.62 | 15 |
| Richardson(1989) | 12.0(2.1) | 43(40) | 5-19 | -0.17 | 6 | 68.2(25.0) | 73(63) | 22-134 | 0.49 | 4 | 7.9(3.8) | 176(148) | 0-52 | 2.39 | 15 |
| Richardson(1991) | 11.7(1.6) | 33(30) | 7-17 | 0.14 | 6 | 86.0(41.6) | 97(61) | 19-206 | 0.90 | 4 | 20.6(4.1) | 77(78) | 0-47 | 0.40 | 15 |
| Sarah | 0.2 | | | | 4 | 1.6 | | | | 5 | 0.3(0.2) | 223(254) | 0-2 | 2.04 | 15 |
| French | 18.7(2.1) | 27(29) | 9-23 | -1.33 | 6 | 25.7(6.4) | 62(61) | 6-47 | -0.03 | 6 | 10.1(2.3) | 89(72) | 0-35 | 1.41 | 15 |

[a] Nets vandalized or tipped by high winds were not reset.

Table 7. Ranges of 0.5- and 1.0-in length groups (smallest to largest fish) of black crappie and white crappie caught in gill (SGN) and trap nets (STN) set during summer, and trap nets set in fall (FTN) at 40 Minnesota lakes, 1989-1991.

| | | Length range (Smallest to largest fish) | | |
|---|---|---|---|---|
| Lake | County | SGN | STN | FTN |
| | | **BLACK CRAPPIE** | | |
| Crystal | Blue Earth | 0.0(9.0) | 6.0(4.0 to 10.0) | 7.5(3.0 to 10.5)[a] |
| Duck | Blue Earth | 4.5(4.0 to 8.5) | 3.5(6.0 to 9.5) | 6.5(3.0 to 9.5)[a] |
| George | Blue Earth | 2.5(6.0 to 8.5) | 1.0(7.0 to 8.0) | 6.5(3.5 to 10.0)[a] |
| Loon | Blue Earth | 2.0(7.5 to 9.5) | 4.0(7.0 to 11.0) | 7.5(3.0 to 10.5)[a] |
| Mountain | Cottonwood | 1.5(7.5 to 9.0) | 4.5(6.0 to 10.5) | 8.0(3.0 to 11.0)[a] |
| Andrew | Douglas | 2.5(8.5 to 11.0) | 5.0(6.0 to 11.0) | 8.0(4.0 to 12.0) |
| Blackwell | Douglas | 5.0(5.0 to 10.0) | 6.0(4.0 to 10.0) | 6.0(4.5 to 10.5) |
| Freeborn | Douglas | 0.0 | 0.5(8.5 to 9.0) | 5.5(8.5 to 13.0) |
| Maple | Douglas | 4.0(4.5 to 8.5) | 0.0(5.0) | 7.5(3.0 to 10.5) |
| Oscar | Douglas | 6.5(4.0 to 10.5) | 7.5(4.5 to 12.0) | 7.5(4.5 to 12.0) |
| Pocket | Douglas | 2.5(4.5 to 7.0) | 7.0(3.5 to 10.5) | 8.5(2.5 to 11.0)[a] |
| Clear | Jackson | 0.0(8.0) | 1.5(9.0 to 10.5) | 2.5(8.0 to 10.5) |
| Fish | Jackson | 0.0 | 5.5(5.5 to 11.0) | 7.5(2.5 to 10.0)[a] |
| Round | Jackson | 1.5(10.5 to 12.0) | 4.0(10.0 to 14.0) | 12.5(2.5 to 15.0)[a] |
| Andrew | Kandiyohi | 0.0 | 4.0(7.0 to 11.0) | 6.0(4.5 to 10.5) |
| Carrie | Kandiyohi | 5.5(4.0 to 9.5) | 3.5(4.5 to 8.0) | 4.5(5.0 to 9.5) |
| Elizabeth | Kandiyohi | 3.5(4.0 to 7.5) | 7.5(4.0 to 11.5) | 8.5(3.0 to 11.5)[a] |
| Florida | Kandiyohi | 1.0(7.0 to 8.0) | 0.0 | 9.5(3.5 to 13.0)[a] |
| Games | Kandiyohi | 3.5(4.0 to 7.5) | 5.5(3.5 to 9.0) | 6.0(4.0 to 10.0) |
| Henderson | Kandiyohi | 0.0 | 4.5(7.5 to 12.0) | 4.5(7.5 to 12.0) |
| Little Bass | Kandiyohi | 0.5(4.0 to 4.5) | 3.5(3.5 to 7.0) | 5.0(3.5 to 8.5)[a] |
