FEED TRAINING CARNIVOROUS FISH[1]

Project ***Termination Report*** for the Period
September 1, 2006 to August 31, 2010

NCRAC FUNDING: $300,000 (September 1, 2006 to August 31, 2010)

PARTICIPANTS:

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REASON FOR TERMINATION

The objectives were completed and funds terminated.

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.

PRINCIPAL ACCOMPLISHMENTS

OBJECTIVE 1

University of Wisconsin-Madison (UW-Madison)

UW-Madison investigators 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 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, fish were immediately stocked in 750-L (198-gal) tanks (2,500 fish/tank, 4–6 tanks for each size), supplied with tempered water (19.0°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

[1]This 2-year funded 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.

were hand-fed 5−8 times daily. 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).

Habituation 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 fry (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%). There was higher size variability 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 it is recommended that grading the harvested fingerlings need to be done prior to feed training when size differences are apparent.

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 via 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 among fish sizes (83.4%, 91.3%, and 78.1%, for fish harvested at 25.0, 35.0, and 45.0 mm [1.0, 1.4, and 1.8 in] TL, respectively). This statistical result may have been limited by the low number of replicates ($N = 4–6$ replicates per fish size) used in this 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, however, it may be logistically unfeasible to harvest and train all fingerlings produced at a commercial scale facility at the same size and at the same time. Techniques should be modified to accommodate the fish on-hand. Low stress harvest methods for small fish and size grading for larger more size-diverse populations will likely result in better overall success for both groups of fish. It is suggested that a technique of sequential harvesting of fingerling ponds (i.e., partial seining of fingerlings every 7−10 days, followed by complete final harvest), where possible, will maximize the total fingerling production in most ponds.

Experiment 2 compared four different feed regimens using three sizes of fish for each regimen. The feed regimens were: (1) Silver Cup feed, (2) four days of INVE feed (Epac 6–8) followed by a seven day transition to Silver Cup, (3) four days of freeze-dried krill followed by a seven day transition to Silver Cup, and (4) four days of krill followed by a seven day transition to INVE followed by a seven 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 113.6-L (30.0-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 [1.4 and 2.2 in] TL fingerlings, respectively). No differences in habituation success were found among 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. UW-Madison researchers recognize the fact that most commercial yellow perch fingerling producers find the use of krill as a transitional feed to be highly beneficial and cost-effective.

University of Wisconsin-Milwaukee (UW-Milwaukee)

Extracts of midge larvae (chironomids), zooplankton, redworms (*Eisenia fotida*), artemia, and tubifex (*Tubifex tubifex)* worms were prepared as natural feed attractors. Feeding trials were conducted to compare feeding responses among feed attractants and identify the best positive response for each species (yellow perch and largemouth bass). Results of feeding trials were inconclusive although the feeding behavior appears to be more relative to sight, prey movement, and auditory signals. Consequently, research effort was shifted to investigating these feeding behavior patterns as a function of sight, movement, and sound.

OBJECTIVE 2

UW-Madison

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 similar size production pond on day 21. All fingerlings were then raised in ponds for the remainder of the growing season.

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 [0.7 ± 0.2 oz] versus 21.0 ± 3.6 g [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 harvested in autumn, however, with fish sizes ranging from 3.0−56.0 g (0.1−2.0 oz). The fingerlings were size-graded into three groups: "small" fish passed through a 7.5 mm (19/64 in) size-grader, and averaged 64.0 mm (2.5 in) and 3.0 g (0.1 oz); "medium" fish passed through a 10.7 mm (27/64 in) size-grader but were retained by a 7.5 mm (19/64 in) size-grader, and averaged 89.0 mm (3.5 in) and 8.0 g (0.3 oz); and "large" fish were retained by a 10.7 mm (27/64 in) size-grader, and averaged 132.0 mm (5.2 in) and 24.0 g (0.8 oz).

