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EVALUATION OF A FRAME TRAWL AND TUCKER TRAWL FOR SAMPLING YOUNG-OF-THE-YEAR FISH

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ABSTRACT

Relative efficiencies of two trawls — a 1.88 m² frame trawl and a 2 m² Tucker trawl — were compared for sampling young-of-the-year (YOY) shad, *Dorosoma* sp., crappies, *Promoxis* sp., and sunfishes, *Lepomis* sp. Seven tests with six replicate hauls for each net in each test were analyzed by non-parametric techniques. Relative efficiency ratios, calculated from mean density estimates, were compared. The Tucker trawl was the more efficient for sampling YOY shad, its relative efficiency increasing as shad length increased. Results for the other two taxa were less consistent. The larger size range of YOY shad captured compared with the size ranges of fish of the other two taxa, seemingly increased the avoidance capabilities of the shad. The absence of a bridle and otter boards on the Tucker trawl and towing the net away from the effect of the propeller wash contributed to its efficiency.

INTRODUCTION

Midwater trawling has been used since 1975 to study young-of-the-year (YOY) fish populations in DeGray Lake, Arkansas. A 1.88 m² frame trawl (Houser, 1972) was used for sampling in 1975-76 and a 2 m² Tucker trawl in 1977-80 (Hopkins et al., 1973). The objective of this study was to evaluate the two midwater trawls for sampling YOY fish and to develop correction factors to make catches from the two trawls comparable. Abundance estimates of shad, *Dorosoma* sp., crappies, *Promoxis* sp., and sunfishes, *Lepomis* sp. were analyzed. Although differences in the sampling efficiencies of small high-speed samplers have been investigated (Colton et al., 1961; Southward, 1962; and Noble, 1970), few comparisons have been made of the sampling efficiencies of midwater trawls. Sampling efficiency expresses the degree of avoidance by fish, and that degree may vary with each sampling device. The avoidance capability of an organism is theoretically related to sampler size, distance at which the organism perceives the sampler and the speed at which the sampler approaches (Barkley, 1964). Unbridled nets have been shown to yield significantly higher catches than bridled nets (Quirk et al., 1976; Smith, 1972). Therefore, efficiency might differ between the frame trawl, which has two bridles, and the Tucker trawl, which has none.

METHODS

All trawling was conducted from an 8.5 m aluminum boat (3.2 m beam), powered by a diesel engine. Trawls were released and retrieved by two hydraulic winches. Seven nighttime tests were made during May or June 1977-80. Each test consisted of six hauls with one trawl followed immediately by six hauls with the other trawl in the same area. The frame trawl had a mesh size of 0.79 mm and the Tucker trawl, 0.50 mm. Sampling was conducted at a time when larvae were vulnerable to both mesh sizes. Oblique hauls to a depth of 7 m were made with both trawls.

When the Tucker trawl was used it was lowered in a closed position, opened, and retrieved at a 45° angle. Because of the steep angle of retrieval, the effective opening of the Tucker trawl was calculated to be only 1.5 m², whereas because of the much longer length of tow of the frame trawl, the effective opening varied little from 1.88 m². Both nets were towed at a speed of about 0.9 m/s. The frame trawl was towed directly astern, and the Tucker trawl off the starboard side, away from the propeller wash. When the Tucker trawl was used, a reinforced, perforated vinyl bag, 1.5 m long, was towed off the port side to offset the drag of the trawl. A General Oceanics flowmeter, suspended in the mouth of the net, was used to estimate the length of tows. The length of tow was multiplied by the effective opening of the net to determine volume of water sampled (about 45 m³ for the Tucker trawl and 400 m³ for the frame trawl.

Fish were preserved in 10% formalin and taken to the laboratory for identification and enumeration. Fish were identified to genus on the basis of taxonomic keys developed by May and Gasaway (1975) and Hogue et al., (1976). Subsamples from each haul were measured to the nearest 0.5 mm for larvae less than 20 mm long and to the nearest millimeter for specimens 20 mm long or longer. Because small gizzard shad *(D. cepedianum)* and threadfin shad *(D. petenense)* are very difficult to separate, data for the two species were pooled for all analyses. Catches of larval sunfishes, *Lepomis* sp., and crappies, *Pomoxis* sp., were also compared.

Since variances were not always homogeneous, Wilcoxon's signed-rank tests (Sokol and Rohlf, 1969) were used to compare estimates of abundance. Mann-Whitney non-parametric tests (Steel and Torrie, 1960) were used to compare length frequencies of YOY shad. Due to the small range in lengths of the YOY sunfishes and paucity of crappies collected, length frequencies were not statistically compared for these two taxa.

The ratio of the mean density estimate (fish/m³) of the Tucker trawl for each test was divided by that of the frame trawl and termed relative efficiency (R E). This ratio was used to compare relative sampling efficiencies for YOY shad, crappies, and sunfishes. Relative efficiencies for YOY shad were pooled by 3 mm size group to assess changes in relative efficiency by size.

RESULTS

Mean density estimates of fish taken in the Tucker trawl were generally higher than those of the frame trawl (Table). Variances were less than the mean in all comparisons, indicating a relatively uniform distribution of YOY fishes (Elliot, 1971). Mean density estimates of shad based on catches in the Tucker trawl were always higher than those based on the frame trawl. The estimates were significantly higher ($P < .05$) in the Tucker trawl in six of the seven comparisons. The R E of the tucker trawl was higher for all seven comparisons, ranging from 1.91 to 3.74 (Table). A significant positive correlation, indicating that the

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Table. Mean catch (fish/m³) of YOY shad, crappies and sunfishes and relative efficiency (R E) for a Tucker and a 1.88 m² frame trawl in seven tests, DeGray Lake, 1977-80.

