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Matthew L. Rogge
Iowa State University

Alan A. Moore
Iowa Department of Natural Resources

Christopher P. Clouse
Iowa Department of Natural Resources

Joseph E. Morris
Iowa State University, jemorris@iastate.edu

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Abstract

Fish culture ponds are commonly fertilized to increase fish production through enhancement of the plankton forage base. Many fish culture facilities rely on natural production of zooplankton and aquatic insects as food sources for larval fish. Literature on pond fertilization regimes varies; recommendations range from no fertilization to a combination of inorganic and organic fertilizers. More research on the interactions among water quality, nutrients, plankton (phytoplankton and zooplankton) and fertilizers of the appropriate nutrient ratios is needed to move fertilization from an art to a science.

Disciplines

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Comments

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Initial observations of plastic-lined ponds for fingerling walleye production

MATTHEW L. ROGGE[1], ALAN A. MOORE[2], CHRISTOPHER P. CLOUSE[2] AND JOSEPH E. MORRIS[1]

Fish culture ponds are commonly fertilized to increase fish production through enhancement of the plankton forage base. Many fish culture facilities rely on natural production of zooplankton and aquatic insects as food sources for larval fish. Literature on pond fertilization regimes varies; recommendations range from no fertilization to a combination of inorganic and organic fertilizers. More research on the interactions among water quality, nutrients, plankton (phytoplankton and zooplankton) and fertilizers of the appropriate nutrient ratios is needed to move fertilization from an art to a science.

For decades, fish culturists have used fertilizer to increase fish production (Piper *et al*. 1982, Boyd 1990, Avault 1996). Because there is a barrier to nutrients leaching in from sediments when a pond is lined, we anticipate fertilization will be even more important in plastic-lined systems. Most fertilization studies have concentrated on fry production in earthen ponds. Different conclusions have been drawn as to what quality and quantity of fertilizers to use in these ponds. Furthermore, culturists disagree on the merits of organic versus inorganic fertilizers relative to enhanced fish growth.

The analogy of using a tub to culture fish describes the use of plastic-lined ponds for fish culture; that means no sediment, but a hard, smooth bottom surface. The result is limited rooted plant growth as well as potentially limited benthic insect populations. Additional nutrients may be necessary to sustain the zooplankton and aquatic insect populations needed as a larval fish food source in such ponds. Perceived benefits of these ponds include: 1) ease of harvest, 2) limited plant growth, 3) limited water loss, and 4) ability to remove excess nutrients or unwanted organisms.

In April 2000, the Iowa Department of Natural Resources completed the construction of ten 0.4 ha and six 0.04 ha plastic-lined ponds for fish production and research purposes. Prior to that time, plastic-lined ponds were not used by the Iowa Department fish hatchery system. Pond fertilization strategies and rearing techniques for walleye need to be investigated to maximize fish production and hatchery efficiency.

The development of fertilization regimes for plastic-lined ponds will increase the quality and size of walleye produced in the ponds. The fish will be used for stocking purposes and habituation to formulated feed. Data garnered will provide Rathbun hatchery personnel with information necessary to maximize fish production without undue experimentation that can jeopardize production. The six 0.04-ha ponds will provide the basis for experimentation. The larger production ponds will be used for walleye production while at the same time utilizing current management strategies to maximize fish production.

Walleye harvest

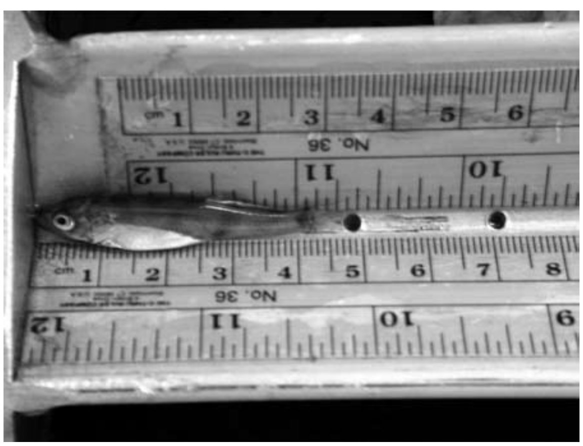
Management of zooplankton in walleye culture is critical to survival and growth of first feeding larvae. Included in this management is the monitoring of water quality, water fertility and fish stocking density. To manage water fertility, walleye hatchery managers regularly add fertilizer, both inorganic and organic, either on an amount per pond basis or to reach a desired nitrogen/phosphorus ratio. In addition, the production of large walleye fingerlings, greater than 0.6 g, requires an adequate aquatic insect forage base.