| Long | Kandiyohi | 3.5(4.5 to 8.0) | 3.0(6.5 to 9.5) | 2.5(6.0 to 8.5) |
| Emily | Lesueur | 4.0(4.0 to 8.0) | 4.0(4.0 to 8.0) | 3.5(5.0 to 8.5) |
| Rays | Lesueur | 4.0(4.0 to 8.0) | 3.5(4.5 to 8.0) | 5.0(3.5 to 8.5)[a] |
| Big Swan | Meeker | 3.0(7.5 to 10.5) | 1.0(8.0 to 9.0) | 1.0(8.0 to 9.0) |
| Betsy | Meeker | 5.5(5.5 to 11.0) | 4.0(6.5 to 10.5) | 7.5(3.0 to 10.5)[a] |
| Dunn | Meeker | 5.5(4.0 to 9.5) | 2.5(6.5 to 9.0) | 7.0(3.0 to 10.0)[a] |
| Long | Meeker | 4.0(4.0 to 8.0) | 2.5(6.0 to 8.5) | 7.0(5.0 to 12.0) |
| Richardson(89) | Meeker | 6.5(4.0 to 10.5) | 3.5(6.0 to 9.5) | 4.0(5.0 to 9.0) |
| Richardson(91) | Meeker | 4.0(5.5 to 9.5) | 2.0(7.0 to 9.0) | 7.0(3.5 to 10.5)[a] |
| Union | Meeker | 4.0(4.0 to 8.0) | 5.0(4.0 to 9.0) | 3.0(5.0 to 8.0) |
| First Fulda | Murray | 2.5(5.5 to 8.0) | 4.5(5.5 to 10.0) | 4.5(6.0 to 10.5) |
| Sarah | Murray | 6.5(4.5 to 11.0) | 4.5(7.5 to 12.0) | 7.0(6.0 to 13.0) |
| Scandinavian | Pope | 1.5(5.0 to 6.5) | 0.5(5.5 to 6.0) | 7.0(3.5 to 10.5) |
| Fox | Rice | 4.0(6.0 to 10.0) | 0.0(6.5) | 0.0 |
| Horseshoe | Stearns | 5.0(3.5 to 8.5) | 6.5(3.5 to 10.0) | 6.0(4.0 to 10.0) |
| Cedar | Wright | 6.0(5.0 to 11.0) | 4.5(5.0 to 9.5) | 7.5(3.0 to 10.5)[a] |
| French | Wright | 4.5(4.0 to 8.5) | 5.0(4.5 to 9.5) | 6.0(6.0 to 12.0) |
| Granite | Wright | 5.5(4.0 to 9.5) | 6.5(4.0 to 10.5) | 6.0(4.5 to 10.5) |
| Ida | Wright | 4.5(4.5 to 9.0) | 4.0(6.0 to 10.0) | 3.0(6.5 to 9.5) |
| Pleasant | Wright | 2.0(7.0 to 9.0) | 7.5(3.5 to 11.0) | 6.5(4.5 to 11.0) |
| | | **WHITE CRAPPIE** | | |
| Duck | Blue Earth | 3.0(6.0 to 9.0) | 2.0(6.5 to 8.5) | 2.5(7.0 to 9.5) |
| Mountain | Cottonwood | 1.0(8.0 to 9.0) | 3.0(7.5 to 10.5) | 6.5(4.0 to 10.5)[a] |
| Round | Jackson | 0.0 | 0.0(9.5) | 9.0(2.5 to 11.5)[a] |
| Carrie | Kandiyohi | 4.5(4.0 to 8.5) | 4.0(4.5 to 8.5) | 4.0(5.5 to 9.5) |
| Elizabeth | Kandiyohi | 1.0(5.5 to 6.5) | 4.5(7.5 to 12.0) | 8.5(3.0 to 11.5)[a] |
| Emily | Lesueur | 0.0(8.0) | 0.0 | 5.5(6.5 to 12.0) |
| Big Swan | Meeker | 1.5(8.0 to 9.5) | 1.0(8.0 to 9.0) | 1.0(8.5 to 9.5) |
| Dunn | Meeker | 4.0(5.0 to 9.0) | 2.0(6.5 to 8.5) | 7.0(3.5 to 10.5)[a] |
| Long | Meeker | 0.0 | 1.0(11.0 to 12.0) | 3.0(8.0 to 11.0) |
| Richardson(89) | Meeker | 4.5(4.5 to 9.0) | 4.0(6.0 to 10.0) | 4.5(5.0 to 9.5) |
| Richardson(91) | Meeker | 5.0(4.0 to 9.0) | 3.0(7.0 to 10.0) | 8.5(3.0 to 11.5)[a] |
| Sarah | Murray | 0.0(10.0) | 0.5(9.0 to 9.5) | 1.0(10.0 to 11.0) |
| French | Wright | 5.5(4.5 to 10.0) | 4.5(4.5 to 9.0) | 3.5(5.5 to 9.0) |

