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Preliminary Studies on Walleye Feed Training in Cages and Second-Year Growth in Ponds

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Abstract.—An inexpensive system to feed-train fingerling (13.1 ± 1.2 g) walleyes *Stizostedion vitreum* in cages suspended in ponds by using automatic feeders is described. Walleyes were initially overwintered unconfined in three 0.04-ha ponds at a density of 74,000 fish/ha. When water temperatures reached 10°C, fish were stocked into four cages (3.5 m^3) suspended in separate 0.04-ha ponds at cage densities of 938 fish/m^3. An automatic feeder was suspended over each cage and dispensed 38 g of feed per feeding at 10-min intervals during daylight hours (0600–1800 hours). After 47 d, 45% of the initial population was healthy and actively feeding. Feed-trained fingerlings (19.9 g) were then stocked into six 0.04-ha ponds at 18,525 fish/ha and fed a 40% protein diet once daily to satiation. After 184 d, the fingerlings in five replicate ponds averaged (±SE) 97.3 ± 9.9 g, individual weight; 67.3 ± 7.0% survival; 491.5 ± 52.3% average individual gain; 0.86 ± 0.6% body weight/d, specific growth rate; and 840.2 ± 52.1 kg/ha, total production.

The walleye *Stizostedion vitreum* has substantial potential as an aquaculture species. Walleye is one of the most important commercial and recreational fish species and a popular food fish in the north-central United States and Canada (Buttner 1989). Currently, the commercial walleye aquaculture industry primarily produces fingerlings for stocking public and private lakes, but the industry has the potential of eventually supplying larger food-size fish to retail markets and restaurants (Barry et al. 1995). To accomplish this, it is essential that practical and economical culture practices be developed.

The North Central Regional Aquaculture Center (NCRAC) listed as research priorities for walleye aquaculture the development of practical techniques and facilities to train pond-raised walleye to accept formulated feeds and efficient procedures for the grow out of walleye to food size (Harding et al. 1992). The current system for feed training and grow out of walleye involves extensive pond production of small fingerlings, followed by intensive habituation to formulated diets under controlled conditions in tanks (Nagel 1976; Nickum 1978; Loadman et al. 1989). To date, growth to advanced fingerling (>100 g) or food sizes (680 g), has also emphasized intensive tank culture (Siegwarth and Summerfelt 1993; Stettner et al. 1994). To date, there have been no published reports on the habituation of walleyes to formulated feeds in a pond environment (Summerfelt 1995). The ability to feed train walleyes in ponds, and thus eliminate the need for tank rearing, could potentially reduce handling stress, labor, and the expenses associated with the tank-rearing system and make walleye culture possible for a large number of potential producers.

Cages may have potential as a component of in-pond feed-training systems. Cages allow fish to be raised in ponds with direct observation of feeding activity and fish health (Schmittou 1970) but without the maintenance (tank cleaning) and energy requirements (pumping, continual aeration, etc.) of intensive tank systems. The habituation of fish to formulated diets in cages is, however, similar to tanks in that fish are confined at high densities and removed from their natural food sources. Feed training of fish in cages may also be a practical step toward the development of technologies for grow out of fish in ponds to marketable size. If growth and survival of walleyes in ponds approach those in intensive systems, the costs of pond grow out may be less. The objectives of these studies were evaluations of cages for in-pond feed training of extensively reared walleye fingerlings and of the subsequent growth of the fish in ponds.

Pond-reared fingerlings (average individual weight ± SE, 13.1 ± 1.2 g) obtained from a commercial supplier (Walleye Farms, Knoxville, Iowa) were stocked 18 November 1994 into three 0.04-ha ponds at 74,100/ha. Walleye fingerlings were harvested from those ponds 24 March 1995 (when water temperature was above 10°C) and were restocked into four cages (2.8 m^3) moored over the deepest area (2 m) of separate 0.04-ha ponds at the Aquaculture Research Facility, Kentucky State University, Frankfort. Rectangular cages with removable lids were constructed of 10-mm polyethylene mesh supported by a polyvinyl chloride frame. Cage dimensions were 2.1 × 1.1 × 1.2 m. Density of fish in cages was 938 fish/m^3 (approximately 12.3 g/L at stocking).

An automatic feeder (The Perfect Feeder, Aqualogic, Inc., San Diego, California) was suspended over each cage. Feed was delivered for a duration of 1 min at 10 min intervals for 12 h during daylight hours (0600–1800 hours daily). Daily feed output was adjusted to 69 kg/ha to limit effects on water quality. Two commercial diets were used in the training process; Biomoist Grower (1.3–1.5 mm; Bioproducts, Inc., Warrenton, Oregon) was used solely for the first week to improve acceptability and palatability. Silvercup Soft Salmon number 4 (Nelson and Sons, Inc., Murray, Utah) was mixed (50:50) with the Biomoist diet for 1 week and then was fed solely for the remaining 5 weeks to reduce feed costs. The training period lasted 47 d. Duration was based on feed response and the determination that nonfeeding fish were too weak to train. The average water temperature (±SD) during the training period was 16.0 ± 2.9°C. Fish fed most actively on overcast days, indicating that high light intensity during the day may have discouraged daytime feeding. A feeding regime that concentrated feeding during early morning and evening hours may be beneficial.

