FEED TRAINING CARNIVOROUS FISH[1]

Project ***Progress Report*** for the Period
September 1, 2006 to August 31, 2007

NCRAC FUNDING: $165,446 (September 1, 2006 to August 31, 2007)

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PROJECT OBJECTIVES

(1) Evaluate strategies including harvest, transport, environmental, and husbandry, to increase survival, growth, to maximize the percent of advanced yellow perch fingerlings trained to accept formulated feeds.

(2) Evaluate strategies including harvest, transport, environmental, and husbandry, to increase survival, growth, to maximize the percent of advanced yellow perch fingerlings and largemouth bass fingerlings retained on formulated feeds after restocking into commercial-scale culture systems.

ANTICIPATED BENEFITS

Studies conducted relating to Objective 1 will document the relative success that can be expected at feed training pond-reared yellow perch fingerlings harvested at different sizes, and using different dietary regimes. These studies will provide valuable information to yellow perch producers for maximizing the productivity and efficiency of their operations. The studies will also provide valuable cost/benefit information on the use of krill and semi-moist feeds as transitional diets. The proposed studies addressing Objective 2 will document the extent to which repetitive size grading can be used during the feed-training process to improve poststocking survival and growth of age-0 yellow perch and largemouth bass fingerlings. They will also provide key data on the performance of age-0 feed-trained yellow perch and largemouth fingerlings restocked into ponds at different densities. These studies will provide valuable information to producers of these species for maximizing the productivity and efficiency of their operations. The prediction is that this project will explain methods for increasing the efficiency of yellow perch and largemouth bass fingerling production by 20–40%, and thereby reduce fingerling

[1]This 2-year project began September 1, 2006 and was originally chaired by Anita M. Kelly who left Southern Illinois University-Carbondale in August 2007, after which Gregory W. Whitledge became chair of the project.

production costs. This, in turn, will significantly reduce the cost of raising these fish to food size, providing a strong stimulus to the growth of this important industry.

Successful poststocking feeding promotes increased growth and survival. Aggregation of fish through attractants and audible signals could potentially enhance feeding, including the delivery of medication, and facilitate handling and harvest in commercial situations. Increased growth and survival from improved feeding and handling translates into increased profit for producers. The strategies used in this study are likely to be easily transferred from yellow perch and largemouth bass to other fish species produced in the North Central Region. With the success that researchers have had in defining attractants/stimulants and sound cues as they apply to feeding behavior, researchers are confident that the biological and/or physical technology can be developed for yellow perch and largemouth bass.

Understanding the physiological and environmental factors involved in poststocking feed acceptance by yellow perch and largemouth bass fingerlings will aid in the understanding as to whether lack of feed retention is a result of stress, cannibalism, or predation by birds. These areas will further reveal potential changes in husbandry practices that will improve the number of feed-trained fingerlings that are produced annually.

PROGESS AND PRINCIPAL ACCOMPLISHMENTS

OBJECTIVE 1

University of Wisconsin-Madison

University of Wisconsin-Madison (UW-Madison) investigators have completed two experiments relevant to the feed training of pond-raised yellow perch fingerlings. Experiment 1 evaluated the influence of fish size at harvest on habituation success. Yellow perch were harvested from the pond at mean total lengths (TLs) of 25.0, 35.0, and 45.0 mm (1.0, 1.4, and 1.8 in). After each harvest, perch were immediately stocked in 750-L (198-gal) tanks (2,500 fish/tank, 4–6 tanks for each size), supplied with tempered water (19°C [66.2°F]; 12 L/min flow [3.2 gpm]) and aerated with an airlift pump which created a circular current. Tanks were continually lighted with overhead low intensity lights. All tanks were equipped with an automatic feeder which continuously delivered the appropriate food type. Additionally, fish were hand-fed 5–8 times daily. Researchers distributed 125.0 g (4.4 oz) of food daily in each tank. During the first four days fish were fed freeze-dried krill. The next 10 days, 10% krill was added to the formulated food (#2 Silver Cup Trout Fry diet, Murray Elevators, Murray, Utah). During the balance of the training period, fish were fed only the formulated feed. Length of the training period was defined by mortality due to starvation as well as visual observation of positive feeding activity of all fish in the tanks. To compare the training success of the fry sizes, calculations were made of: (1) harvest losses, defined as the percentage of fish which died during the first two days, (2) habituation success, defined as the percentage of fish surviving at the end of the training period (after harvest losses), (3) starvation, defined as the percentage of recovered dead fish, (4) cannibalism, defined as the percentage of fish which were unaccounted for at end of the training period, and (5) overall success, defined as the percentage of fish remaining at the end of the training period (including harvest losses). The definition of starvation is substantiated by observations that virtually all dead fish recovered were extremely emaciated and losses attributed to disease or injuries were negligible. The definition of cannibalism is substantiated by observations of cannibalistic behavior and the fact that fish could not escape from the tanks through the standpipe screen or by any other means. Cannibals were not removed during the experiment.

