2007

Effects of Formulated Feed on water Quality in Fingerling Waleye Production Ponds

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Abstract

Six 0.04-ha plastic-lined ponds were used at the Iowa Department of Natural Resources' Rathbun Fish Culture and Research Facility to evaluate the use of supplemental fish food on walleye (Sander vitreus) fingerling growth and survival, and on the benthic invertebrate community. Walleye were stocked 3-4 days post hatch on 2 May 2003, and harvested 5-6 June 2003. Organic fertilizer (alfalfa pellets, 112kg/ha/week) was used to increase primary production and inorganic fertilizers were added periodically to maintain a target nutrient ratio of 7:1 nitratenitrogen to total phosphorus (NO3-N: TP). Additional nutrients in the form of Lansy CW fish feed were added to three of the six ponds. The objective of this project was to determine the effect of a commercial fish diet on water quality. At the end of the culture season, there were significant differences between water chemistry parameters in the ponds; the feed treatments had higher levels of nitrogenous compounds and total phosphorus.

Keywords

Walleye, feed, water quality

Disciplines

Natural Resources and Conservation | Natural Resources Management and Policy | Terrestrial and Aquatic Ecology

Comments

This article was published as Kaatz, S. E. and J. E. Morris. 2007. Effects of formulated feed on water quality in fingerling walleye production ponds. Scientific Papers Animal Science and Biotechnologies 40:29-36. Posted with permission.

Lucrări ştiinţifice **Zootehnie şi Biotehnologii**, vol. **40(2),** (**2007**), Timişoara

EFFECTS OF FORMULATED FEED ON WATER QUALITY IN FINGERLING WALEYE PRODUCTION PONDS

EFECTELE FURAJELOR COMBINATE ASUPRA CALITĂŢII APEI DIN HELEŞTEIELE DE CREŞTERE A ALEVINILOR DE ŞALĂU AMERICAN

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Six 0.04-ha plastic-lined ponds were used at the Iowa Department of Natural Resources' Rathbun Fish Culture and Research Facility to evaluate the use of supplemental fish food on walleye (Sander vitreus) fingerling growth and survival, and on the benthic invertebrate community. Walleye were stocked 3-4 days post hatch on 2 May 2003, and harvested 5-6 June 2003. Organic fertilizer (alfalfa pellets, 112kg/ha/week) was used to increase primary production and inorganic fertilizers were added periodically to maintain a target nutrient ratio of 7:1 nitrate-nitrogen to total phosphorus (NO_3-N: TP). Additional nutrients in the form of Lansy CW fish feed were added to three of the six ponds. The objective of this project was to determine the effect of a commercial fish diet on water quality. At the end of the culture season, there were significant differences between water chemistry parameters in the ponds; the feed treatments had higher levels of nitrogenous compounds and total phosphorus.
Key words: walleye, feed, water quality.

Introduction

Many agencies raise fish for the stocking of lakes and streams. The Iowa Department of Natural Resources has such a stocking program, and their goal is to stock 40 million 203-mm walleye each year. Their stocking program at the Rathbun Fish Culture and Research Facility includes both indoor and outdoor rearing stages. Fertilized eggs are kept inside until hatched, at which point the walleye fry are moved outdoors to plastic-lined ponds. Walleye fingerlings typically eat natural prey in the culture ponds, including zooplankton and benthic invertebrates (Crowder and Cooper 1982; Fox 1989; Culver and Geddes 1993; Summerfelt et al. 1993; Flowers 1996; Mischke 1999). After 5-6 weeks, the walleye fingerlings are brought back inside and reared in cement tanks. It is at this point that they are feed trained and moved back outside until the reach they desired stocking size.

The majority of fingerling mortalities occur while the fish are inside being feed trained. To overcome this transition period during the feed training, we introduce a commercial diet directly into the ponds prior to walleye being harvested. The objective of this paper was to determine the effect of a commercial fish diet on water quality.

Materials and Methods

Study site

This study took place at the Rathbun Fish Culture and Research Facility, Moravia, Iowa. Six 0.04-ha ponds were used to determine the effects of using a formulated feed for the culture of walleye fingerlings. There were three ponds per treatment, which were feed and no feed. Individual ponds were experimental units, and were randomly assigned a treatment. Water from Rathbun Lake was used to fill all ponds. Walleye 3 to 4-days-old were stocked at a rate of 250,000 fish/ha 2 May 2003. Fry were counted using an optical fry counter (Jensorter Model FC2, Jensorter Incorporated, Bend, Oregon). Fingerlings were harvested 5-6 June 2003.

