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A Review Paper on the Effects of Aquatic Vegetation on Predator-Prey Interactions

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Abstract: In this paper, the effects of aquatic vegetation on fish species interactions has been reviewed. Predator-prey interaction between largemouth bass (LMB) (*Micropterus salmoides*) and bluegill (BLG) (*Lepomis macrochirus*) has been as an excellent example of understanding the effects of aquatic vegetation on the predator-prey interactions. So the focus has been given on the interactions between those species in order to evaluate a general pattern of aquatic vegetation effects on predator-prey interactions of most fish species. Predatory success of largemouth bass on bluegill can vary with complex habitat, predator and prey body size. Complex habitat affects bluegill distribution and largemouth bass predatory success. Bluegill can avoid predation risk by hiding itself in complex habitat. Most of the authors agreed that largemouth bass predatory success declined as habitat complexity increased. Thus it can be concluded that aquatic vegetation should be kept an intermediate density so that both interacting species can benefit.
Key Words: Predator-prey interactions, aquatic vegetation, aquatic vegetation density, *Micropterus salmoides*, *Lepomis macrochirus*

Av-Avcı Etkileşimine Akvatik Vejetasyonun Etkileri Üzerine Bir Derleme

Özet: Bu makalede su bitkilerinin balıklar arasındaki interaksiyonlara olan etkileri irdelenmiştir. *Micropterus salmoides* ve *Lepomis macrochirus* arasındaki av-avcı ilişkisi, su bitkilerinin av-avcı ilişkilerine etkilerini anlamada mükemmel bir örnek teşkil etmektedir. Bu yüzden su bitkilerinin bütün balık türleri arasındaki av-avcı ilişkisine etkilerini değerlendirmek için bu iki tür arasındaki av-avci ilişkisi üzerinde durulmuştur. Bu derlemenin sonucunda, *Micropterus salmoides*'in *Lepomis macrochirus*'ın üzerindeki av başarısı kompleks habitat, av ve avcı balığın büyüklüğü ile değişim gösterdiği sonucuna varılmıştır. Kompleks habitat *Lepomis macrochirus*'in dağılımına ve *Micropterus salmoides*'in av başarısına etki etmektedir. Birçok bilim adamı, habitat karmaşıklığının artmasıyla *Micropterus salmoides*'in av başarısının azaldığı üzerinde hemfikirdirler. Su bitkilerinin, hem avcı hemde av balıkların faydalanabileceği şekilde orta yoğunlukta tutulması gerektiği bir sonuç olarak tavsiye edilebilir.
Anahtar Kelimeler: Av-avcı ilişkisi, akvatik vejetasyon, akvatik vejetasyon yoğunluğu, *Micropterus salmoides*, *Lepomis macrochirus*

1. Introduction

Aquatic vegetation is one of the major biogenic habitats for both marine and freshwater systems worldwide and is inhabited by a diverse and abundant assemblage of fishes. Fish may recruit to vegetated habitats because complex habitat offers them a refuge from predator (Heck and Orth 1980, Orth et. al. 1984). In addition, fish may prefer these habitats in order to consume vegetation-associated invertebrates, epiphytes on vegetation, or vegetation itself (Stoner 1982; Luczkovich et. al. 1995); consequently, fish may also respond to variability in macrophyte-associated food resources (Levin 1994).

Predation is one of the major forces influencing population dynamics and community structures (Sih, A. 1987). Predator effects on prey can be observed directly and indirectly. Direct effect (lethal) mainly involve in killing prey. By killing prey, predator can control prey population and alter the relative and absolute abundance and species diversity of prey (Sih, 1987). However, indirect effects (sub-lethal) can alter prey life styles, feeding behavior, growth and reproduction.

Largemouth bass and bluegill are among the most common fish species in lakes and ponds across much of Eastern North America and they potentially interact trough both competitive and predatory stages (Olson and Mittelbach, 1995). Predator-prey interactions between these species are affected by abiotic and biotic factors. Abiotic factors are related to habitat types, temperature, salinity and dissolved oxygen; whereas biotic factors are related to predator and prey body sizes.

The objectives of this paper are to provide an overview on (1) the effects of habitat complexity on the predation between LBM and BLG, and (2) evaluating predation interactions into the management of these species in aquatic ecosystems.