Training success was higher for fry harvested at 25.0 and 35.0 mm (1.0 and 1.4 in) TL (93.6% in each case) than for those at 45.0 mm (1.8 in) TL (79.4%). The principal difference in training success is the higher cannibalism rate demonstrated by the larger fish (12.5%) versus those harvested at 35.0 mm (1.4 in) TL (5.5%) or 25.0 mm (1.0 in) TL (2.4%). Higher size variability was recorded in the 45.0 mm (1.8 in) TL group that remained in the production ponds longer than the other groups of fish. This size difference led to a situation where larger fish were able to consume smaller fish. Thus, grading the harvested fingerlings prior to feed training when size differences are apparent is recommended.

Losses due to harvest stress were higher in fingerlings harvested at 25.0 mm (1.0 in) TL (11%), than for those harvested at 35.0 mm (1.4 in) TL (2.4%) or 45.0 mm (1.8 in) TL (1.8%). The fact that no difference in harvest losses was found between fish harvested at 35.0 mm (1.4 in) TL with a seine and fish harvested at 45.0 mm (1.8 in) TL by pond drawdown suggests that losses in the smaller fish were not due to the harvest method, but rather because of the small size and fragile nature of fish harvested at 25.0 mm (1.0 in) TL.
No difference was found in overall success between fish sizes (83.4%, 91.3%, and 78.1%, respectively), for fish harvested at 25.0, 35.0 and 45.0 mm (1.0, 1.4, and 1.8 in) TL. This statistical result may have been limited by the low number of replicates (*N* = 4–6 replicates per fish size) used in the study. Harvest losses in fish at 25.0 mm (1.0 in) TL were offset by cannibalism losses in fish at 45.0 mm (1.8 in) TL. Fish harvested at 35.0 mm (1.4 in) TL displayed low losses from both harvest stress and cannibalism, and may be recommended as the best size for habituation using the techniques set forth in this study. From a practical standpoint, it is logistically unfeasible to harvest and train all fingerlings produced at a commercial scale facility at the same size. Techniques should be modified to accommodate the fish on-hand. Low stress harvest methods (e.g., light trapping) for small fish and size grading for larger, more size-diverse populations would likely result in better overall success for both groups of fish.

Experiment 2 compared four different feed regimens using three sizes of fish for each regimen. The feed regimens were: (1) Silver Cup feed, (2) 4 days of INVE feed (Epac 6–8) followed by a 7-day transition to Silver Cup, (3) 4 days of freeze-dried krill followed by a 7-day transition to Silver Cup, and (4) 4 days of krill followed by a 7-day transition to INVE followed by a 7-day transition to Silver Cup. Yellow perch were drain-harvested from the pond at mean TLs of 31.0, 37.0, and 55.0 mm (1.2, 1.5, and 2.2 in). Fingerlings were size-graded prior to being stocked into 114-L (30-gal) flow-through tanks (200 fish/tank, three tanks/treatment-size). Endpoints examined in experiment 2 were the same as described in experiment 1.

No incidences of loss to harvest stress or cannibalism were noted in any of the treatment groups for this experiment. Overall habituation success was slightly lower in the 31.0 mm (1.2 in) TL group (94.4%) as compared to the two larger sizes (98.7% and 99.4% for 37.0 and 55.0 mm [1.5 and 2.2 in]) TL fingerlings, respectively. No differences in habituation success were found between the four feeding regimens (97.0%, 97.0%, 98.1%, and 98.3% for regimens 1 through 4, respectively), although regimens that included the use of krill (treatments 3 and 4) improved habituation success in the smallest fingerlings by approximately 3.5% (96.0% versus 92.6%). The excellent habituation success demonstrated by all of the treatment groups in this experiment may have been a result of several factors including size-grading prior to training and isolated culture conditions which limited disturbance of the fish.

University of Wisconsin-Milwaukee

The University of Wisconsin-Milwaukee (UW-Milwaukee) was unable to conduct research on this project in 2006-2007 due to the state of Wisconsin restricting the movement of fish from ponds to indoor facilities and vice versa. It is anticipated that the research will resume in the coming year.

OBJECTIVE 2

University of Wisconsin-Madison

UW-Madison researchers conducted one experiment on size-grading fingerlings during the habituation period. Pond-raised fingerlings were habituated according to the conditions described above under objective 1, experiment 1. Two 750-L (198-gal) tanks containing 3,000 fingerlings each were used for each of three trials during this experiment resulting in three ponds of size-graded and three ponds of non-size-graded fish. For each of the three replicates, the harvest of the fish was staggered in time by 8–12 days. Size grading was conducted on day 7 and day 14 of the training period with the large sized fish removed and stocked into a 0.04 ha (0.1 acre) production pond. The remaining fish were stocked on day 21. Non-size-graded fingerlings were left undisturbed and stocked into a 0.04 ha (0.1 acre) production pond on day 21.

