EFFECT OF INOCULATION AND SUPPLEMENTAL FEEDING OF ZOOPLANKTON ON FLORIDA LARGEMOUTH BASS (*Micropterus salmoides floridanus*) FINGERLING PRODUCTION IN PLASTIC-LINED PONDS

by

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ABSTRACT

The efficacy of inoculating ponds with zooplankton and subsequently feeding zooplankton to Florida largemouth bass *Micropterus salmoides floridanus* in fingerling rearing ponds was evaluated at Texas Parks and Wildlife Department's A.E. Wood fish hatchery (AEWFH) in San Marcos, Texas. Ten 0.4-ha plastic-lined ponds were used for this study. Prior to filling ponds with water, all sediments were removed from the pond liners and harvest kettles. Incoming water was filtered through a 400-□m sock filter. Five ponds were assigned to a treated group (inoculation and supplemental feeding with zooplankton) and five ponds were assigned to an untreated control group (no inoculation and supplemental feeding with zooplankton). All ponds received the same application rates of organic (cottonseed meal) and inorganic (53% phosphoric acid, 70% urea nitrogen) fertilizers. The treated ponds were inoculated with zooplankton 3 days after filling was started and received supplemental zooplankton three times a week (Monday, Wednesday, and Friday) through the final week before harvest. Five to seven days after filling, each pond was stocked with 150,000 swim-up largemouth bass fry (7-10 days post hatch). Zooplankton densities were higher in treated ponds than in control ponds. However, fish production variables (growth, harvest density, survival, and condition) did not differ significantly between treated and control ponds. This study revealed that inoculation and supplemental feeding of zooplankton did increase zooplankton densities but did not significantly improve production of Florida largemouth bass fingerlings.

INTRODUCTION

Successful production of Florida largemouth bass *Micropterus salmoides floridanus* fingerlings in hatchery ponds is heavily dependent on adequate zooplankton populations of the proper quality and quantity (Morris and Mischke 1999). Rotifers, cladocerans and copepods are the zooplankters considered essential for survival and growth of fry to the fingerling stage (Morris and Mischke 1999). When ponds are dominated by small-sized zooplankters or have low zooplankton densities during most of the production period, growth, survival and condition of largemouth bass fingerlings are reduced (Morris and Mischke 1999). Therefore, it is essential to match adequate densities of the right-sized zooplankton to the growing fish to achieve fingerling production success.

Fertilization and inoculation of rearing ponds with zooplankton are common practices used to establish and maintain adequate quality zooplankton populations. Both organic and inorganic fertilizers are used to stimulate phytoplankton blooms to support zooplankton population development in ponds (Hoff and Snell 1993), and zooplankton culture ponds are often used as source of 'seed zooplankton' for establishing or supplementing zooplankton populations in rearing ponds (Anderson and Tave 1993). Zooplankton supplementation of largemouth bass rearing ponds has been practiced at the Parks and Wildlife Department's A.E. Wood fish hatchery (AEWFH) in San Marcos, Texas for several years to increase the zooplankton food base for fish but the efficacy of this practice in terms of improved fingerling fish production has not been investigated.

Typically, fry and fingerling rearing ponds at AEWFH are fertilized with organic and inorganic fertilizers and inoculated with zooplankton 7-10 days prior to fish stocking. These rearing ponds are sampled twice a week to monitor zooplankton communities. If the zooplankton community density of a rearing pond is less than 200 organisms per liter, the pond is provided with supplemental zooplankton. Zooplankton introduction and pond fertilization continue weekly until 1-2 weeks (14-21 days after fry stocking) before the fingerlings are harvested.

In addition to production variables, it is important to consider whether the labor required to introduce zooplankton into ponds is an efficient use of resources. Approximately 100 man-hours are used each production year at AEWFH to supplement largemouth bass rearing ponds with zooplankton. If the practice is not beneficial in terms of increased fish production, staff may be better utilized in other hatchery activities.

MATERIALS AND METHODS

Pond Management

Ten 0.4-ha plastic-lined ponds at the AEWFH were used for this study. The water source for the hatchery is the San Marcos River. Water quality variables of the incoming water average as follows: total hardness of 317 mg/L as $CaCO_3$, total alkalinity of 239 mg/L as $CaCO_3$, phosphorus of 0.003 mg/L , nitrate nitrogen of 0.98 mg/L, and ammonium nitrogen 0.01 mg/L (Kurten 2001). Prior to filling the ponds with water, all sediments were removed from pond liners and kettles. Ponds were started filling May 13-18, 2004 and the incoming water was filtered through a 400-□m-mesh sock filter.