1.1. Largemouth bass feeding behaviour

LMB is the dominant top carnivores of many North American lakes and reservoirs. LMB is also one of the popular sport fish in North America (Howick and O`Brein, 1983). LMB diet includes BLG *(Lepomis macrochirus)*, pumpkinseed (*Lepomis gibbosus*), yellow perch (Perca flavescens), bluntnose minnows *(Pimephales notatus)*, common tadpoles (*Rana catesbeiana*) and crayfish (*Astacus fluviatilis*) (Hoyle, 1987). The feeding success of LMB depends on its mouth size and prey body size. Largemouth bass can consume prey with maximum body depths less than or equal to its mouth width (Schramm and Zale, 1985).

2. Predation in Complex Habitat

In structurally complex environment prey can avoid predators and reduce the risk of predation by hiding itself in dense habitat (vegetation, dead tree branches etc.). Complex structures may create refuges to provide complete protection for prey. They also reduce the predation risk of prey to a minimum. Thus, complex habitats may attract prey. Bettolli et al. (1982) showed that complex structures of high density of submerged vegetation in Lake Conroe, Texas, prevented LMB from efficient feeding on other fishes.

Hayse and Wissing (1996) studied the effects of stem density (artificial vegetation) on the attraction of bluegill and largemouth bass. They used 0 (zero), 400 (low), 961 (medium) and 3844 (high) stems/m^2 in experimental ponds and field. They concluded that all of the mats containing artificial vegetation were colonized by age-0 bluegills, and mean number of age- 0 bluegills increased as stem density increased. Vegetation density significantly affected predation of age-0 bluegills by largemouth bass in both filed and laboratory predation experiments (Figure 1).

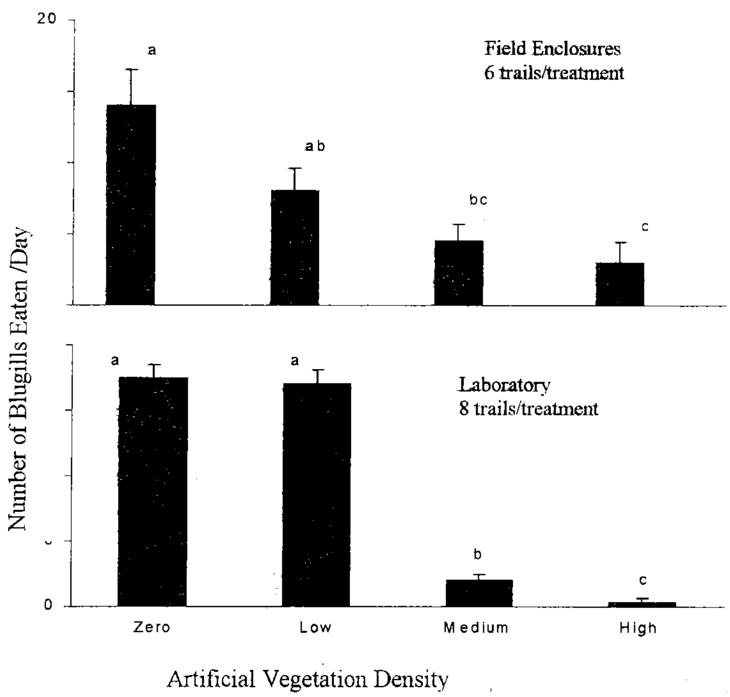


Figure 1. Mean number of 0- bluegills eaten in 24 h by largemouth bass in different densities of artificial vegetation (redrawn from Hayse and Wissing 1996).