[a] denotes age-0 crappie captured

Table 8. Chi-square statistics ($X^2$) and probabilities ($P$) that length frequencies of black and white crappie caught in gill nets (SGN) and trap nets (STN) set in 40 Minnesota lakes during summer surveys were from the same population, 1989-1991.

| Lake | Month sampled | Chi square statistics $X^2$ | df | $P$ | Sample size SGN | STN |
|---|---|---|---|---|---|---|
| | | | BLACK CRAPPIE | | | |
| Crystal | June | 2.432 | 5 | 0.7868 | 2 | 19 |
| Duck | June | 9.815 | 7 | 0.1993 | 101 | 47 |
| George | June | 0.582 | 5 | 0.9888 | 114 | 4 |
| Loon | July | 10.690 | 8 | 0.2198 | 15 | 140 |
| Mountain | July | 6.392 | 9 | 0.7001 | 7 | 148 |
| Andrew | June | 3.750 | 4 | 0.4409 | 6 | 3 |
| Blackwell | August | 53.170 | 11 | <0.0001 | 127 | 47 |
| Freeborn | July | | | | 0 | 2 |
| Maple | June | 6.964 | 4 | 0.1378 | 8 | 5 |
| Oscar | August | 33.810 | 15 | 0.0036 | 42 | 101 |
| Pocket | July | 24.210 | 9 | 0.0040 | 4 | 89 |
| Clear | July | 3.000 | 2 | 0.2231 | 1 | 2 |
| Fish | July | | | | 0 | 30 |
| Round | August | 4.423 | 6 | 0.6196 | 5 | 39 |
| Andrew | June | | | | 0 | 3 |
| Carrie | July | 7.860 | 9 | 0.5483 | 91 | 25 |
| Elizabeth | June | 36.990 | 13 | 0.0004 | 6 | 67 |
| Florida | July | | | | 2 | 0 |
| Games | June | 4.675 | 6 | 0.5861 | 6 | 18 |
| Henderson | June | | | | 0 | 54 |
| Little Bass | July | 1.877 | 3 | 0.5983 | 2 | 9 |
| Long | June | 27.920 | 8 | 0.0005 | 22 | 90 |
| Emily | July | 12.750 | 6 | 0.0471 | 162 | 145 |
| Rays | August | 14.520 | 7 | 0.0426 | 240 | 55 |
| Big Swan | August | 7.400 | 6 | 0.2844 | 211 | 11 |
| Betsy | August | 40.400 | 10 | <0.0001 | 68 | 26 |
| Dunn | June | 6.649 | 8 | 0.5749 | 80 | 28 |
| Long | June | 16.570 | 8 | 0.0349 | 50 | 17 |
| Richardson(89) | June | 9.532 | 12 | 0.6569 | 364 | 26 |
| Richardson(91) | June | 6.008 | 6 | 0.4222 | 87 | 86 |
| Union | August | 19.850 | 8 | 0.0109 | 38 | 7 |
| First Fulda | June | 29.860 | 7 | 0.0001 | 20 | 164 |
| Sarah | August | 26.910 | 9 | 0.0014 | 9 | 69 |
| Scandinavian | July | 1.477 | 3 | 0.6876 | 9 | 2 |
| Fox | July | 0.900 | 3 | 0.8254 | 8 | 1 |
| Horseshoe | July | 36.820 | 13 | 0.0004 | 27 | 109 |
| Cedar | June | 17.520 | 10 | 0.0637 | 30 | 50 |
| French | July | 19.290 | 10 | 0.0368 | 136 | 185 |
| Granite | July | 20.260 | 10 | 0.0269 | 87 | 66 |
| Ida | July | 17.870 | 10 | 0.0571 | 79 | 32 |
| Pleasant | July | 10.700 | 12 | 0.5552 | 5 | 85 |
| | | | WHITE CRAPPIE | | | |
| Duck | June | 24.560 | 6 | 0.0004 | 150 | 142 |
| Mountain | July | 1.176 | 6 | 0.9781 | 2 | 92 |
| Round | August | | | | 0 | 2 |
| Carrie | July | 20.050 | 9 | 0.0179 | 86 | 28 |
| Elizabeth | June | 33.000 | 10 | 0.0003 | 2 | 31 |
| Emily | July | | | | 1 | 0 |
| Big Swan | August | 2.300 | 3 | 0.5100 | 3 | 5 |
| Dunn | June | 10.150 | 7 | 0.1803 | 63 | 67 |
| Long | June | | | | 0 | 4 |
| Richardson(1989) | June | 64.870 | 10 | <0.0001 | 61 | 134 |
| Richardson(1991) | June | 48.940 | 10 | <0.0001 | 32 | 118 |
| Sarah | August | 9.000 | 2 | 0.0111 | 1 | 8 |
| French | July | 42.690 | 9 | <0.0001 | 112 | 120 |

Table 9. Geometric means of CPUE of black crappie caught in summer gill nets, summer trap nets, and fall trap nets in relation to lake area and maximum depth, 1989-1991.

| Gear | ≤ 120 hectares | > 120 hectares |
|---|---|---|
| | **Maximum depth ≤ 9.1 m** | |
| Summer gill nets | 8.08[a] | 1.72 |
| Summer trap nets | 5.15 | 3.40 |
| Fall trap nets | 3.75 | 2.47 |
| | **Maximum > 9.1 m** | |
| Summer gill nets | 16.60[a] | 2.84 |
| Summer trap nets | 14.83[a] | 2.87 |
| Fall trap nets | 6.14 | 4.46 |

[a] $P \leq 0.05$

cies. Significant rank correlations ($P < 0.05$) between CPUE and CV of CPUE were -0.34 for black crappie and -0.86 for white crappie.

Variation of catch in summer gill and trap nets was usually lower than variation in fall trap nets. Mean CV of black crappie CPUE in summer gill and trap nets among lakes (where CPUE ≥ 1/lift) were both significantly lower than CV of black crappie CPUE in fall trap nets (Table 2). Mean CV of white crappie CPUE in summer gill nets among lakes was also significantly lower than CV of white crappie CPUE in fall trap nets, however, CV of white crappie CPUE in summer and fall trap nets among lakes did not significantly differ (Table 3).

Net catch ranges and distributions were usually smaller during summer gill and trap netting than during fall trap netting. Mean range of black crappie catch in summer gill nets among lakes was significantly lower than mean range of catch in fall trap nets, but mean range of black crappie catch in summer and fall trap nets among lakes were not significantly different (Table 2). Mean range of white crappie catch in summer gill nets and fall trap nets among lakes were not significantly different, but mean range of catch in summer trap nets was significantly higher than mean range of catch in fall trap nets (Table 3).

Skewness coefficients of black crappie catch in summer gill and trap nets were significantly lower than skewness coefficients of black crappie catch in fall trap nets (Table 2). Skewness coefficients of white crappie catch in summer gill and trap nets, and fall trap nets were not significantly different (Table 3).

Summer gill and trap netting caught narrower length ranges of black and white crappie than fall trap netting. Mean ranges of 13 and 25 mm length groups of black and white crappie in summer gill and trap nets were significantly smaller than mean ranges of length groups of each species in fall trap nets among lakes (Tables 2 and 3). Black and white crappie < 100 mm were seldom caught in summer gill and trap nets, and age-0 fish of neither species were caught (Table 7). Conversely, fall trap netting often caught fish < 100 mm. During fall, age-0 black crappie were caught in 39% of the sampled lakes, and age-0 white crappie in 38% of the lakes with white crappie populations.