The ponds received an initial fertilization of 57 kg/ha cottonseed meal, 0.08 mg/L P from 53% liquid phosphoric acid and 0.3 mg/L N from 70% liquid urea on the day filling began. Cottonseed meal was broadcast over the surface of the pond with a mechanical feed blower, and inorganic fertilizers were mixed together, diluted with pond water and sprayed over the pond surface with a mechanical sprayer. Five days after pond filling was started, ponds received an additional 227 kg/ha cottonseed meal, 0.16 mg/L P and 0.6 mg/L N. Thereafter, ponds received 57 kg/ha cottonseed meal, 0.08 mg/L P and 0.3 mg/L N twice weekly until one week before pond draining to harvest fish.

The ponds were assigned to either a treated (inoculation and supplemental feeding with zooplankton) group or an untreated control (no inoculation and supplemental feeding with zooplankton) group. The treated ponds were inoculated with zooplankton 2-3 days after filling was started then received supplemental zooplankton three times a week (Mondays, Wednesdays and Fridays) though the final week before fish harvest. Zooplankton was collected from a zooplankton culture pond and the AEWFH effluent filtration plant using a zooplankton harvester (Graves and Morrow 1988). The zooplankton from both locations were thoroughly mixed in a tub and adjusted to a final volume of approximately 19 L. A 100-mL sample of the zooplankton concentrate was used to estimate the zooplankton density and the rest was distributed equally among the treated ponds. The 100-mL zooplankton samples were dewatered to 90 mL each before enumeration and if necessary preserved with 4% formalin for later analysis.

The zooplankton culture pond was filled 7 days prior to filling of the study ponds. The pond was cleaned and the incoming water was filtered as was done for the study ponds. Similarly, the pond was fertilized like the study ponds and its zooplankton was sampled on the same days and in the same manner as the study ponds.

Fingerling Production

Five to seven days after filling, each pond was stocked with 150,000 swim-up largemouth bass fry (7-10 days post hatch). The fry were acclimated to pond water temperature and pH prior to stocking by slowly exchanging half of the water containing the fish with pond water every 15 minutes for a total of 45 minutes. The fry were stocked before 1000 hours to avoid elevated afternoon pond water temperature and pH. When fingerlings averaged 38 mm total length, the ponds were harvested. All ponds were harvested within one week and were harvested in pairs (one treated and one untreated control) so as to equalize the average production days for the groups.

Data Collection

Zooplankton density was monitored in all ponds on Monday and Thursday of each week between 0600 and 0700 hours by an oblique 4-m tow with a 5.75-cm-diameter 80-□m-mesh Wisconsin plankton net. Each sample was dewatered to 90 mL and densities of major zooplankton groups (cladocerans, copepod naupii, copepod adults and rotifers) were determined on two separate 1-mL aliquots using a zooplankton counting wheel (Aquatic Eco-systems, inc., Apopka, FL) and a variable magnification dissecting microscope.

Data Analysis

The zooplankton and fish production data [yield (number/ha), harvest biomass (kg/ha) and survival (%)] were compared between treatment and control groups using t-test. Appropriate data transformation was performed before statistical analysis. For all analyses, differences were considered significant at $P \leq 0.05$.

RESULTS AND DISCUSSION

There was no significant difference in any of the harvest variables compared between treated and control ponds (Table 1). Yield from treated ponds was about 46% higher than that from the control ponds yet we did not find a significant difference in yield ($P = 0.253$) between treated and control ponds likely because of high within-group variation (Table 1). Similarly, harvest biomass and fish survival for treated ponds were 23% and 55% higher respectively than the corresponding values for control ponds yet the differences were not statistically significant. Harvest length and growth rate were similar between treated and control ponds indicating that pond carrying capacity was not exceeded or food supply was not limiting for any group of ponds.

