Distributions of Largemouth Bass in Relation to Submerged Aquatic Vegetation in Flat Top Lake, West Virginia

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Abstract. Abundance and, to a lesser degree, size distributions (in 1 of 2 sample years) of largemouth bass (*Micropterus salmoides*) were influenced by the presence of submerged aquatic vegetation in Flat Top Lake, West Virginia. Relative abundance and size distributions of adult largemouth bass (≥200 mm in length) were compared among high, intermediate, and low densities of submerged aquatic vegetation in September–October 1986. Largemouth bass were more abundant at high and intermediate vegetation densities than at low densities, but no differences in size distribution were noted among vegetation levels. In June and August 1987, the relative abundance and size distributions of all sizes of largemouth bass were compared between high and low vegetation densities. High vegetation contained significantly greater numbers of largemouth bass. Largemouth bass lengths were smaller in high vegetation samples, primarily due to a higher proportion of age–0 fish in these areas. Vegetation was an important habitat component to largemouth bass in Flat Top Lake, and could be managed to improve largemouth bass fisheries.

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Submerged aquatic vegetation is an important component of many aquatic systems inhabited by largemouth bass (Maceina et al. 1984). However, documented use of vegetated habitats by adult largemouth bass varies considerably. From telemetry studies, largemouth bass have been found to use both vegetated habitats and open water habitats extensively (Mesing and Wicker 1986, Betsill et al. 1988, Colle et al. 1989). Wiley et al. (1984) found a parabolic relationship between the production of adult largemouth bass and vegetation density with maximum production at moderate vegeta-

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tion coverage. Bailey (1978) could discern no relationship between the abundance of age–0 or harvestable largemouth bass and aquatic vegetation.

Use of vegetated habitats by largemouth bass appears to vary with size of fish. Barnett and Schneider (1974) noted the use of densely vegetated habitats by juvenile largemouth bass, but not by adults. In contrast, Durocher et al. (1984) found a positive association with aquatic vegetation for adult largemouth bass, but not for juvenile fish among different lakes. In a study by Wanjala et al. (1986), juvenile and large adult largemouth bass utilized littoral structure, whereas intermediate sized largemouth bass utilized open limnetic habitats.

It is apparent that the use of aquatic vegetation by largemouth bass is highly variable. This study was designed to evaluate the importance of vegetated habitat to largemouth bass in Flat Top Lake, West Virginia. We examined this relationship by comparing relative abundance and size distributions of largemouth bass between vegetated and unvegetated shoreline areas.

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Study Site

Flat Top Lake is a 94-ha multiple use impoundment in Raleigh County, West Virginia (elevation = 850 m above mean sea level). Abundant fish species in the lake include largemouth bass, bluegill (*Lepomis macrochirus*), yellow perch (*Perca flavescens*), black crappie (*Pomoxis nigromaculatus*), and green sunfish (*L. cyanellus*). Two taxa of submerged aquatic vegetation were common: *Najas* sp. and *Nitella* sp. *Najas* covered approximately 13% of the surface area of the impoundment during the study, and occupied the entire water column down to depths of 3.0 m. *Nitella* covered approximately 10%–20% of the reservoir's area, and was found at depths of 0.1–6.0 m. However, *Nitella* only grew to a height of 0.15 m above the substrate, and consequently provided less vegetated cover on a per volume basis. Biomass of aquatic vegetation, obtained by quadrat (10 × 10 cm) sampling by scuba divers, was 113 g dry wt/m^2 for *Najas* and 77 g dry wt/m^2 for *Nitella*.

Methods

In September and October 1986, relative abundance and size distributions of adult largemouth bass (≥200 mm in length) were compared among 3 classes of aquatic vegetation coverage: low density (habitats with sparse or no vegetation), intermediate density (habitats dominated by *Nitella*), and high density (habitats dominated by *Najas*). Shoreline segments were classified into 1 of these 3 groups based on observations by scuba divers. Each shoreline segment was electrofished after sunset on 3–10 September 1986 and again on 1–10 October 1986. Water depths at these shoreline segments ranged from 0.1–3.5 m. Electrofishing samples were collected with a 5.5-m boat electrofisher (Smith-Root Electronics, Inc., Vancouver, Wash.). Pulsed-DC current was used at output ranges of 250–350 V and 7.0–12.0 A. Effort was quantified by unit on-time, and each shoreline segment was treated as a separate sample. Sampling design resulted in 25 samples in low, 14 samples in intermediate, and 9 samples in high vegetation segments.