Larger crappie of both species were caught more often during fall. Black crappie ≥ 254 mm were caught in 24% of the lakes gill netted and 49% of the lakes trap netted during summer, and in 73% of the lakes trap netted during fall (Table 7). Black crappie ≥ 305 mm were caught in 2% of the lakes gill netted and 10% of the lakes trap netted during summer, and in 22% of the lakes trap netted during fall. White crappie ≥ 254 mm were caught in 15% of the lakes gill netted and 38% of the lakes trap netted during summer, and in 62% of the lakes trap netted during fall. White crappie ≥ 305 mm were caught in 15% of the white crappie lakes trap netted during summer and in 8% of the lakes trap netted during fall. Gill nets did not sample white crappie ≥ 305 mm.

*Factors Affecting the Analysis of Net Catches*

The number of sampled locations and catch in individual nets strongly affected the skewness of catch distributions and related measures of variation. Differences between the crappie species were also observed.

The number of locations sampled affected skewness of catch distributions in summer gill and trap nets. Skewness coefficients of black crappie catch in summer gill and trap nets within lakes were positively correlated with the number of locations where nets were set (Table 10). Skewness coefficients of black crappie catch in summer trap nets were also significantly correlated with lake surface area since more locations were sampled in larger lakes (Table 10).

Differences in skewness of catch distributions between summer and fall trap netting were affected by the number of locations sampled. Catch of black crappie in summer trap nets among lakes, where less than seven locations were sampled, were significantly less skewed than in fall trap nets at the same lakes (Table 11). In lakes where seven or more locations were sampled with summer trap nets, skewness of black crappie catch in summer trap nets and fall trap nets did not significantly differ (Table 11). Similar results were observed for white crappie caught in summer trap nets, however, sample sizes were small and no differences were significant.

Differences in skewness of catch distributions between summer gill netting and fall trap netting were not related to the number of locations sampled. Black crappie catch in summer gill nets were significantly less skewed than

Table 10. Spearman's rank correlations between coefficient of variation of catch-per-unit-of-effort (when CPUE > 1/lift) of black and white crappie in summer gill nets, summer trap nets and fall trap nets, and skewness coefficients of catch distributions in nets; and Spearman's rank correlations between these two coefficients and range of net catches within lakes, number of net sets, maximum depth, and lake surface area, 1989-1991 (* = $P \leq 0.05$; ** = $P \leq 0.01$).

| Variable | Summer gill nets r | df | Summer trap nets r | df | Fall trap nets r | df |
|---|---|---|---|---|---|---|
| | | | **BLACK CRAPPIE** | | | |
| *Coefficient of variation* | | | | | | |
| Skewness coefficient | 0.26 | 29 | 0.79** | 29 | 0.85** | 28 |
| Range of net catches | -0.45* | 29 | 0.02 | 29 | 0.26 | 28 |
| Number of net sets | -0.13 | 29 | 0.33 | 29 | -0.10 | 28 |
| Maximum depth | -0.02 | 29 | 0.04 | 29 | 0.00 | 28 |
| Surface area | 0.16 | 29 | 0.27 | 29 | 0.25 | 28 |
| *Coefficient of skewness* | | | | | | |
| Range of net catches | 0.25 | 33 | -0.18 | 36 | -0.03 | 38 |
| Number of net sets | 0.37* | 33 | 0.58** | 36 | -0.14 | 38 |
| Maximum depth | -0.20 | 33 | 0.05 | 36 | -0.21 | 38 |
| Surface area | 0.06 | 33 | 0.36* | 36 | 0.14 | 38 |
| | | | **WHITE CRAPPIE** | | | |
| *Coefficient of variation* | | | | | | |
| Skewness coefficient | 0.54 | 4 | 0.78** | 7 | 0.74** | 6 |
| Range of net catches | 0.41 | 4 | -0.54 | 7 | -0.13 | 6 |
| Number of net sets | 0.65 | 4 | 0.38 | 7 | -0.49 | 6 |
| Maximum depth | 0.38 | 4 | -0.74* | 7 | -0.12 | 6 |
| Surface area | 0.32 | 4 | 0.21 | 7 | 0.10 | 6 |
| *Coefficient of skewness* | | | | | | |
| Range of net catches | -0.63* | 8 | -0.25 | 9 | -0.42 | 11 |
| Number of net sets | 0.24 | 8 | 0.51 | 9 | 0.28 | 11 |
| Maximum depth | -0.47 | 8 | -0.84** | 9 | 0.20 | 11 |
| Surface area | 0.57 | 8 | 0.25 | 9 | 0.23 | 11 |
| | | | **BLACK CRAPPIE in lakes with white crappie** | | | |
| *Coefficient of variation* | | | | | | |
| Skewness coefficient | 0.77 | 4 | 0.90** | 7 | 0.79* | 6 |
| Range of net catches | 0.31 | 4 | 0.30 | 7 | -0.10 | 6 |
| Number of net sets | 0.65 | 4 | 0.40 | 7 | 0.07 | 6 |
| Maximum depth | -0.38 | 4 | -0.51 | 7 | 0.08 | 6 |
| Surface area | 0.32 | 4 | -0.14 | 7 | -0.11 | 6 |
| *Coefficient of skewness* | | | | | | |
| Range of net catches | 0.14 | 8 | 0.23 | 9 | 0.36 | 11 |
| Number of net sets | 0.22 | 8 | 0.57 | 9 | 0.21 | 11 |
| Maximum depth | 0.09 | 8 | -0.23 | 9 | -0.06 | 11 |
| Surface area | 0.31 | 8 | 0.05 | 9 | 0.05 | 11 |