Fertilization

Alfalfa pellets were used as organic fertilizer. At initial flooding of the ponds, organic fertilizer was applied to each pond at a rate of 112 kg/ha. Initial TP was adjusted to 0.10 mg/L at the initiation of the project; phosphorus (12-49-6) was used (0.09 – 0.15 kg). Nitrogen (36-0-0) was added weekly to each pond to maintain a nitrate-nitrogen to total phosphorus ratio (NO_3-N:TP) of 7:1 (Mischke 1999). Inorganic fertilization began 29 April 2003. Total organic fertilizer added to all ponds was 18.1 kg; ponds received variable amounts of inorganic fertilizers to maintain the nutrient ratio (total application 1.02-2.03 kg in seven applications).

Feeding

Feeding started the evening of 14 May 2003. Sweeney feeders, (Model AF3, Boerne, Texas) were mounted on the kettle at the deep end of the pond. When set in the “feed” position, feeders were directly over a submerged light; light was used to concentrate the walleye in an attempt to get them on feed quicker (Howey et al. 1980). The light was powered by a deep cycle 12-volt battery, and regulated by a 12-volt digital timer. Feeders were set to disperse feed every half hour starting at 21^{00}h and ending at 05^{30}h the next morning, for a total of 18 feeding events. The feed was Lansy CW larval diet (58% protein, 14% lipid and 1.2% phosphorus) from INVE (Salt Lake City, Utah). The ratio was 2:1 Lansy CW 4/6 (400-600μm) to Lansy CW 8/12 (600-800μm). The larger size feed was used as a carrier to allow for more even distribution of the smaller diet. The goal was to feed 0.681kg per day. From the aforementioned ratio, 0.454kg of Lansy CW 4/6 was fed, which was the small food that the fish could theoretically consume, and 0.227kg of Lansy CW 8/12 was added as the carrier

Sampling methods

Water sampling began 21 April 2003. Water samples were collected twice a week (Monday and Thursdays) using a tube sampler to sample the water column. Pond-side water quality testing included pH, temperature, and Secchi disk readings. A YSI Model 60 pH meter (Yellow Springs, Ohio) was used to record pH and temperature. Standards were used weekly to calibrate the pH meter. Water chemistry was conducted using a Hach DR/2010 spectrophotometer (Hach, Loveland, Colorado). Variables analyzed include ammonia-nitrogen (NH_3-N), nitrite-nitrogen (NO_2-N), nitrate-nitrogen (NO_3-N), total phosphorus (TP), and bi-weekly alkalinity and hardness.

Morning (06^{00}h) and afternoon (15^{00}h) temperature and dissolved oxygen levels at the bottom, middle, and top of the ponds were taken twice per week (Tuesdays and Fridays) with a YSI Model 55 Oxygen Meter (Yellow Springs, Ohio).

Water samples for chlorophyll *a* were collected twice a week (Mondays and Thursdays). Samples of 300-ml were filtered through 47mm glass Microfibre filters using a vacuum pump (Barnant Company, Barrington, Illinois). The filters were frozen and stored in darkness until analysis. Chlorophyll *a* and phaeophytin levels were analyzed using the procedures described by APHA et al. (1998).

Data analysis

Treatment differences were analyzed using JMP 5.0 (SAS Institute, Cary, North Carolina) to determine significant differences in water chemistry parameters. Overall differences between treatments were analyzed via repeated measures, and weekly differences between treatments were analyzed with a t-test. Pool data was analyzed using a factorial design. Significance was also set at $P \leq 0.10$.

Results and Discussions

Water Quality

Ponds in the "feed" treatment had slightly higher values in nearly every parameter examined (Table 1). This was especially true toward the end of the culture season when the fish were being fed; the extra incoming nutrients manifested themselves in higher phosphorus and ammonia readings (Figure 1 and Table 1). There were overall significant differences between treatments. Ponds in the feed treatment had significantly higher NH_3-N, NO_2-N, and NO_3-N. During week 5, there was a significant difference between treatments; the feed treatment had significantly higher NH_3-N, NO_2-N, and TP. There were also significant differences between treatments in weeks 6 and 7; the feed treatments had higher NH_3-N and TP. However, this did not appear to have much effect on the nutrient ratios of the "feed" ponds (Figure 2). The dissolved oxygen levels were affected by the incoming nutrients; there were significant differences between treatments during weeks 4 and 6 with the no feed treatments having higher levels of dissolved oxygen. The "feed" ponds did have elevated chlorophyll *a* levels; again, this could be due to the higher level of incoming nutrients (Figure 3). The only significant difference between treatments in chlorophyll a levels was week 7. There were several rain events throughout the culture season, and a week of cool weather impacted some of the primary production and resulted in clearing of ponds (Figure 4).