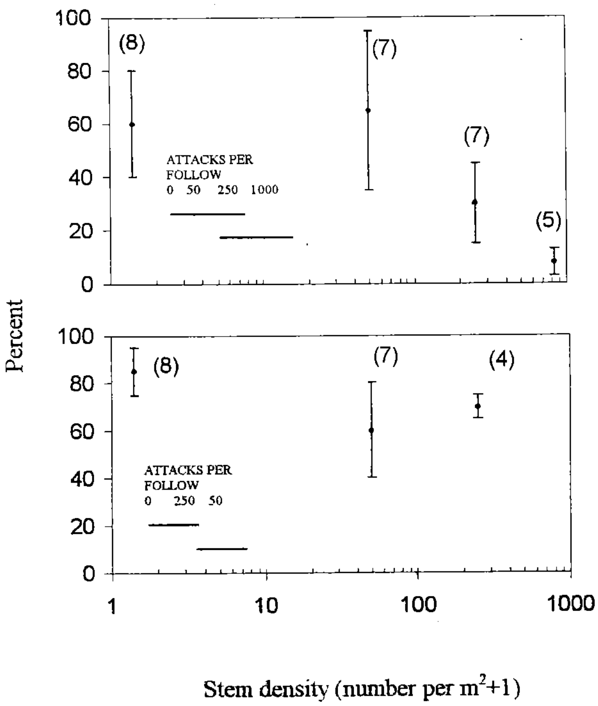
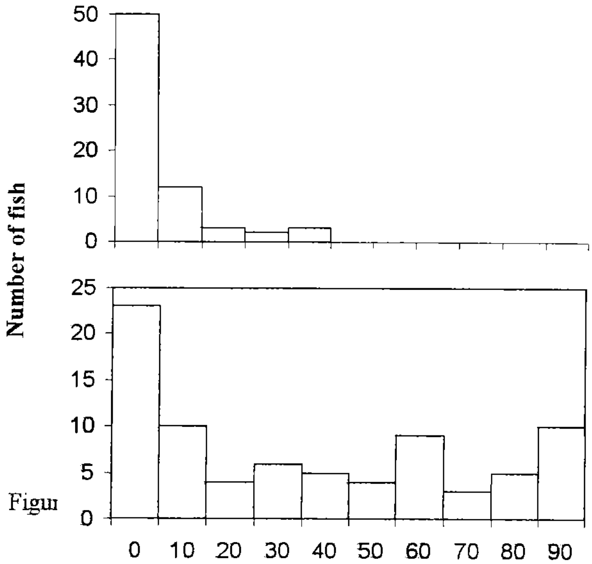


Figure 2. LMB predatory success (number of captures) in different stem densities (redrawn from Savino and Stein 1983).

Savino and Stein (1982) designed a study indicating that low visibility due to high density or artificial vegetation reduced predatory success of LMB. They used four laboratory pools each with a different stem density (0, 50, 250, 1000 stems/ m^2) of artificial plant stems. They found that predatory success (number of captures) by LMB was reduced as density of stem per m^2 increased (Figure 2). They found also that visual barriers, artificial stems, influenced LMB and BLG behaviour.

Werner et al. (1983) studied distributional shift of BLG caused by LMB predatory pressure. They placed juvenile BLG of three size classes (small, medium and large) in experimental ponds that contained or lacked LMB. All prey were under 75 mm. When predators were absent, all three size classes of prey occurred in the open water sections of the ponds where more profitable food occurred. When predators were added, the smallest prey fish restricted their foraging to the vegetated regions of the pond which had less food (Figure 3). Foraging in this region was 1/3 of what was in open water and growth rates were reduced 27%. When predators were present, the vulnerable size class was apparently able to shift to the less profitable but safer habitat. They also studied growth rates of three size classes of BLG. They found that larger sizes classes exhibited progressively higher growth rates (Table 1). However, in the presence of LMB, the small fish exhibited a significant depression in growth, whereas the medium and large classes grew larger than in the absence of LMB (Table 1). The presence of LMB significantly depressed growth rates of the small fish in accord with their increased use of the poorer habitat (vegetation). Because the small fish spent more time in the less profitable vegetation, this apparently released resources for the larger fish in the sediments and open water.



Figur f LMB (redrawn from Werner et al. 1983)

Table1. Mean individual dry mass for three size clasess of BLG in the presence and absence of LMB (redrawn from E. E. Werner et al. 1983)

	Size-class					
	Small		Medium		Large	
	Predator	No Predator	Predator	No Predator	Predator	No Predator
Initial mass (g)	0.28 ± 0.01 (n=44)		1.35 ± 0.03 (n=27)		3.64 ± 0.12 (n=30)	
Final mass (g)	0.90±0.02 (n=348)	1.13±0.02^{xxx} (n=359)	4.45±0.05 (n=270)	4.35±0.05 (n=270)	9.17±0.15 (n=89)	8.64±0.15^{xx} (n=81)
Increment (g)	0.62	0.85	3.10	3.00	5.53	5.00
Population increment (g)	191.0	269.5	768.8	750.0	392.6	230.0
Difference in population in	-78.5		18.8		72.6	