Table 11. Coefficients of variation of catch-per-unit-of-effort and skewness coefficients of black and white crappie catches in summer gill nets (SGN), summer trap nets (STN), and fall trap nets (FTN) associated with selected numbers of net sets within 40 Minnesota lakes, 1989-1991.

| Category (Summer netting only) | Coefficients | | Statistic | df | *P* |
|---|---|---|---|---|---|
| | | **BLACK CRAPPIE** | | | |
| *Coefficients of variation* | | | | | |
| Lakes with < 6 gill nets set | SGN = 79 | FTN = 130 | *F* = 9.78 | 1,18 | 0.0058 |
| Lakes with ≥ 6 gill nets set | SGN = 69 | FTN = 126 | *F* = 50.25 | 1,26 | <0.0001 |
| Lakes with < 7 trap nets set | STN = 88 | FTN = 131 | *F* = 17.26 | 1,30 | 0.0002 |
| Lakes with ≥ 7 trap nets set | STN = 106 | FTN = 122 | *F* = 0.66 | 1,14 | 0.4310 |
| *Coefficients of skewness* | | | | | |
| Lakes with < 6 gill nets set | SGN = 0.16 | FTN = 1.5 | *F* = 34.77 | 1,32 | <0.0001 |
| Lakes with ≥ 6 gill nets set | SGN = 0.69 | FTN = 1.48 | *F* = 23.70 | 1,32 | <0.0001 |
| Lakes with < 7 trap nets set | STN = 0.44 | FTN = 1.58 | *F* = 24.87 | 1,34 | <0.0001 |
| Lakes with ≥ 7 trap nets set | STN = 1.35 | FTN = 1.50 | *F* = 0.49 | 1,36 | 0.4891 |
| | | **WHITE CRAPPIE** | | | |
| *Coefficients of variation* | | | | | |
| Lakes with < 6 gill nets set | (insufficient sample size) | | | | |
| Lakes with ≥ 6 gill nets set | SGN = 43 | FTN = 99 | *F* = 6.85 | 1,8 | 0.0307 |
| Lakes with < 7 trap nets set | STN = 98 | FTN = 100 | *F* = 0.01 | 1,10 | 0.9051 |
| Lakes with ≥ 7 trap nets set | STN = 126 | FTN = 158 | *F* = 1.08 | 1,2 | 0.4083 |
| *Coefficients of skewness* | | | | | |
| Lakes with < 6 gill nets set | SGN = 0.64 | FTN = 0.95 | *H* = 0.43 | 1 | 0.5127 |
| Lakes with ≥ 6 gill nets set | SGN = 0.62 | FTN = 1.42 | *F* = 1.81 | 1,12 | 0.2032 |
| Lakes with < 7 trap nets set | STN = 0.66 | FTN = 1.30 | *H* = 1.33 | 1 | 0.2496 |
| Lakes with ≥ 7 trap nets set | STN = 1.20 | FTN = 1.47 | *F* = 0.25 | 1,6 | 0.6334 |

catch in fall trap nets among lakes regardless of the number of gill net locations sampled (Table 11). Similar results were observed for white crappie, but the differences were not significant.

Lower coefficients of variation were associated with the less skewed catch distributions from summer gill and trap netting (Table 11). Coefficients of variation for summer trap net CPUE of black crappie was significantly lower than for fall trap nets if fewer than seven locations were netted, but did not differ significantly if seven or more locations were netted. Coefficient of variance for summer gill net CPUE of black crappie was significantly lower than for fall trap nets regardless of the number of locations netted. Results for white crappie were similar, but were not significant.

The highest net catch accounted for most of the variation for both net types and both sampling periods. The net with the highest catch of black crappie explained 97% of the variation of CPUE for gill nets, 87% of the variation for summer trap nets, and 92% of the variation for fall trap nets among lakes ($P < 0.0001$, df = 1, 36 to 38). The lowest net catch explained an additional 10% of the variation of black crappie CPUE for summer trap nets, but only an additional 1% of the variation for summer gill nets and fall trap nets ($P \leq 0.0193$; df = 2, 36 to 38). The highest net catch of white crappie explained 78% of the variation of CPUE for gill nets, 98% of the variation for summer trap nets, and 72% of the variation for fall trap nets ($P \leq 0.0001$; df = 1, 10 to 11). An additional 21% of the variation of white crappie CPUE for gill nets was explained by the lowest net catch ($P < 0.0001$; df = 2,9), but the lowest fall trap net catch (always zero) did not explain any additional variation. Nearly all (99.6%) of the variation of CPUE of white crappie for summer trap nets was explained by the highest and lowest net catch ($P = 0.0001$; df = 2,9).

The net with the highest catch also affected CV of CPUE. Within lakes, CV usually decreased when the highest net catch was excluded if CPUE was ≥ 1/lift and increased, sometimes becoming infinite, if CPUE was < 1/lift (Tables 5 and 6). Among lakes, CV of black crappie CPUE for gill nets did not change significantly if the highest net catch was excluded, but was significantly reduced for summer trap nets (Table 12). Coefficients of variation of white crappie CPUE ($\geq$ 1/lift) for summer gill nets, summer trap nets, and fall trap nets among lakes did not change significantly when the net with the highest catch was excluded (Table 12).

Other variables were significantly correlated with CV of CPUE. Coefficient of variation of black crappie CPUE in summer gill nets was negatively correlated with the range of net catches among lakes (Table 10). Coefficient of variation of black crappie CPUE and white crappie CPUE in summer trap nets and fall trap nets among lakes were significantly correlated with respective skewness coefficients (Table 10).