In June and August 1987, relative abundance and size distributions of juvenile and adult largemouth bass were compared between areas of high and low vegetation coverage. Six sampling stations were chosen; 3 in areas of abundant *Najas* and 3 in areas of sparse *Nitella* or no vegetation. All 6 stations were electrofished after sunset on 3 separate occasions in June and 3 times in August. Each station was sampled for 1,000 seconds of unit on-time to standardize effort. In both years, all fish were weighed (g) and measured (mm total length). Largemouth bass ≥200 mm were released at the capture site; smaller fish were preserved.

Data from 1986 and 1987 were analyzed separately. Samples from September and October 1986 were pooled prior to analysis as only 2 weeks separated the samples. Samples from June and August 1987 were analyzed independently to observe seasonal influences. Significance levels for all tests were set at alpha = 0.05.

Catch/effort estimates of largemouth bass ≥200 mm captured in 1986 were compared among high, intermediate, and low vegetation densities with the method of Byers et al. (1984). Comparisons were made between expected catch (based on the total catch and the proportion of time spent electrofishing each vegetation type) and the actual catch in each vegetation class. Differences in proportional stock density (PSD) among vegetation types were compared by calculating 95% binomial proportion confidence intervals (Zar 1984). Differences in size distributions of largemouth bass among vegetation densities were examined by comparing log-transformed mean lengths with analysis of variance (ANOVA) and by comparing actual length distributions with 2-sample Kolmogorov-Smirnov tests (Hollander and Wolfe 1973). Relative weights (W_r) of largemouth bass (Wege and Anderson 1978) were compared with ANOVA.

In 1987, catch/effort estimates of largemouth bass (juveniles and adults) at high and low vegetation densities were compared with ANOVA. Log-transformed mean lengths of all largemouth bass were compared between vegetation classes with ANOVA procedures, and actual length distributions were compared with 2-sample Kolmogorov-Smirnov tests. PSD values were compared between high and low vegetation with 95% binomial proportion confidence intervals. Relative weights of largemouth bass ≥200 mm were analyzed with ANOVA. Statistical significance was declared at the $P < 0.05$ level.

Results

Habitat use by largemouth bass ≥200 mm in length was not in proportion to plant densities in September–October 1986 (Table 1); use of the low vegetation

Table 1. Proportion of habitat sampled and used by largemouth bass (LMB) ≥200 mm in length in high, intermediate, and low density vegetation as determined by electrofishing catch/effort in Flat Top Lake, West Virginia, September–October 1986.

Vegetation density	Amount of available habitat[a]	Number of LMB expected	Number of LMB captured	% habitat availabl	% habitat use	95% bonferroni confidence interval
High	6,369	61.19	73	22.2	26.5	20.1–32.8
Intermediate	7,462	71.70	87	26.0	31.5	24.3–38.2
Low	14,891	143.08	116	51.8	42.0	34.9–49.2
Totals	28,722	275.97	276			
Chi-square = 10.67, $P < 0.005$						

[a]Amount of available habitat = number of seconds spent electrofishing each habitat type.

habitat was significantly less than expected. Mean lengths of adult largemouth bass were not significantly different among vegetation densities. Length distributions of adult largemouth bass at high, intermediate, and low densities of vegetation were not significantly different based on Kolmogorov-Smirnov tests (Fig. 1). The 95% confidence intervals around PSD estimates at all vegetation densities revealed no vegetation-related differences (Fig. 1). Similarly, relative weights (W_e) of adult largemouth bass ranged from 94.7 at low to 98.8 at high vegetation stations, but were not significantly different.