For the 7-day period prior to stocking bass fry, no significant difference in total organisms per liter ($P = 0.091$) was found between the treated and control groups. However, densities of certain individual zooplankton groups were significantly different between treated and control ponds. During this time, no significant difference was seen in rotifer ($P = 0.600$) and Cladocera ($P = 0.668$) densities, but copepod nauplii ($P = 0.009$) and copepod adult ($P = 0.021$) densities were significantly different (Figure 2). Copepod nauplii comprised 30% of the zooplankton population in the treated ponds, 19% of the population in the zooplankton inoculation pond and 12% of the population in the control ponds. Copepod adult comprised 31% of the zooplankton population in the treated ponds, 56% of the population in the zooplankton inoculation pond and 12% of the population in the control ponds. These differences in zooplankton densities are likely due to the age of the zooplankton inoculation pond (Parmley et al. 1986). Thus, if inoculation ponds are to be managed to provide larger zooplankters, one might start establishing a zooplankton community in the pond a few weeks prior to filling fingerling-rearing ponds to take advantage of higher densities of the target zooplankton groups.

When fish were in the ponds (5/21-6/29), a significant difference in zooplankton density ($P = 0.005$) was found between treated and untreated control groups (Figure1). Cladocerans ($P = 0.014$), adult copepod ($P = 0.000$) and copepod nauplii ($P = 0.019$) densities were higher in the treated group while rotifer densities (P=0.814) were not significantly different (Figure 2). These first three groups of organisms are important dietary items to largemouth bass fingerlings (Smith et al. 2000) and their higher densities indicate that the desired result of providing higher densities of food organisms to fish was achieved through inoculation. The dynamics of the zooplankton groups in this study were similar to that of Parmley et al. (1986).

The higher abundance of copepod nauplii and adults in the treated ponds than in the untreated ponds around the time of fish stocking should have been beneficial to small largemouth bass because these two groups of organisms comprise the primary diet of small largemouth bass in hatchery ponds (Smith et al. 2000). This also indicates that the desired outcome of elevating the densities of these organisms through inoculation was achieved. Since rotifers are not utilized by fingerling largemouth bass (Smith et al. 2000) we looked at the total non-rotifer (cladocerans and copepods) zooplankton (Figure 3). Density trends of these organisms indicate that inoculation provided higher initial food densities and higher late food densities in inoculated ponds.

While inoculation and subsequent regular introductions of zooplankton into ponds appeared to enhance zooplankton densities in largemouth rearing ponds at AEWFH, it did not enhance fish production and is probably not an efficient use of manpower for this facility at current fish stocking densities. However, AEWFH typically has high densities of large-sized zooplankton and experiences excellent fish production. Whether or not supplemental introductions of zooplankton enhances zooplankton production to the point that fish stocking densities could be increased to higher levels, or whether such practices might be beneficial at other hatcheries with lower native zooplankton densities and smaller sizes of zooplankton should be further examined.

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Table 1. Mean values (ranges in parentheses) of harvest variables for Florida largemouth bass fingerlings reared in ponds that received regular supply ofsupplemental zooplankton (treated) or no zooplankton (untreated control) at the A.E. Wood fish hatchery in 2004.

Variable	Treated ponds	Untreated control	*P*-value
Yield (number/ha)	290,450 (80,225 - 389,928)	198,383 (105,148 - 345,163)	0.253
Harvest biomass (kg/ha)	205.6 (114.83 - 254.03)	166.05 (90.25 - 212.75)	0.142
Survival (%)	76 (21.19 - 102.49)	49 (19.59 - 74.05)	0.912
Harvest length (mm)	44.2 (37.1 - 50.4)	44.0 (38.3 - 53.5)	0.958
Growth rate (mm/d)	1.2 (1.0 - 1.3)	1.1 (1.0 - 1.3)	0.611
Production days	32 (30 - 37)	33 (30 - 36)	0.215