Species specific differences were also observed. Skewness coefficients of black crappie catch in trap nets were not significantly correlated with maximum depth, however, skewness coefficients of white crappie catch in the same lakes were negatively correlated with maximum depth (Table 10).

*Summer Netting Vs Angler Crappie Catch*

Crappie harvest (number caught/hectare) and catch rates (number caught/hour) by anglers, and crappie CPUE in gill and trap nets varied among lakes where creel surveys were done (Table 13). Black crappie CPUE in gill and trap nets were significantly correlated with black crappie harvest and catch rates (Table 4). Trap net catches were more strongly correlated than gill net catches. White crappie CPUE in gill nets and trap nets were not significantly correlated with either harvest or catch rates of white crappie, however, sample sizes were small (Table 4).

Length frequencies of black and white crappie caught in summer gill and trap nets does not reflect length frequencies of angler harvested crappie. At Madison Lake, length frequencies of black crappie $\geq$ 203 mm harvested by anglers differed significantly from those caught in gill and trap nets during summer 1988 and 1989 (Table 14). Length frequencies of white crappie in gill nets and caught by anglers did not differ significantly during summer 1988, but did differ significantly during summer 1989 (Table 14). Length frequencies of white crappie in trap nets and caught by anglers did not differ significantly in either year, however, sample sizes were small (Table 10).

Table 12. Mean coefficients of variation (CV) of catch-per-unit-of-effort ($\geq$ 1/lift) of black and white crappie in summer gill nets, summer trap nets, and fall trap nets, and mean CV of CPUE excluding the net with the highest catch (CVM) among 40 Minnesota lakes, 1989-1991.

| Gear | CV | CVM | Statistic | df | *P* |
|---|---|---|---|---|---|
| | | | BLACK CRAPPIE | | |
| Summer gill nets | 74 | 67 | $F$ = 0.95 | 1,50 | 0.3337 |
| Summer trap nets | 97 | 80 | $F$ = 4.05 | 1,60 | 0.0487 |
| Fall trap nets | 130 | 114 | $F$ = 3.24 | 1,56 | 0.0771 |
| | | | WHITE CRAPPIE | | |
| Summer gill nets | 43 | 34 | $H$ = 0.27 | 1 | 0.6015 |
| Summer trap nets | 116 | 113 | $F$ = 0.01 | 1,16 | 0.9077 |
| Fall trap nets | 103 | 95 | $F$ = 0.21 | 1,12 | 0.6566 |

Table 13. Surface area (hectares), maximum depth (m), method of pressure estimate (s = stratified random, n = nonuniform probability), method of harvest estimate (r = roving creel survey, a = access creel survey), angler harvest (crappie/hectare), angler catch rates (crappie/hr kept), gill net CPUE and trap net CPUE at Minnesota lakes where creel surveys were done and black or white crappie were harvested or netted.

| Lake | Area (hectares) | Maximum depth (m) | Pressure Method | Harvest Method | Creel Statistics Harvest | Creel Statistics Catch | Net catch Gill | Net catch Trap |
|---|---|---|---|---|---|---|---|---|
| | | | **BLACK CRAPPIE** | | | | | |
| Artichoke | 814 | 4.0 | s | r | 0.51 | 0.2 | 35.3 | 0.0 |
| Big Stone | 5,004 | 4.9 | s | a | 0.07 | TR[a] | 3.6 | |
| Birch | 520 | 13.7 | s | r | 3.8 | 0.4 | 2.2 | 0.8 |
| Clear | 183 | 2.7 | s | r | 0.3 | TR | 0.2 | 0.2 |
| Crane | 1,375 | 24.4 | s | a | 2.5 | 0.1 | 0.2 | |
| Dudley | 51 | 18.3 | s | r | 30.3 | 0.1 | 1.0 | 0.5 |
| Elysian | 770 | 4.0 | s | r | 0.3 | TR | 11.6 | 12.9 |
| Fish | 124 | 8.2 | s | r | 0.2 | TR | 0.0 | 3.7 |
| French | 363 | 17.1 | s | r | 9.5 | 0.1 | 179.0 | 6.7 |
| Horseshoe | 169 | 8.5 | s | r | 157.6 | 0.6 | 58.9 | 63.7 |
| Hunt | 65 | 8.2 | s | r | 108.3 | 0.7 | 32.5 | 2.2 |
| Island | 221 | 12.5 | s | r | 19.6 | 0.2 | 0.7 | 30.3 |
| Kabetogama | 10,429 | 18.3 | s | a | 0.4 | TR | 0.6 | |
| Little Pine | 157 | 11.0 | s | r | 1.7 | TR | 1.4 | 1.4 |
| Loon | 275 | 2.4 | s | r | 0.0 | 0 | 0.0 | 0.3 |
| Madison (1988) | 451 | 18.0 | s | r | 37.4 | 0.1 | 67.3 | 41.5 |
| Madison (1989) | 451 | 18.0 | s | r | 77.7 | 0.1 | 45.5 | 49.8 |
| Mazaska | 277 | 15.2 | s | r | 19.6 | 0.1 | 12.0 | 6.9 |
| Mille Lacs | 53,650 | 10.7 | n | a | 0.02 | TR | 0.5 | |
| Namakan | 5,688 | 45.7 | s | a | 0.1 | TR | 0.1 | |
| Nest | 383 | 12.2 | s | r | 14.5 | 0.1 | 6.2 | 2.2 |
| North Lida | 2,544 | 17.7 | s | r | 0.2 | TR | 0.0 | 0.0 |
| Oliver | 208 | 5.5 | s | r | 0.05 | TR | 1.8 | 1.9 |
| Rainy | 21,919 | 49.1 | s | a | 0.2 | TR | 0.2 | |
| Rice | 635 | 12.5 | s | r | 0.3 | TR | 4.9 | 2.9 |
| Round | 415 | 2.7 | s | r | 0.6 | TR | 1.0 | 4.9 |
| Sand Point (1984) | 2,300 | 56.1 | s | a | 0.7 | TR | 2.8 | |
| Sand Point (1985) | 2,300 | 56.1 | s | a | 0.2 | TR | 1.2 | |
| South Lida | 347 | 14.6 | s | r | 3.6 | TR | 0.3 | 1.5 |
| Square | 79 | 20.7 | s | r | 4.3 | TR | 1.0 | 1.0 |
| Sturgeon | 569 | 12.2 | s | r | 2.6 | TR | 1.0 | 0.5 |
| Sunfish | 48 | 9.1 | s | r | 150.0 | 0.4 | 0.0 | 42.5 |
| Ten Mile | 1,890 | 63.4 | s | r | 1.1 | TR | 0.3 | 0.0 |
| West Battle | 2,230 | 32.9 | s | r | 0.6 | TR | 0.2 | 0.6 |
| Wirth | 15 | 7.6 | s | r | 158.1 | 0.2 | 22.5 | 16.8 |
| | | | **WHITE CRAPPIE** | | | | | |
| Dudley | 51 | 18.3 | s | r | 0.7 | TR | 0.0 | 0.0 |
| Elysian | 770 | 4.0 | s | r | 0.1 | TR | 0.0 | 0.2 |
| French | 363 | 17.1 | s | r | 0.7 | TR | 7.2 | 0.0 |
| Horseshoe | 169 | 8.5 | s | r | 30.6 | 0.1 | 0.6 | 0.3 |
| Hunt | 65 | 8.2 | s | r | 35.5 | 0.2 | 0.0 | 0.5 |
| Madison (1988) | 451 | 18.0 | s | r | 18.2 | TR | 21.7 | 5.5 |
| Madison (1989) | 451 | 18.0 | s | r | 32.7 | 0.1 | 2.3 | 2.5 |
| Sunfish | 48 | 9.1 | s | r | 6.3 | TR | 0.3 | 0.0 |
| Wirth | 15 | 7.6 | s | r | 2.6 | TR | 0.0 | 0.6 |