Largemouth bass of all sizes were significantly more abundant at high vegetation sites than at low vegetation sites in June and August 1987 (Table 2); there was no significant interaction effect. Length-frequencies of largemouth bass appeared to differ between vegetation densities, particularly in August (Fig. 2), although differences were not significant. Mean total lengths of largemouth bass were significantly greater at low vegetation (Table 2). Most of this difference was explained by the greater proportion of age–0 largemouth bass at high vegetation sites in August (Fig. 2). The actual distribution of largemouth bass lengths did not differ between high and low vegetation (Fig. 2). The 95% binomial proportion confidence intervals of PSD values were not significantly different between high and low vegetation densities or months (Fig. 2). Mean relative weights (W_r) of adult largemouth bass ranged from 94.7 to 98.8 and were not significantly different between vegetation levels or months.

Discussion

The relative abundance of largemouth bass, both juveniles and adults, was positively related to the presence of submerged aquatic vegetation in Flat Top Lake. Size distributions of largemouth bass differed between vegetation densities in 1987 primarily due to a greater abundance of age–0 largemouth bass in the high vegetation samples. Thus, attraction of largemouth bass to vegetated habitats may have been greater for juveniles than adults. Differences in abundance in the fall samples were less than in June and August.

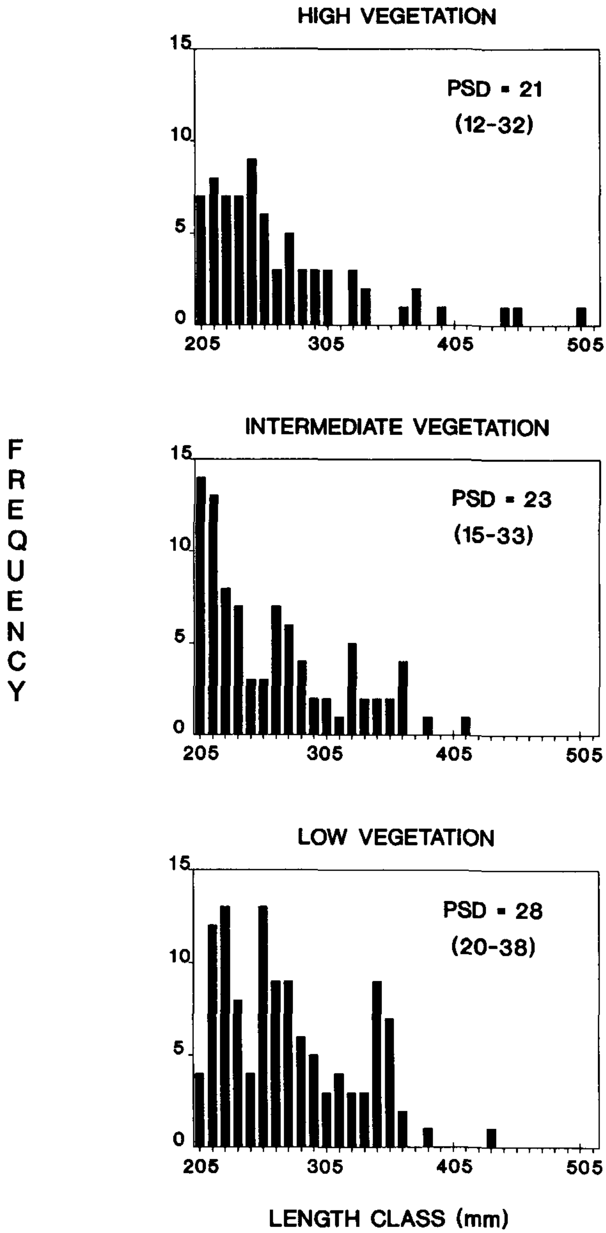

Figure 1. Length-frequencies and proportional stock densities (PSD, 95% confidence limits in parentheses) of largemouth bass ≥200 mm in length captured at high, intermediate, and low vegetation densities in Flat Top Lake, West Virginia, September–October 1986.