Sampling Date	Shad			Crappies			Sunfish			Total YOY		
	Tucker	Frame	RE	Tucker	Frame	RE	Tucker	Frame	RE	Tucker	Frame	RE
25 May 1977	1.846[a/]	0.695	2.66	0.183	0.142	1.28	2.434	2.352	1.03	4.549[a/]	3.220	1.41
22 June 1977	0.090	0.047	1.91	0.050	0.084	0.62	1.665	1.729	0.96	1.892	1.913	0.99
08 June 1978	6.387[a/]	2.585	2.47	0.119	0.062	1.92	1.219	1.316	0.93	7.767[a/]	3.988	1.95
22 June 1978	1.031[a/]	0.468	2.20	0.004	0.024	0.17	1.529[a/]	0.348	4.39	2.764[a/]	0.992	2.79
28 June 1979	2.452[a/]	0.656	3.74	0.331[a/]	0.206	1.61	1.841[a/]	0.694	2.65	5.171[a/]	1.588	3.26
27 May 1980	2.373[a/]	1.202	2.27	0.749[a/]	0.408	1.83	0.808[a/]	0.241	3.35	3.930[a/]	1.851	2.12
10 June 1980	0.749[a/]	0.391	1.91	0.138	0.073	1.89	1.124[a/]	0.695	1.62	2.011[a/]	1.150	1.75

a/ Significantly greater ($P < .05$) than the frame trawl.

Tucker trawl was more efficient as fish length increased, was noted in only two of the seven comparisons when R E's were compared by 1 mm increments. When catches were combined from all tests and densities were pooled by 3 mm increments, a significant positive correlation was noted (Figure). When length frequencies were compared by the Mann-Whitney test, significant differences ($P < .05$) were noted in only three of the comparisons.

The Tucker trawl was more efficient than the frame trawl for crappies in five of the comparisons (Table). However, in only two instances were the catches of the Tucker trawl significantly higher ($P < .05$).

The Tucker trawl was nominally more efficient for YOY sunfishes than the frame trawl in five of the seven series and was significantly higher ($P < .05$) in four (Table). For all taxa combined, the Tucker trawl was significantly more efficient ($P < .05$) in all but one comparison (Table).

DISCUSSION

Differences in the relative sampling efficiencies of the two trawls are related to differences in trawl design, deployment of gear, size of YOY fish being sampled, and distributional patterns of fish. Our comparisons indicate that the Tucker trawl consistently captured larger numbers of YOY shad per unit of volume sampled (1.9 to 3.7 times greater) than the frame trawl. However, neither trawl was consistently more efficient in sampling YOY crappies and sunfishes. The differences in efficiency between taxa are partly due to the size of the fish. Lengths of YOY shad were 5 to 40 mm, those of most YOY crappies were 20 mm or less and those of most YOY sunfish were 10 mm or less. Barnes (1977) found that swimming speed more than doubled for shad 25 to 55 mm long in comparison with those less than 25 mm long. The difference should have a significant effect in avoidance of the trawl of YOY shad.

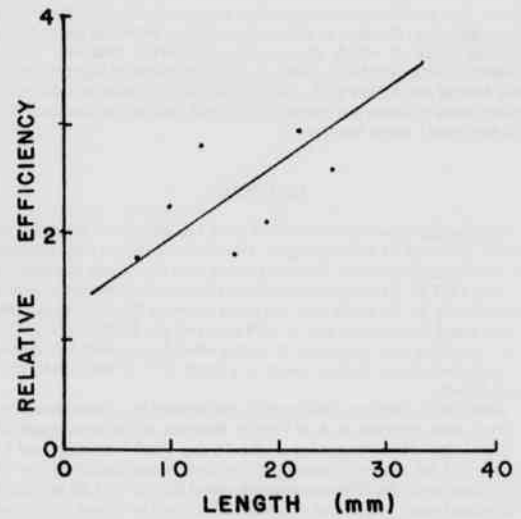

Figure. Relative efficiency by length group for seven tests when catches of shad (fish/m³) were pooled by 3 mm increments.

However, the Tucker trawl apparently reduces this avoidance to some extent, since the relative efficiency increased as shad length increased. For the smaller crappies and sunfish, differences between the two trawls were probably related to distributional patterns, and not to avoidance.

Factors other than fish size are also important in influencing sampling efficiency. Positioning the bridles and otter boards in advance of the frame trawl may decrease its sampling efficiency for some taxa. Bridles cause pressure waves in the mouth of the net which might influence net avoidance by larval fish being sampled (Clutter and Anraku, 1968; Fleminger and Clutter, 1965). Lasker (1975) found that bridleless bongo nets made significantly greater catches of large larval anchovies than did standard meter nets.

Deployment may account for differences in sampling efficiency of the two trawls. The Tucker trawl was towed off the side of the boat away from the propeller wash, whereas the frame trawl was towed directly behind the boat. Bowles et al. (1978) reported that gear deployed over the stern of a vessel may yield biased samples due to active and passive avoidance responses to turbulent propeller wash.

At low towing speeds, the size of the net mouth is an important factor affecting sampling efficiency (Bowles et al., 1978). There was a 25 per cent difference in the effective area of the mouth openings for the two trawls tested. However, we believe the size of the net mouth was not a major factor influencing sampling efficiency in these tests.

Speed of the tow can be increased to reduce gear avoidance by larger fish larvae (Aron et al., 1975; Noble, 1970; Bernhard et al., 1973; Quirk, Lawler, and Matusky, 1974). However, speed of the tow was similar for both trawls tested.

The Tucker trawl was consistently more efficient in sampling YOY shad. Our research provides the correction factors necessary to compare catches of YOY shad from frame and Tucker trawls.

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