[a]TR - trace

Table 14. Chi square statistics ($X^2$) and probabilities ($P$) that length frequencies of black and white crappie ≥ 200 mm in sampled in gill nets or trap nets were the same as length-frequencies of black and white crappie harvested by anglers during the same period, Madison Lake, Blue Earth County, June 1988 and 1989.

| Gear | Year | Chi square statistics $X^2$ | df | $P$ | Sample size Net | Creel |
|---|---|---|---|---|---|---|
| | | | BLACK CRAPPIE | | | |
| Gill net | 1988 | 19.23 | 6 | 0.0038 | 9 | 66 |
| Gill net | 1989 | 28.47 | 4 | <0.0001 | 48 | 315 |
| Trap net | 1988 | 25.31 | 5 | <0.0001 | 31 | 66 |
| Trap net | 1989 | 16.71 | 4 | 0.0022 | 30 | 315 |
| | | | WHITE CRAPPIE | | | |
| Gill net | 1988 | 10.18 | 6 | 0.1174 | 5 | 12 |
| Gill net | 1989 | 14.61 | 4 | 0.0056 | 17 | 78 |
| Trap net | 1988 | 4.47 | 6 | 0.6130 | 2 | 12 |
| Trap net | 1989 | 0.31 | 4 | 0.9890 | 8 | 7 |

## Discussion

No clear advantage for estimating abundance and size structure of black and white crappie was evident for any of the netting types and seasons. Summer gill nets caught fewer crappie, but the catch was less variable than either summer or fall trap netting. Crappie caught in gill nets, however, tended to be smaller than those caught in trap nets. Fall trap net catches were more variable than either summer net type, but crappie > 254 mm were more likely to be caught and age-0 fish were sampled only in fall. Significant differences in length frequencies between summer gill and trap net catches were common, but we do not know which gear was better for estimating size-structure.

CPUE from summer gill and trap netting of both crappie species were correlated with angler harvest and catch rates. Correlations were stronger for summer trap netting than for summer gill netting. Length frequencies from both gears, however, differed from length frequencies caught by anglers in Madison Lake. Length frequencies from nets is a poor measure of angler harvest which is in contrast to the results reported by McInerny (1988).

Correlations between CPUE in summer nets and catch indices by anglers in Minnesota lakes were lower than correlations between CPUE in fall trap nets and angler catches reported elsewhere. Studies by Colvin and Vasey (1986), Colvin (1991), McInerny (1988), and Miranda (1990) reporting strong correlations ($r \geq 0.80$) were done on man-made impoundments rather than on natural lakes. Physical factors that affect crappie net catch are probably more diverse among natural lakes than among reservoirs. Reservoirs are typically created by damming relatively narrow valleys so that the deepest water is usually located near the dam, and the slope of the bottom perpendicular to shore is probably more uniform within most of the reservoir. The location of the deepest water and steepness of shoreline slopes within and among natural lakes is more varied.

Variation in year-class strengths could have contributed to the significantly different length frequencies from Madison Lake and could have weakened correlations between CPUE and angler catch indices. Strengths of consecutive year-classes of black and white crappie in Minnesota lakes were highly variable, and some year-classes were not represented (McInerny and Cross in press; Minnesota Department of Natural Resources unpublished data). Anglers in Minnesota rarely harvested crappie < 180 mm (Minnesota Department of Natural Resources unpublished data), and typically find and harvest larger crappie from older age classes that appear less vulnerable to either type of netting.