Table 2. Relative abundance and mean lengths (mm) of largemouth bass at high and low vegetation densities in Flat Top Lake, West Virginia, 1987. Relative abundance measured as mean number of largemouth bass captured per 1,000 seconds of electrofishing. Standard deviations in parentheses. (N = 3 for all samples.)

	N largemouth bass/sample			Mean lengths (mm) of largemouth bass	
Month	High vegetation	Low vegetation		High vegetation	Low vegetation
June	58.8 (8.88)	39.21 (29.90)		186 (6.6)	194 (16.1)
August	42.3 (4.73)	18.9 (5.50)		168 (6.0)	189 (9.9)
	ANOVA		*P*	*ANOVA*	*P*
	Vegetation		0.0130	Vegetation	0.0189
	Month		0.0554	Month	0.0032
	Interaction		0.4028	Interaction	0.0571

The association between largemouth bass and aquatic vegetation is not consistent across fish size, seasons, or location. Largemouth bass inhabited areas of aquatic vegetation extensively in Florida lakes, Texas ponds, and the Potomac River, Maryland (Mesing and Wicker 1986; Betsill et al. 1988; and Killgore et al. 1989, respectively). However, Colle et al. (1989) observed no habitat selection in Florida largemouth bass: areas of open water, artificial structure (piers), and vegetation (*Nyssa aquatica*) were used in approximately equal proportions. Furthermore, Bailey (1978) and Colle et al. (1987) found no relationship between the abundance of largemouth bass and the surface area coverage of aquatic vegetation in 31 Arkansas reservoirs and Orange Lake, Florida, respectively.

Previous inter-lake comparisons suggest that dense vegetation may depress the condition of largemouth bass: Colle and Shireman (1980) found that the condition factors of largemouth bass were greater in lakes with <30% surface area coverage of *Hydrilla verticillata* than in lakes with more extensive cover. Our results indicate that dense vegetation does not necessarily depress condition of largemouth bass on a within-lake basis. Areas of dense vegetation can attract largemouth bass and support higher densities without affecting fish condition.

The size-related differences that we observed in habitat use have also been observed in previous studies. Barnett and Schneider (1974) noted higher abundances of age–0 largemouth bass in dense submerged aquatic vegetation (*H. verticillata, Ceratophyllum demersum, Egeria densa, Vallisneria americana,* and *N. guadalupensis*) than in more open habitats, whereas adult largemouth bass were found at the periphery of dense vegetation beds but not in the vegetation itself. Wanjala et al. (1986) observed a strong association between littoral structure (vegetation, woody debris, and man-made structures) and largemouth bass in the 190–250 mm and