Size-graded fish were returned to separate tanks to observe their feeding behavior. Almost 100% of fish in the medium and large groups actively consumed formulated food, while only ~25% of the small fish consumed food. Three subsequent trials were then conducted (2007–2009) to evaluate the extent to which the small fish can be "re-trained" in autumn to accept formulated food in tanks. In each trial the fish were stocked into replicate tanks using the procedures described in Objective 1, for the initial feed-training of fingerlings in late-spring/early summer. The fish were then fed for a period of eight weeks. The primary result of these trials was that the survival of these small, autumn-harvested fingerlings in tanks was very low, averaging 37.6%. In each trial the fish showed a steady lingering mortality, despite the fact that the fish had a good condition factor and seemed otherwise to be in good condition. The exposure of these fish to the declining temperatures and photoperiods of autumn prior to pond harvest may have had a negative impact on their subsequent performance in tanks.

Also in each of two years two replicate ponds were stocked with these small fingerlings for overwintering and second year survival and growth studies. The ponds were stocked in the autumn at 124,000–184,000 fish/ha (50,000–75,000 fish/acre). Fish were then overwintered and not fed until the following spring. Fish in these ponds were then fed daily in a similar fashion to ponds containing larger second-year fingerlings. The four ponds were harvested in autumn; the mean survival was 63.2% and the mean fish size was 182 mm (7.2 in) and 75.6 g (2.7 oz). This finding demonstrates that even the smallest fingerling yellow perch harvested from ponds in autumn have surprisingly good potential for growth, if they are exposed to proper environmental and aquacultural conditions.

UW-Madison researchers also conducted a study comparing different pond stocking densities for fingerling yellow perch. After feed-training, groups of yellow perch fingerlings were stocked into six replicate 0.04-ha (0.1-acre) ponds, three ponds at approximately 62,000 fish/ha (25,000 fish/acre) and three at approximately 185,000 fish/ha (75,000fish/acre). The fish were reared until the end of the growing season in October, at which time the ponds were harvested. No differences in pond survival (68.7% ± 7.7 versus 70.0% ± 9.8) or mean fish size (22.3 ± 4.7 g [0.8 ± 0.2 oz] versus 21.0 ± 3.6 g [0.7 ± 0.1 oz], for low and high stocking densities, respectively) were found.

Based on the above study, it is recommended that yellow perch fingerling producers can successfully use stocking densities as high as 185,000 fish/ha (75,000 fish/acre) to improve their production. It is important, however, to include the following caveat regarding this recommendation. In parallel with these studies, additional fingerling ponds were stocked at densities of 185,000–250,000 fish/ha (75,000–100,000 fish/acre). At times, particularly during August and early September when temperatures and feeding rates are at their highest, levels of dissolved oxygen became problematic. Accordingly, it is recommended that fingerling producers who use high stocking densities regularly monitor levels of dissolved oxygen in the early morning, and be prepared to rapidly employ corrective actions if needed.

University of Missouri-Columbia
Eight experimental ponds at the Missouri Department of Conservation's Little Dixie Lake (LDL) site were secured for use in 2007 and 2008. 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 June 2007 were not delivered. This resulted from 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.

From late-April through mid-May 2008, repairs were made to pond dividers that were installed in the LDL ponds during 2007.

Due to continued unavailability of fish from the original producer, additional producers were contacted; 30,000 juvenile largemouth bass (average 55.18 mm [2.17 in], 1.86 g [0.07 oz] were purchased and transported from Cambridge, Ohio to the LDL location in August 2008. Fish were stocked into eight pond halves (four ponds total) at 37,000 fish/ha (15,000 fish/acre). Fish in treatment halves of the ponds were confined to 1/3 of the surface area of these pond halves during the initial two weeks of the study using block nets. This "crowding" in the treatment halves was done on the deep end of the pond to help alleviate any water quality problems that may have ensued from crowding.

Fish were fed a 50:50 mixture of Silver Cup and Aquamax feeds at 4% of body weight/day. Each week the Silver Cup feed was reduced by 10% and replaced by Aquamax due to its local availability and lower cost. Feeding rates were recalculated for each pond-half each week from mean weight information gathered during weekly samplings. Feedings were shifted from twice daily to once daily on September 15th due to a road wash out that made accessing the ponds difficult.

Survival, percentage of fish on feed, and percentage of fish cannibalized were estimated and stomach contents analyses done. Percent starvation was estimated from length and weight data (through use of relative weight (Wr), index of body plumpness with target being 100).

Mortality was estimated to be 3.58% in the first 10 days post-stocking. Fish that were not feeding subsequently perished within 1–2 weeks after stocking. This is supported by the observation that the percentage of fish with commercial feed in their stomachs steadily increased from the third sampling date until the end of the study.