Habituation success averaged 81% and was not different between treatment groups. No differences in pond survival (69.7% ± 7.7 versus 67% ± 9.8) or mean fish size (18.3 ± 4.7 g versus 21.0 ± 3.6 g [0.6 ± 0.2 oz versus 0.7 ± 0.1 oz]), for graded and non-graded fish, respectively, were found. A high degree of size variability was noted in all ponds with fish sizes ranging from 3.0–56.0 g (0.1–2.0 oz). Researchers found that ponds stocked earlier in the season produced larger fingerlings than those stocked later in the season. Pooling data across treatments (size-graded and non-size-graded), fingerlings stocked ranged 18.4–24.6 g (0.6–0.9 oz) for the three sets of ponds. It is recommend that fingerling producers harvest and feed-train fingerlings as early as possible in the season.

University of Missouri-Columbia (UM-C)

Eight experimental ponds at the Missouri Department of Conservation's Little Dixie Lake (LDL) site were secured for use in 2007 and 2008. Substantial effort was put into preparing the ponds for the study. Beginning in April 2007, all ponds were longitudinally divided into halves with plastic mesh nets that were attached to 10.2 × 10.2 cm (4 × 4 in) posts driven approximately 0.9 m (3.0 ft) into pond bottoms. The plastic mesh panels were staked into the pond bottoms to preclude fish passage under the nets. Wire lines spanning pond lengths held the net tops approximately 0.9 m (3.0 ft) above the water surface so that largemouth bass could not jump into adjacent pond halves.

The 50,000 pellet-trained, fingerling largemouth bass that were ordered from a commercial producer (for Year 1 activities) to arrive at the LDL facility during the first two weeks of June were not delivered due to a severe weather event at the producer's facility that caused the loss of most of the pellet-trained fingerlings. Substantial efforts were made both by the PI and by the commercial producer to secure fish from another source, however, attempts to secure this number of fish on relatively short notice were unsuccessful.

Southern Illinois University-Carbondale (SIUC)

Largemouth bass were produced and feed habituated at Logan Hollow Fish Farm, Murphysboro, Illinois. After the largemouth bass fingerlings were harvested from the nursery ponds, they were placed into a 5,000-L (1,320-gal) grading tank where they were then graded through grading boxes to ensure uniform sizes in each tank and to reduce cannibalism. Fish were stocked at a density of 7.9 fish/L (30.0 fish/gal). Freeze-dried krill (Southern Aquaculture Supply, Lake Village, Arkansas) was used as the starter diet and Bio Diet (Bio-Oregon, Inc., Warrenton, Oregon) was the moist pellet feed used in this study. Fish were fed 8% body weight daily. Five different combinations of hand feeding and automatic feeders were examined on three size classes, small, medium, and large (31.0–39.0, 40.0–51.0, 52.0–60.0 mm [1.2–1.5, 1.6–2.0, 2.0–2.4 in] TL, respectively) of largemouth bass fingerlings in an effort to increase the number of fish that were feed-trained and to determine the amount of labor involved in the process. A twenty-tank feed-training system with a randomized block design was utilized. All treatments utilized automatic belt feeders. The treatments were: (1) feeding by hand for the full two weeks, (2) hand feeding for three days and then automatic feeders only for the remaining time, (3) hand feeding for seven days and then automatic feeders only for the remaining seven days, (4) one automatic feeder per tank for the entire time with no hand feeding, and (5) two automatic feeders per tank with no hand feeding for the entire time. This study also examined small fish stocked at 13.2 and 7.9 fish/L (50.0 and 30.0 fish/gal).

Treatments did not have a significant effect on survival but did have a highly significant effect on feed training success. Fish size had a highly significant effect on survival as well as feed training success. Small fish had higher feed training success (96.4%) in treatment 3, medium and large fish feed trained better in treatment 2 (97.3% and 86.1%, respectively). Treatments using densities of 13.2 fish/L (50.0 fish/gal) did not differ significantly in terms of survival or feed habituation success compared to tanks stocked at 7.9 fish/L (30.0 fish/gal) with fish of the same size. More research needs to be done regarding stocking density. Shortly after the initiation of the increased stocking density portion of the study, an outbreak of *Ichthyobodiasis* occurred. As soon as the infestation was detected, an aggressive formalin treatment regimen was instituted. Mortality was reduced to expected levels and the outbreak was contained. For the remainder of the study, formalin treatments were conducted weekly to prevent further disease problems. Because the increased density treatments in this study only utilized the smallest size group of fish, it is not possible to determine whether it was the size, stocking density, an additional factor, or a combination of all three that resulted in the disease outbreak.