Common fertilization practices for walleye culture vary among managers. Call (1996) stated that fertilization at Garrison Dam National Fish Hatchery began immediately after pond filling, using alfalfa meal at 149 kg/ha and every three days until just before harvest. Fairport, Iowa hatchery personnel used cottonseed meal, wheat shorts, meat and bone meal and yeast at 392.4 kg/ha until 1992. From 1993 to date, no fertilization has been used. A similar regime was used at Mt. Ayr, Iowa hatchery until 1992, when solely alfalfa meal at 560.5 kg/ha was used (Mischke and Morris 1997). Cassidy (1997) compared alfalfa pellets with inorganic liquid nitrogen and phosphorus in a test to produce walleye fingerlings in plastic-lined ponds in Nebraska. He found ponds fertilized with inorganic fertilizer produced larger fingerling walleye with about the same harvest return as ponds fertilized with organic fertilizer.

Choice of fertilizer and stocking rates affect fish production

Lined pond bottom

Sampling from pond.



Walleye fingerling length

in earthen ponds (McIntire and Bond 1962, Boyd 1979, Qin *et al*. 1994, Kurten 1995, Tice *et al*. 1996). The addition of nitrogen and phosphorus to newly excavated ponds led to the development of plankton and benthos populations more rapidly than occurred in ponds without fertilization. For both walleye and saugeye, growth is inverse to stocking density. Research at the Rathbun facility was designed to determine the best-case scenario for pond fertilization and larval walleye stocking density to promote maximum fingerling production in Rathbun water.

Pond Studies

The objective of this study was to determine proper pond fertilization techniques necessary to maximize production of primary forage, thereby maximizing production of walleye fingerlings (50 percent survival at a minimum size of 1,760 fish per kg).

Three treatments (control, inorganic, and organic) were assigned to six 0.04-ha ponds, two replicates per treatment. Control ponds were unfertilized. Inorganic ponds were treated with 10-0-0 and 12-49-6 (N-P-K) to a target nitrate to phosphorus ratio of 7:1 (Mischke 1999); organic ponds were treated weekly with alfalfa and cottonseed pellets (84 kg/ha). All research ponds were stocked at 250,000 fish/ha. Ponds were filled one week before stocking.

Three stocking densities were evaluated in nine 0.40-ha ponds. Fertilization was similar in all ponds: weekly applications of 112 kg/ha alfalfa pellets. Three ponds each were stocked at 250,000/ha, 375,000/ha and 500,000/ha. Ponds were filled one week before stocking.

We measured various water chemistry and physical parameters, including alkalinity, nitrogenous compounds and phosphorus, as well as temperature, pH, and dissolved oxygen. Zooplankton was sampled the same day as water quality. Since these ponds had plastic liners, we were not able to use a standard grab sampler to assess the insect populations. Instead, we used a multiple-plate sampler. Fingerlings were harvested after an approximate 30 day culture period. Ponds were drained and fish collected in a concrete catch basin.

Study Results

The 0.04-ha ponds. All research ponds had similar survival. Fish in ponds fertilized with organic fertilizer were heavier and longer than fish in the control ponds and those fertilized with inorganic fertilizer. All fertilization treatments had high zooplankton populations within days of initial fry stocking, but those populations declined drastically. Organic fertilization had a significant positive impact on insect populations, which consisted principally of midge larvae. Most water quality parameters were similar among treatments, except for pH and dissolved oxygen. Ponds treated with organic fertilizers had depressed oxygen levels while ponds receiving inorganic fertilizer had increased pH. Other than ponds fertilized with organic fertilizer, no treatments reached our goal of 1,760 fish/kg; survival was low in all ponds.

The 0.40-ha ponds. Harvest figures showed higher survival in production ponds stocked at 250,000/ha compared with ponds stocked at 500,000/ha. There were no differences in other treatment comparisons. Plankton populations varied only slightly among stocking densities. As with the research ponds, benthos communities consisted primarily of midge larvae. Water quality parameters were similar between production pond treatments. As with the smaller ponds, no treatment met our production goal.

Discussion

Survival was poor in all ponds and all treatments. While fertilization regime or stocking density did not seem to influence this outcome, the decline in plankton might have affected survival; however, no definite answer could be found for poor survival. Fish size was influenced by fertilization regime. Fish in unfertilized control ponds seemingly lacked adequate food in terms of plankton and benthic organisms, thus, growth was limited. Organic fertilizer produced higher numbers of midge larvae than did the other two treatments.

The only water quality parameters that were significantly different were dissolved oxygen and pH. Dissolved oxygen levels were sometimes lower in ponds with organic fertilizer, probably due to aerobic decomposition of organic matter.

The slightly better fish survival in production ponds stocked at 250,000/ha might be explained by higher food availability because of less competition. Another plausible factor might be the condition of fry and pond conditions at stocking; the production ponds stocked at 250,000/ha were stocked last. While production values for the 2000 production season did not meet our goals, valuable data on the importance of benthic insects and plankton management were gathered. Those data were used in making suitable adjustments in the 2001 walleye culture season.

Notes

[1]Department of Animal Ecology, Iowa State University, Ames, Iowa USA
[2]Iowa Department of Natural Resources

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Effect of Carotenoids

(Continued from page 58)

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