Table 1

Means ± SEs (range) of water quality variables in plastic-lined research ponds under two treatments during the 2003 walleye fingerling culture period at Rathbun Fish Culture and Research Facility, Moravia, Iowa.

Variable	Treatment	
	Feed	No Feed
Dissolved Oxygen (mg/L)		
Morning		
Bottom	5.44 ± 0.79 (0.1-14.0)	6.86 ± 0.69 (0.1-14.1)
Middle	9.21 ± 0.49 (3.3-15.0)	9.46 ± 0.46 (5.0-16.0)
Top	9.12 ± 0.43 (3.7-14.2)	9.58 ± 0.45 (5.1-16.1)
Afternoon		
Bottom	8.31 ± 0.78 (0.1-14.6)	9.78 ± 0.71 (1.4-17.3)
Middle	10.60 ± 0.58 (3.9-18.0)	10.74 ± 0.56 (5.8-18.0)
Top	10.70 ± 0.43 (5.6-14.4)	10.8 ± 0.49 (6.4-17.5)
Temperature (° C)		
Morning		
Bottom	17.7 ± 0.47 (14.3-22.6)	17.6 ± 0.46 (14.1-22.6)
Middle	18.1 ± 0.47 (14.1-23.0)	18.0 ± 0.45 (14.4-22.9)
Top	18.2 ± 0.46 (14.2-23.0)	18.0 ± 0.45 (14.4-22.8)
Afternoon		
Bottom	18.2 ± 0.60 (11.7-23.6)	18.3 ± 0.58 (12.3-23.2)
Middle	19.4 ± 0.63 (11.7-24.6)	19.3 ± 0.61 (12.3-24.2)
Top	20.4 ± 0.71 (11.7-26.2)	20.2 ± 0.70 (12.1-26.2)
pH		
Bottom	8.04 ± 0.21 (5.65-9.40)	8.11 ± 0.19 (5.93-9.42)
Top	8.21 ± 0.20 (5.90-9.46)	8.24 ± 0.18 (6.27-9.56)
Secchi disk (m)	1.01 ± 0.06 (0.30-1.6)	1.11 ± 0.07 (0.4 -1.7)
Alkalinity (mg/L)	86.40 ± 1.70 (71.0-100.0)	86.90 ± 1.3 (76.0-97.0)
Hardness (mg/L)	135.30 ± 11.4 (96.0 - 225.0)	132.40 ± 9.6 (102.0-219.0)
Ammonia (NH3-N; mg/L)	0.26 ± 0.03 (0.06-0.82)	0.17 ± 0.02 (0.03-0.39)
Nitrite (NO2-N; mg/L)	0.01 ± 0.001 (0.005-0.018)	0.009 ± 0.004 (0.005-0.014)
Nitrate (NO3-N; mg/L)	0.2 ± 0.01 (0.1-0.4)	0.2 ± 0.01 (0.1-0.4)
Total Phosphorus (mg/L)	0.09 ± 0.008 (0.0-0.21)	0.08 ± 0.008 (0.0-0.28)
Ratio (NO3-N:TP)	3.2 ± 0.4 (0.0-10.0)	4.8 ± 1.7 (0.0-66.7)

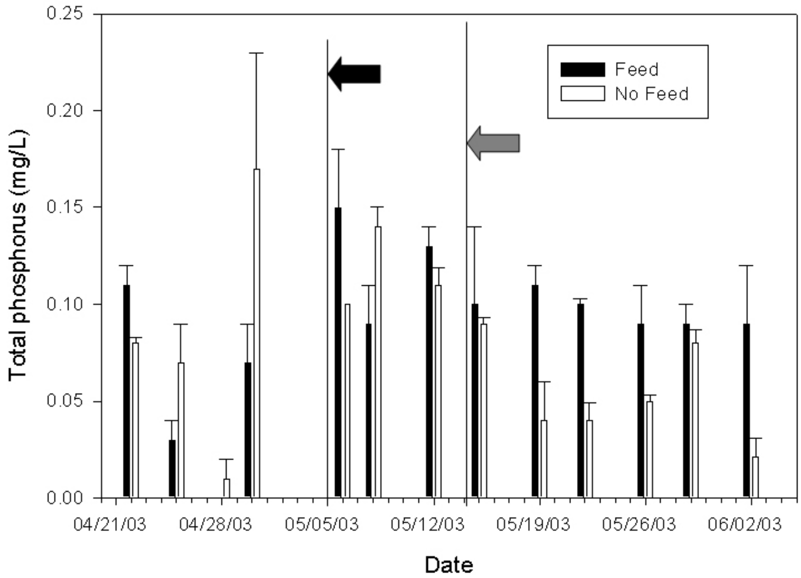

Figure 1. Means and standard errors of total phosphorus (mg/L) concentrations in plastic-lined walleye culture ponds under two treatment regimes, feed and no feed, during the 2003 fingerling culture season at Rathbun Fish Culture and Research Facility, Moravia, Iowa. Black arrow indicates when fish were stocked. Gray arrow indicates when feeding began.