The effect of different light intensities on survival and feed habituation success was also examined. Three light intensities were utilized: light = 21 lux, medium = -0.54 lux and dark=-1.08 lux. All treatments were conducted in triplicate. Light intensity measurements were taken with a LI-250

LiCor meter (LiCor Biosciences, Lincoln, Nebraska).

Light intensity was found to have no impact on feed habituation success (P = 0.7249) and no impact on survival except at the darkest level tested (P = 0.0261). The number of cannibals differed significantly between the light and dark treatments (P = 0.0331). Reduced light levels result in decreased ability of culturists to observe fish for health and cannibalism.

Additionally, because little research has been done to evaluate bird predation on largemouth bass fingerlings and on non-lethal methods or devices to deter piscivorous birds and prevent their consumption of fingerling fishes, piscivorous bird feeding behavior and the effectiveness of a birds of prey call in deterring fish-eating birds were evaluated. Bird numbers at pond banks were recorded at various times throughout the day during the summer months. Three different bird deterrent devices were evaluated for use on a commercial fish farm. They were an electrical shock device (Scat Mat), a random noise generator, and a birds of prey call.

The Bird Gard Pro was programmed to produce the call of a peregrine falcon (*Falco peregrinus*) at random intervals from 10–30 min apart, 24 h a day. Observations were then made of bird behavior and response to the call. Species, activity before call, response to call, distance from call, and time of day were recorded for each bird observed when the call was activated. Distance from the call was measured using a Bushnell Yardage Pro 400 laser range finder (Bushnell Outdoor Products, Overland Park, Kansas). After testing the effectiveness of the peregrine falcon call, the Bird Gard Pro was programmed to produce the call of a sharp-shinned hawk (*Accipiter striatus*) at the same time intervals and durations as the peregrine falcon call. The same observations were made.

Sunrise and sunset were time periods during which bird activity at the study ponds apparently increased, as did bird activity across the farm. Less bird activity was observed during mid-morning and mid-afternoon observations than at other times, although bird activity was not significantly different in the different observation time periods (P = 0.3493). It was determined that noise and electrical shock devices placed on the automatic feeders in the ponds would be of little value because a vast majority of the birds feeding at these ponds were wading birds and were not observed utilizing the feeders as perches. Birds of prey calls failed to repel fish-eating birds from the fish farm.

In summary, labor costs may be reduced because hand feeding is not necessary in feed habituation of largemouth bass. Light intensity should remain at intermediate levels at most, as other researchers have shown that extremely bright conditions cause increased stress responses in fish. To date, physical barriers are the only demonstrated effective prevention mechanism for bird predation in aquaculture.

<u>University of Wisconsin-Milwaukee</u>
The UW-Milwaukee was unable to conduct research on this project in 2006-2007 due to the state of Wisconsin restricting the movement of fish from ponds to indoor facilities and vice versa. It is anticipated that the research will resume in the coming year.

WORK PLANNED

OBJECTIVES 1 & 2

The UW-Madison pond stocking density study will be conducted as described in the original proposal.

It is anticipated that the UW-Milwaukee research will begin in the coming year.

Researchers at the UM-C plan to conduct both Year 1 and Year 2 activities in tandem (June-July) at the LDL site in 2008. The fish producer dealt with in Year 1 will again attempt to provide the required numbers of fish, however, efforts are in progress to identify alternative sources of fish as back-up, to ensure that work can move ahead this upcoming spring and summer.

SIUC pond stocking studies using different densities will be conducted as outlined in the proposal.

IMPACTS

Studies will provide valuable information to yellow perch fingerling producers for maximizing the productivity and efficiency of their operations. The studies will also provide valuable cost/benefit information on the use of krill and semi-moist feeds as transitional diets.

SUPPORT

NCRAC funds provided to date total $165,446; a total of $300,000 has been allocated for this 2-year project.

PUBLICATIONS, MANUSCRIPTS, OR PAPERS PRESENTED

See the Appendix for a cumulative output for all NCRAC-funded Fingerling Feed Training activities.

APPENDIX

FEED TRAINING CARNIVOROUS FISH

Publications in Print

Sims, D.W. 2007. Effects of feed training methods and light intensity on survival and feed training success of largemouth bass*Micropterus salmoides* and effectiveness of new bird repellant devises in a commercial aquaculture setting. Master's thesis. Southern Illinois University-Carbondale.

Papers Presented

Sims, D.W., and A.M. Kelly. 2007. Effects of different feed training methods on survival and feed training success of largemouth bass *Micropterous salmoides*. Aquaculture America 2007, San Antonio, Texas, February 26-March 2, 2007.