Dead fish were removed daily, and fish were checked for disease twice weekly. Fish from one cage were diagnosed as infected with *Trichodina* sp. and *Ambiphria* sp. (both protozoans) and with *Flexibacter columnaris* 2 weeks into the training regime. Disease was controlled with a copper sulfate treatment at 0.5 mg/L that was administered with a backpack sprayer and concentrated in the cage. The disease was largely attributed to accumulated organic material (uneaten feed) on the pond bottom. Larger (>0.04 ha) and deeper (>1.5 m) ponds should help avoid these problems. The bottoms of the cages must be high enough off the bottom to prevent wastes from building up near the fish. Cages were checked weekly to ensure that filamentous algae did not accumulate and that circulation was maintained. Cannibalism appeared to account for a small amount of mortality.

Mortalities of 40–50% have been reported for walleyes overwintering in ponds (Stevens 1988). Mortality in the overwintering portion of this study (before stocking in cages) was 17%. Feed-training success in cages was 45% as determined by usable fingerlings (with high condition factors) remaining after 47 d. Survival was actually higher than 45%, but emaciated fish were not restocked and were counted as deaths. Kuipers and Summerfelt (1994) reported feed-training survivals of 65% with Biomoist Grower under controlled intensive conditions (120-L tanks).

Results from this study indicate that feed-training walleye fingerlings in cages is possible and may yield similar results to tank-rearing conditions. Feed-training walleyes in cages may be a more economical alternative for commercial aquaculture producers and for public stock enhancement programs that seek to produce advanced fingerlings.

On 11 May 1995, feed-trained walleye fingerlings (average individual weight, 19.9 g; average length, 14.0 cm) were transferred from the training cages to six 0.04-ha ponds and stocked at a density of 18,525 fish/ha. For 2 weeks, fish were confined to approximately 20% of the pond area by a 4.8-mm-mesh block net to maintain feeding on formulated diets by crowding and minimizing available natural food. Fish were then released to the entire pond. During the pond production period, fish were fed an extruded floating diet formulated to contain 40% protein and 9% fat (Integral Fish Foods, Inc., Grand Junction, Colorado). Fish were fed at 2.0% of body weight once daily (0700 hours).

Water temperature and dissolved oxygen were monitored twice daily (0900 and 1500 hours) in all ponds at a depth of 0.75 m with a YSI model 57 oxygen meter (Yellow Springs Instrument Co., Yellow Springs, Ohio). Emergency aeration was provided when dissolved oxygen was predicted (by graph) to decline below 4.0 mg/L (Boyd 1979). On 17 August 1995, the oxygen level in one pond reached 1.5 mg/L, which resulted in 25% mortality. An electronic pH meter was used weakly to determine pH (Hanna Instruments, Ltd., Mauritius). Total ammonia nitrogen and nitrite were determined in each pond with a DREL/2000 spectrophotometer (Hach Co., Loveland, Colorado). Over the duration of the study, average water quality variables (±SD), were as follows: dissolved oxygen, 7.0 ± 2.3 and 11.8 ± 3.4 mg/L at 0700 and 1500 hours, respectively; temperature, 23.5 ± 10.8 and 25.2 ± 9.8°C; total ammonia nitrogen, 1.06 ± 1.03 mg/L; nitrite, 0.06 ± 0.03 mg/L; and pH, 8.8 ± 0.4.

On 2 August 1995, 11 deaths were recorded for one pond, and fish in that pond were diagnosed with an infection of *Flexibacter columnaris.* Fish in all six ponds were treated with Terramycin (TM 100) that was incorporated into the diet (7.7 g active ingredient/kg feed) for 10 d. Deaths ceased after 2 d.

Fish were harvested on 9 November 1995 (culture period, 184 d). All fish from each pond were counted and weighed in bulk. Data from the pond with high mortality that resulted from dissolved oxygen depletion were not included. At harvest, walleye fingerlings in the five replicate ponds averaged (±SE) 97.3 ± 9.9 g, individual weight; 67.3 ± 7.0% survival; 491.5 ± 52.3% average individual gain; 0.86 ± 0.06% body weight/d, specific growth rate (SGR); and 840.2 ± 52.1 kg/ha, production.

These results appear comparable to data from intensive tank culture systems reported in the literature. Malison et al. (1990) reported an SGR of 1.42%/d with similar size fish in temperature controlled tanks (21°C) compared with 0.86%/d in this study under ambient pond conditions (average, 24.8°C; range, 7.9–32.6°C). Siegwarth and Summerfelt (1990) attained a growth rate of 0.23 g/d over a 73-d culture period at a controlled temperature of 21°C, compared with a growth rate of 0.42 g/d in this study. The reported optimum temperature for fingerling walleye growth has been estimated to be 22–26°C (Hokanson and Koenst, 1986). The average water temperature during this 184-d pond growth period was 24.8°C. This preliminary investigation indicates that conditions found in temperate regions (such as Kentucky) appear to be acceptable for walleye culture in ponds and may produce growth rates and survivals comparable to controlled systems.

The development of commercial culture of food-size walleyes largely depends on the establishment of practical and economical culture practices. If walleyes can be trained to consume formulated feed and be grown to harvest size in ponds, production costs and energy requirements should be lower than for intensive culture systems. It was previously thought that neither large numbers nor predictable production could be obtained from pond culture of walleye fingerlings (Nickum 1986). This opinion assumed extensive pond production; however, with more intensive pond management, yields comparable to intensive culture systems may be possible.

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