Size specific spatial distribution, variable year-class strength, and net mesh sizes affected CPUE, skewness of net catches, and variation. Spatial distribution patterns during summer suggests that more crappie size groups would be vulnerable to gill netting than trap netting. During summer, black crappie in natural lakes in Michigan, South Dakota, and Ontario were most concentrated in water 2.1 to 4.9 m deep (Hall and Werner 1977; Guy et al. 1992; Keast and Fox 1992). Hall and Werner (1977) also reported that black crappie concentrations in a Michigan lake were more than 15 m offshore during summer.

White crappie ≤ 152 mm inhabit offshore open water areas near the surface, while white crappie > 254 mm occupy deep water (> 4.3 m deep) during summer (Grinstead 1969; Gebhart and Summerfelt 1975; O'Brien et al. 1984; Markham et al. 1991). Smaller and larger white crappie could be less susceptible to capture in trap nets during summer because trap nets sampled shallow shoreline habitats. Size-specific spatial distribution of black crappie has not been reported.

Crappie (one or two year classes) vulnerable to gill netting were probably more uniformly distributed within offshore habitats which resulted in less skewed net catch distributions and relatively low CV. This would lead to more precise estimates of crappie CPUE caught in gill nets than in trap nets. Conversely, wider length ranges of crappie consisting of several year classes, each with different spatial distribution patterns, probably contributed to the more skewed catch distributions and higher variation during summer and fall trap netting. Moyle (1949), and Moyle and Lound (1960) reported that skewness of net catch distributions reflects habitat uniformity and behavior patterns of sampled fish.

Net mesh sizes probably affected CPUE and size-selectivity of summer netting. Smaller and larger black and white crappie should have been susceptible to gill netting because these nets sampled deeper, offshore habitats, however, small mesh sizes could have limited the catch of larger individuals. Grinstead (1969) reported that 254 to 376 mm white crappie in an Oklahoma reservoir were captured in experimental gill nets where the largest mesh size was 152 mm stretch. Muoneke et al. (1992) reported white crappie up to 445 mm, in another Oklahoma reservoir, were captured in experimental gill nets with mesh sizes as large as 203 mm stretch. The largest mesh size of gill nets used in Minnesota was 102 mm stretch.

Trap net catch variation of black and white crappie in lakes where few (< 7) locations were sampled during summer probably did not represent the true population variation. Skewness coefficients in lakes where less than seven locations were sampled with trap nets were low and sometimes negative, but were more positive in lakes where ≥ 7 locations were sampled with trap nets during summer and fall. Moyle (1949), and Moyle and Lound (1960) reported that the distribution of fish catch in nets within Minnesota lakes were usually positively skewed. Consequently, positive skewness in catch distributions of black and white crappie in trap nets is probably more representative of the actual of the population distribution.

Physical characteristics unique to each lake could have affected CPUE and subsequent reported correlations. Because correlations of variables were among lakes and within years rather than among years and within lakes, those characteristics unique to each lake that affect catches in nets were incorporated. For example, black crappie CPUE in summer and fall trap nets at Big Swan Lake, Meeker County, were low compared to CPUE in gill nets. Suitable locations to set trap nets were limited. Bottom contours perpendicular to shore in this lake had little slope, consequently, the frames of these trap nets were seldom submerged, even when nets were set 9 to 15 m offshore. Black crappie in Michigan and Ontario lakes are usually found in deeper water than where these nets could be set (Hall and Werner 1977; Keast and Fox 1992) and were probably less vulnerable to trap netting. The higher catches in fall trap nets from Andrew and Maple lakes may also be unique to those waters. Significant differences in length frequencies between summer gill and trap net catches were common, and we do not know which gear was better for estimating size-structure.

None of the gear-season combinations effectively caught age-0 crappie, due to the mesh sizes being too large. Age-0 crappie were caught in trap nets set at several lakes during the fall, however, 19 mm bar mesh was too large to effectively sample age-0 crappie. First-year growth of black and white crappie was usually ≤ 76 mm (McInerny and Cross in press; Minnesota Department of Natural Resources unpublished data). Trap nets with 13 mm or 16 mm bar mesh captured high numbers of age-0 white crappie (61 to 119 mm) in impoundments in Kansas, Missouri, and Oklahoma (Willis et al. 1984; Colvin and Vasey 1986; Boxrucker and Ploskey 1988), but not in natural lakes in Minnesota (Minnesota Department of Natural Resources unpublished data).

Species specific differences in gill and trap netting were expected because each species has specific habitat requirements. Little is known about specific habitat requirements of either crappie species, however, black crappie seem to be less successful in turbid water than white crappie (Ellison 1984). Habitat requirements likely differ because the natural ranges of each species differ. The black crappie range includes all of Minnesota, whereas white crappie populations are found only in the southern half of the state (Scott and Crossman 1979).

## Management Implications

Standard lake surveys and assessments were adequate to assess abundance of black and white crappie for most of the lakes netted in this study. Very low summer net catch, however, may not indicate low crappie populations as shown by the samples at Andrew and Maple lakes. Fall trap netting should be considered if there is a concern that summer net catches are not representative and crappie management is a priority. Crappie > 254 mm and < 76 mm are also more likely to be caught by fall trap netting.

A minimum of seven trap net locations within a lake should be sampled for the catch to better represent the sampled fish population. The number of habitats sampled with summer gill nets were usually adequate during this study, but an insufficient number were sampled by summer trap netting.

Specialized trap netting can also be done in lakes where standard trap netting does not work or gives inadequate sample sizes. For example, trap nets set offshore along steep bottom gradients or using trap nets with longer leads could result in larger and more representative samples in lakes such as Big Swan.

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