xx $p<0.01$
xxx $p<0.005$

3. Management implications

As it is seen from literature review, predation between LMB and BLG is heavily affected by complex habitat. Habitat complexity decreases the predation success of LMB. High dense complex habitat may cause stunting problem. Neither largemouth bass nor bluegill grows at an increased rate in high dense complex environment. Because small BLG chooses the dense habitat as a refuge, the density of small BLG increases in this habitat. This may cause competition for limited food in the habitat. Reduced habitat density may be a solution for the stunning problem. As BLG population is reduced by LMB, there are more food resources available per BLG. Complex habitats should be kept at certain density in an aquatic environment when LMB and BLG are present. The most desirable physical design of habitat complexity would be a heterogeneously distributed set of patches at intermediate density. Such an implication most likely may increase both BLG and LMB growth rates. Hayse and Wissing (1996) suggested that habitat complexity (including vegetations), could be manipulated to influence the survival of juvenile BLG that uses vegetation as a refuge from predation. If carrying capacities of vegetation and predation risk can be quantified, one might able to predict the number of fish that would survive to a certain size over a given time period. If the effects of vegetation type, distribution, and abundance on fish communities can be understood, fishery managers might be able to manipulate aquatic vegetation in ways that would help maintain populations of game fishes such as LMB near desired levels for a particular time.

References

Bettolli, P. W., M. J. Maceina, R. L. Noble and R. K. Betsill 1992. Piscivory in largemouth bass as a function of aquatic vegetation abundance. North American journal of Fisheries Management 12: 509-516.

Hayse, J. W. and T. E. Wissing 1996. Effects of stem density of artificial vegetation on abundance and growth of age-0 bluegills and predation by Largemouth bass. Transactions of the American Fisheries Society 125:422-433.

Heck, K. L and R.J. Orth 1980. Seagrass habitats: the roles of habitats complexity, competition and predation in structuring assisted fish and motile macroinvertebrate assemblages. In: Kennedy VS (ed) Estaurine perspective. Academic Press, New York, pp 449-464.

Hoyle, J. A. and A. Keast 1987. The effects of prey morphology and size on handling time in a piscivore, the largemouth bass (*Micropterus salmoides*). Canadian Journal of Zoology 65: 1972-1977.

Howick, G. L. and W. J. O'Brien 1983. Piscivorous feeding behaviour of largemouth bass: An experimental analysis. Transactions of the American Fisheries Society 112: 508-516.

Levin, P. S. 1994. Small-scale recruitmrnt variation in a temperate fish: the roles of macrophytes and food supply. Environmental Biology of Fishes 40:271-281.

Luckzkovich, J. L., S. F. Norton and R. G. Gillmore 1995. The influence of oral anatomy on prey selection during ontogeny of two percoid fishes. Lagodon rhomboides and Centropomus undecimalis, Environmental Biology of Fishes 44: 79-85.

Olson, M. H. and G. G. Mittelbach 1995. Competition between predator and prey: Resource-based mechanism and implications for stage-structure dynamics. Ecology 76 (6): 1758-1771.

Orth, R. J., K. L. Heck, and J. V. Van Montfrans 1984. Faunal communities in seagrass beds: a review of the influence of plant structure and prey characteristics on predator-prey interactions. Estauries 7: 339-350.

Savino, J. F. and R. A, Stein 1982. Predator-prey interaction between largemouth bass and bluegills as simulated submersed vegetation. Transactions of the American Fisheries Society. 111: 255-266.

Scramm, H. L. Jr. and A. V. Zale 1985. Effects of cover and prey size on preferences of juvenile largemouth bass for blue tilapias and bluegills in tanks. Transactions of the American Fisheries Society. 114: 725-734.

Sih, A. 1987. Predators and prêt life styles: An evolutionary and ecological overview. Pages 203-224 in W. Charlers Kerfoot and A. Sih editors. Predation direct and indirect impacts on aquatic communities.

Stoner A. W. 1982. The influence of benthic macrophytes on the foraging behavior of pinfish, *Lagodon rhomboides* (L.). Journal of Experimental Marine Biology and Ecology 58: 271-284.

Werner, E. E., J. F. Gilliam, D. J. Hall and G. G. Mittelbach 1983. An experimental test of the effects of predation risk on habitat use in fish. Ecology 64 (6): 1540-1548.