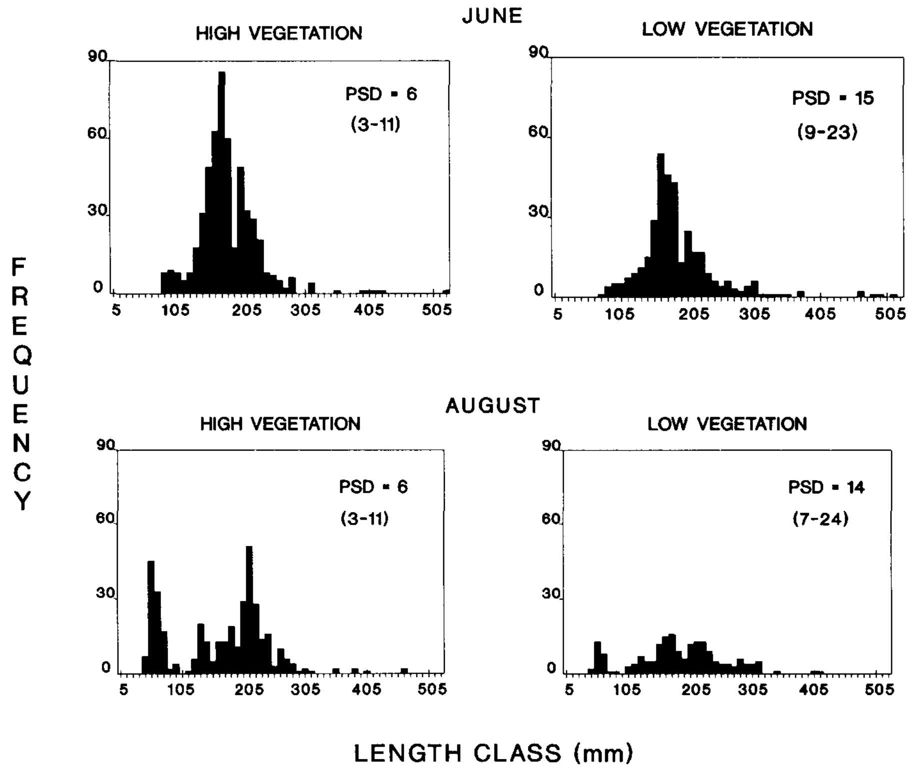

Figure 2. Length-frequencies and proportional stock densities (PSD, 95% confidence limits in parentheses) of largemouth bass captured at high and low vegetation densities in Flat Top Lake, West Virginia, 1987.

≥380 mm size classes, whereas 251–379 mm largemouth bass were associated with open limnetic habitats in Alamo Lake, Arizona. The most striking difference among vegetation levels in Flat Top Lake was the greater abundance of age–0 largemouth bass in August. The attraction to dense beds of *Najas* was weaker for larger fish.

Interactions between largemouth bass and aquatic vegetation could be influenced by several factors. The availability of alternative structures (man-made structures, woody debris, rock, etc.) that may serve as shelter or forage fish attractors can alter the value of aquatic vegetation to largemouth bass. In Flat Top Lake, cover other than vegetation was minimal; aquatic vegetation was the most abundant cover type. The assessment of preferred habitat for largemouth bass in waters with alternative structures would surely yield a different picture of the value of aquatic vegetation.

The species and growth patterns of aquatic vegetation likely affect the distribution of largemouth bass and may explain some inconsistencies in previous findings. Keast (1984) reported that the native *Potamogeton-Vallisneria* plant community had higher abundances of fish (all species combined) than did areas of introduced

Myriophyllum spicatum in Lake Opinicon, Ontario, Canada. In contrast, although the physical structure of *Najas* and *Nitella* habitats were quite different, adult largemouth bass use of these 2 habitats were not very different, at least in September–October in Flat Top Lake. Killgore et al. (1989) observed changes in largemouth bass abundance with seasonal changes in the biomass and successional stage of aquatic vegetation: largemouth bass were most abundant at high plant densities in August and at intermediate plant densities in November. In Flat Top Lake, the association of adult largemouth bass and vegetation also seemed to be weaker later in the season (September–October).

The forage base likely influences habitat use by largemouth bass. Open-water forage species (clupeids, osmerids, atherinids) were not present in Flat Top Lake, and the forage fish community was dominated by small centrarchids. The abundance of these centrarchids was consistently greater in areas of dense vegetation (Smith 1989). Therefore, largemouth bass/aquatic vegetation relationships will likely differ between reservoirs dominated by a littoral forage base as opposed to a pelagic forage base.

Aquatic vegetation may have been important to largemouth bass in Flat Top Lake because alternative habitats did not provide suitable forage or cover. Due to the absence of pelagic species, the forage base in low-structure habitats may have been limited. Also, the amount of high density vegetation in Flat Top Lake (13% surface area coverage of *Najas*) was less than the optimal coverages suggested by Colle and Shireman (1980) and Wiley et al. (1984) of 30% and 36%, respectively. Therefore, vegetation densities in Flat Top Lake may have been below the level for maximum largemouth bass abundance.

In Flat Top Lake and elsewhere, vegetation was an important habitat component for largemouth bass. This suggests that submerged vegetation in this system should be managed for sport fish production rather than eradicated. The manipulation of aquatic vegetation as a fisheries management tool will require more predictable vegetation/largemouth bass relationships. These relationships should vary with other factors such as vegetation type, density, and structure, the availability of alternative cover types, and forage base characteristics. Research to further examine these influences as they relate to aquatic vegetation and their effects on the game fish communities is warranted.

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