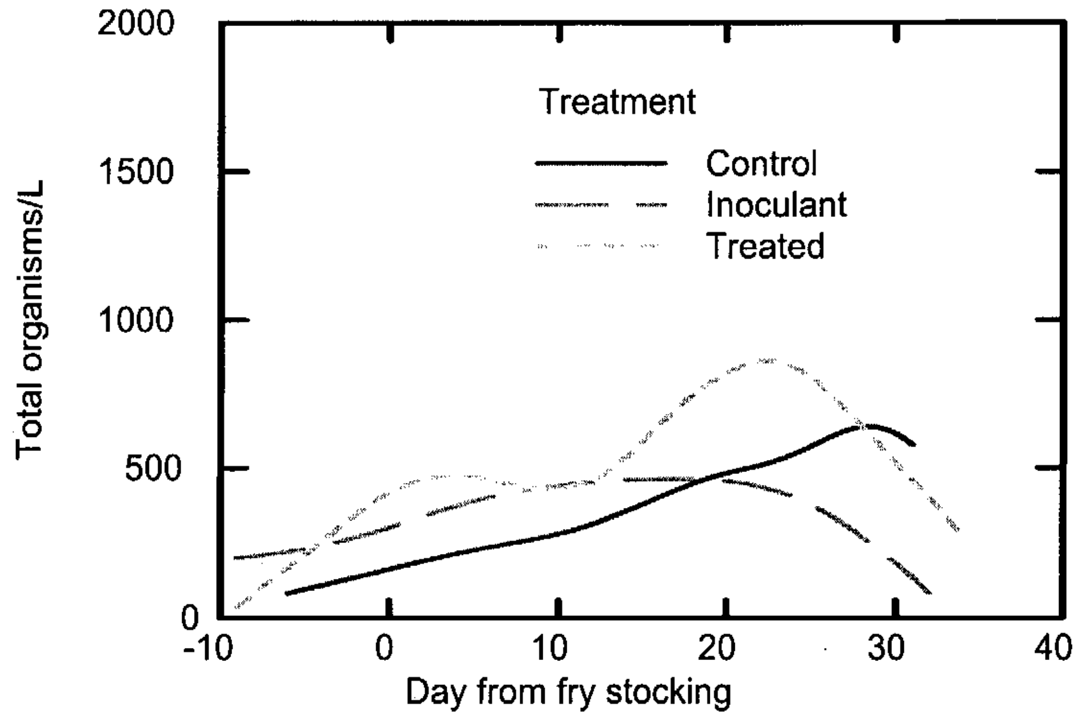

Figure 1. Zooplankton densities in Florida largemouth bass fingerling rearing ponds that received regular supply of supplemental zooplankton (treated) or no zooplankton (untreated control) and in the pond used as the source of the zooplankton for the treated ponds (inoculant) at the A.E. Wood fish hatchery in 2004.