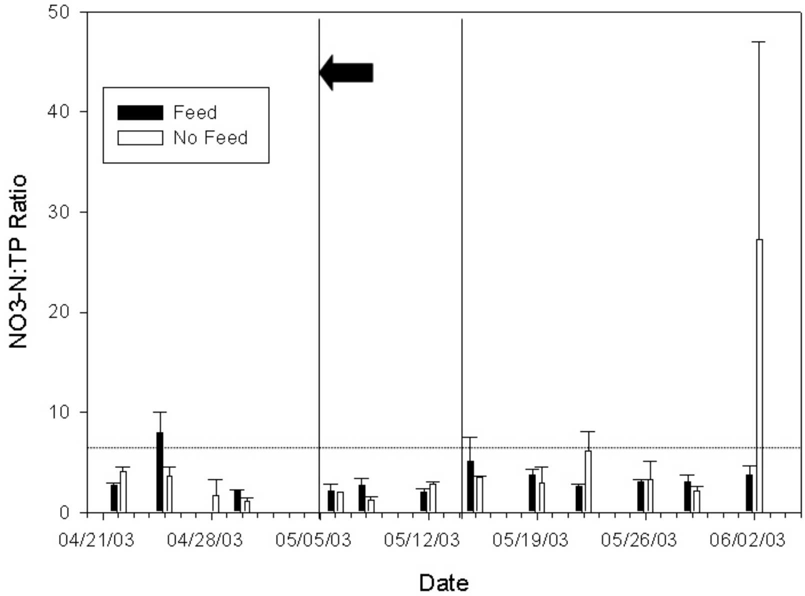

Figure 2. Means and standard errors of ratios of nitrate-nitrogen to total phosphorus (NO_3-N:TP) in plastic-lined walleye culture ponds under two regimes, feed and no feed, during the 2003 fingerling culture season at Rathbun Fish Culture and Research Facility, Moravia, Iowa. Dashed line indicates target ratio of 7:1 NO_3-N:TP. Black arrow indicates fish stocking date, and gray arrow indicates when feeding began

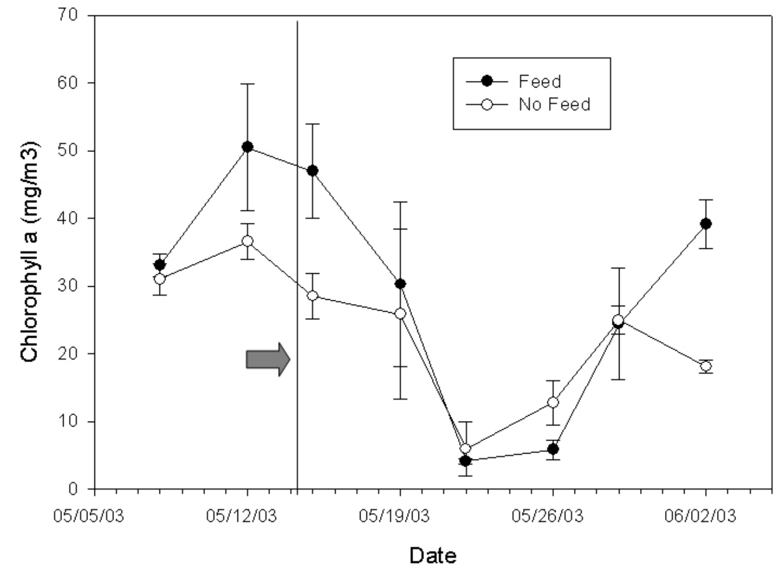

Figure 3. Means and standard errors of chlorophyll *a* (mg/m3) levels in plastic-lined walleye fingerling culture ponds under two regimes, feed and no feed, during the 2003 walleye fingerling culture period at Rathbun Fish Culture and Research Facility, Moravia, Iowa. Gray arrow indicates when feeding began

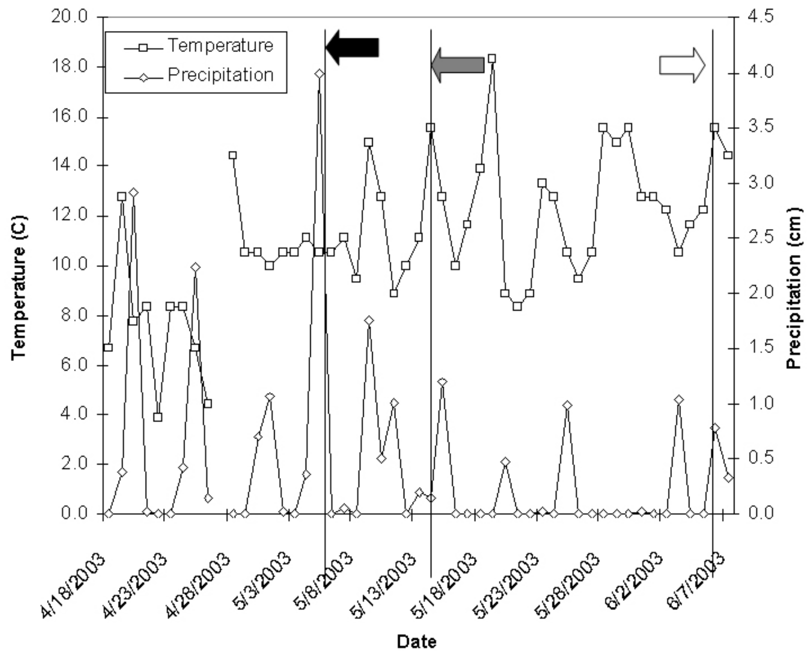

Figure 4. Temperature and precipitation during the 2003 walleye culture season at the Rathbun Fish Culture and Research Facility, Moravia, Iowa. Black arrow indicates stocking date, gray arrow indicates when feeding began, and white arrow indicates harvest date. Data obtained from http://cdo.ncdc.noaa.gov/dly/DLY , visited 6 November 2003.

Conclusions

The use of fish feed did impair pond water quality in this study. The ponds in the "feed" treatment typically had lower dissolved oxygen, and higher nutrient loads as indicated by high levels of NH3-N, NO_2-N, and NO_3-N. This is mostly likely attributed to the incoming nutrients associated with the fish feed, since feeding fish in an aquaculture setting tends to increase nutrients in the water and can lead to water quality problems (Huner and Dupree 1984; Barrows and Hardy 2001). These increased nutrient levels led to an increase in the amount of primary production, which resulted in increased chlorophyll *a* levels as well as decreased Secchi disk readings. Because fish were not consuming the feed (Kaatz 2003), it sank to the bottom of the ponds and began to decompose, thereby dropping the oxygen levels. This indicates that possibly the feeding rate was too high, since much of the feed was being wasted, leading to water quality issues. The feed had such an affect on the water quality, especially the dissolved oxygen that concern for the health and survival of fish led to feed being withheld later in the season.

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EFECTELE FURAJELOR COMBINATE ASUPRA CALITĂŢII APEI DIN HELEŞTEIELE DE CREŞTERE A ALEVINILOR DE ŞALĂU AMERICAN

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Şase heleşteie acoperite cu folie din plastic au fost utilizate la Uniteatea de Creştere şi Cercetare a Peştilor a Departamentului de Resurse Naturale Iowa pentru a evalua utilizarea furajelor suplimentare asupra creşterii şi supravieţuirii puietului de şalău american - walleye (Sander vitreus) şi asupra comunităţii de nevertebrate bentonice. Şalăul s-a introdus în bazine la 3-4 zile după ecloziune pe data de 2 mai 2003 şi s-a pescuit în data de 5-6 iunie 2003. S-au utilizat îngrăşăminte organice (granule de lucernă, 112 kg/ha/săptămână) pentru creşterea productivităţii primare, iar periodic s-au administrat îngrăşăminte anorganice pentru a se menţine raportul de 7:1 între azot-nitrat şi fosfor total(NO_3-N : TP). În trei din cele şase heleşteie s-au mai adăugat nutrienţi sub formă de furaj pentru peşti Lansy CW. Obiectivul acestei lucrări a fost acela de a determina efectul unui furaj comercial pentru peşti asupra calităţii apei. La sfârşitul sezonului de creştere, au existat diferenţe semnificative între parametrii chimici ai apei din heleşteie; în urma furajării au rezultat nivele mai ridicate de compuşi pe bază de azot şi fosfor total.

Cuvinte cheie: şalău american, furajare, calitatea apei.