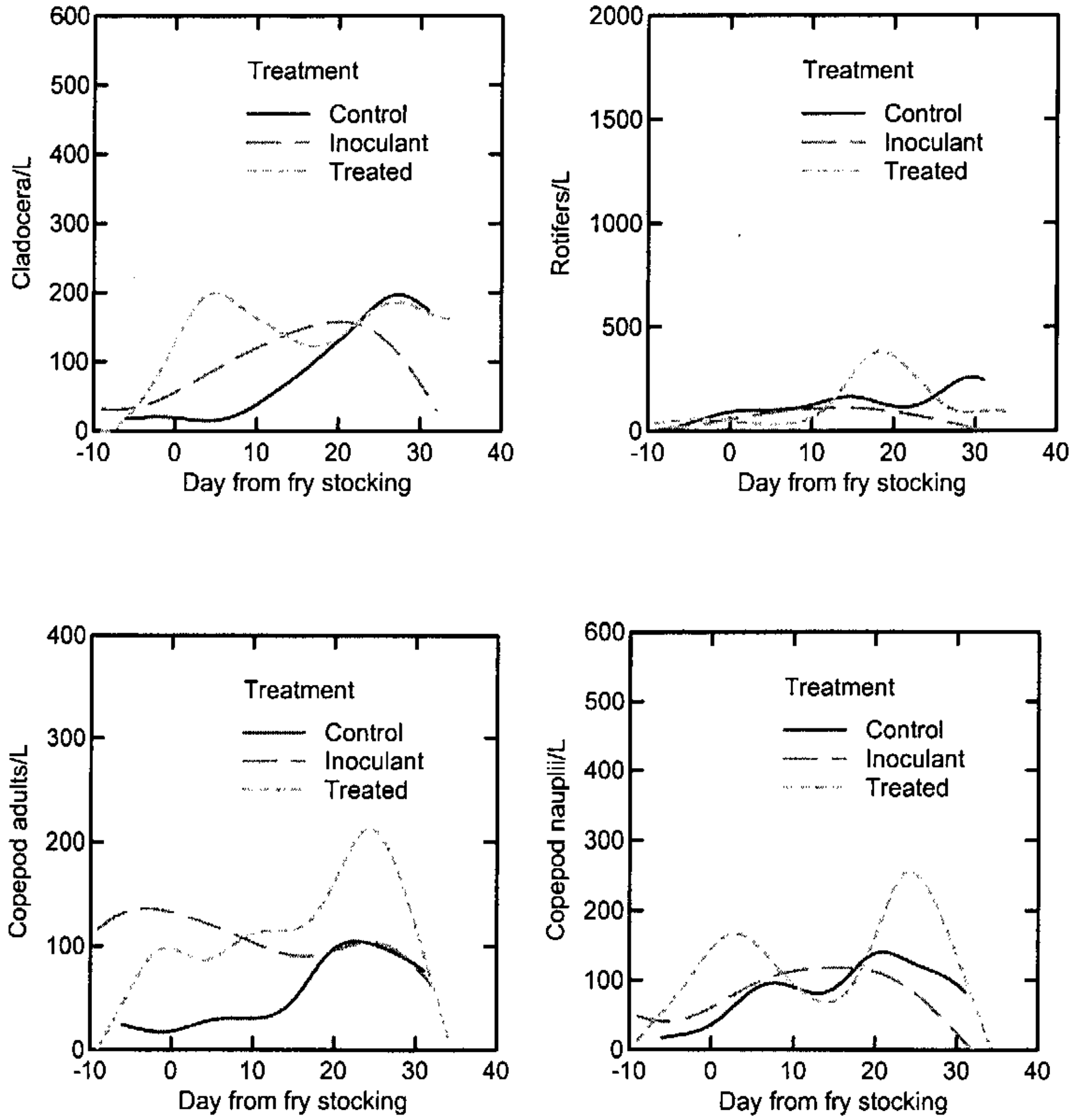

Figure 2. Zooplankton densities in Florida largemouth bass fingerling rearing ponds that received regular supply of supplemental zooplankton (treated) or no zooplankton (untreated control) and in the pond used as the source of the zooplankton for the treated ponds (inoculant) at the A. E. Wood fish hatchery in 2004.

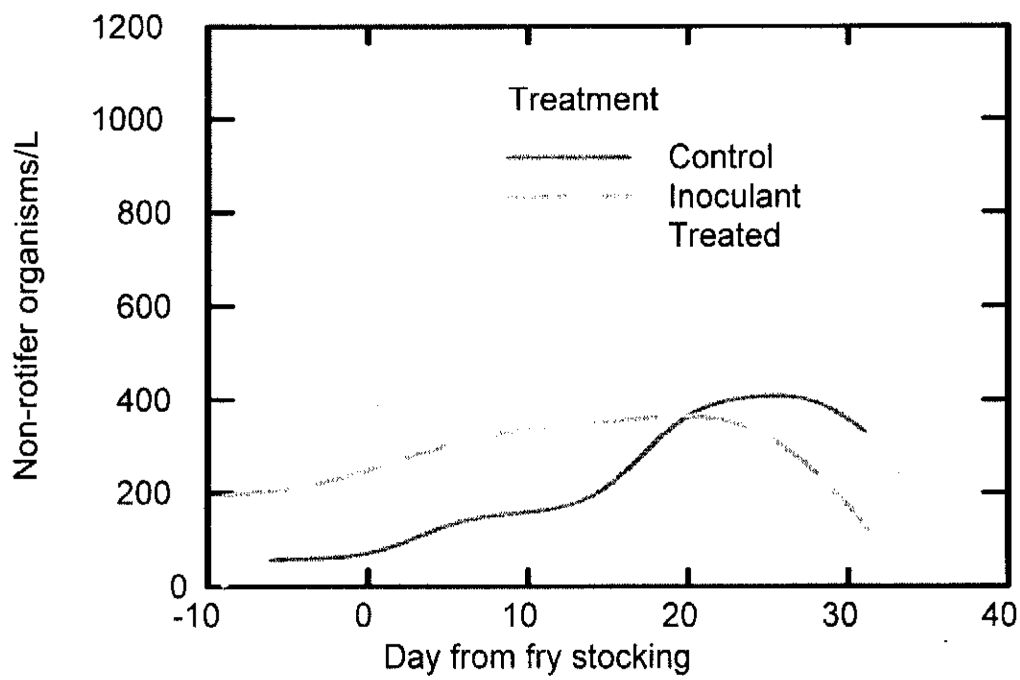

Figure 3. Zooplankton densities (non-rotifer) in Florida largemouth bass fingerling rearing ponds that received regular supply of supplemental zooplankton (treated) or no zooplankton (untreated control) and in the pond used as the source of the zooplankton for the treated ponds (inoculant) at the A.E. Wood fish hatchery in 2004.