By the end of the seven week sampling period, the fish exhibited an average length of 102.32 mm (4.03 in) and an average weight of 17.44 g (0.6 oz) and similar survival, ca. 50+% in the two treatments. Average feed conversion of the ponds during the sampling period was 1.16:1.

On average, cannibalized fish were 44.8% as long as the fish that consumed them. In control-pond halves, it required four weeks for sufficient size variation to develop to allow cannibalism, while it took five weeks for this to occur in treatment-pond halves. Once cannibalism occurred in the control ponds it continued for four weeks, while cannibalism was only present in treatment ponds for two weeks. Total mortality due to cannibalization during the seven week sampling period for the treatment was estimated to be 15.65% of the population and 40.38% of the population for the control. Although it is often believed that cannibals no longer feed on the commercial feed provided in ponds, and that they should be removed from the population, every largemouth bass that had cannibalized other fish also had commercial feed in their stomachs in this study. Frequent grading, as often as every four weeks, should be conducted to reduce cannibalism.

Individuals found with commercial feed in their stomachs had an average Wr of 136.8, while individuals not found to contain commercial feed had an average Wr of 110.1. A consistent response of statistically higher percentages of fish remaining on feed in the crowded pond halves (79.2%) versus the control halves (54.1%) was indicated with fish having commercial feeds in their stomachs being relatively plumper. During the crowding phase (the initial two weeks of the study), treatment halves also showed statistically higher Wr values (146.3 versus 134.8). Crowding fish to areas where food will be provided is a viable approach for improving feed retention rates and slowing the onset of size disparities.

Two, 0.10-ha (0.25-acre) production ponds at the Lincoln University (LU) pond facility in Jefferson City, Missouri were secured for use during winter 2008–2009. Seventy-five hundred fish from the LDL site were held over-winter in the ponds at LU to determine their ability to return to feeding on commercial diets in the following spring. Fish were fed at 4% body weight/day until they went off-feed due to declining temperatures. Once the fish resumed feeding activity in the spring, they were fed for two weeks. The percentage of fish “on feed” (77.5%) was only slightly less than the 83% of fish “on feed” during the preceding fall at LDL; 87.4% of the fish were harvested in the following spring.

<u>Southern Illinois University-Carbondale (SIUC)</u>

During Year 1 of the project, 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 (1,321-gal) grading tank where they were treated with a 5 ppm potassium permanganate bath for 30 min to prevent introduction of diseases or parasites.

Fingerlings 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 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 were examined 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 20-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 7.9 and 13.2 fish/L (30.0 and 50.0 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.

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

The effectiveness of a bird of prey call in deterring fish-eating birds from ponds stocked with largemouth bass fingerlings at a commercial fish farm was evaluated. A Bird Gard Pro™ was programmed to produce the call of a peregrine falcon (*Falco peregrines*) at random intervals from 10–30 min apart, 24 h/day. Observations were then made of bird behavior and response to the call. Species, activity before call, response to call, distance from call (using a laser range finder), and time of day were recorded for each bird observed when the call was activated. After testing 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 as described for the falcon call. Birds-of-prey calls failed to repel fish-eating birds from the fish farm. Physical barriers are the only demonstrated effective prevention mechanism for bird predation in aquaculture.

Pond studies evaluating the effect of stocking density on growth and survival of feed-trained fingerling largemouth bass were conducted during 2008. Pellet-feed trained largemouth bass fingerlings were obtained from a commercial producer in Arkansas and transported to experimental ponds at SIUC. Two ponds were stocked with fingerlings at a density of 37,000 fish/ha (14,980 fish/acre) and two ponds were stocked at a density of 74,000 fish/ha (29,960 fish/acre). A sub-sample of 100 fish stocked into each pond was measured for initial length and weight. Fish were fed to satiation several times daily. Fish were harvested in fall and counted to determine survival. A random sample of 100 fish from each pond were weighed and measured to estimate growth.

Initial size of stocked fish was 59.8 mm (2.35 in) and 2.4 g (0.08 oz). Mean size of fish at harvest was 72.3 mm (2.85 in) and 5.1 g (0.18 oz) and was not significantly different between ponds stocked with different densities of largemouth bass fingerlings. Survival in ponds averaged 73% and was not significantly different between treatments. The percentage of fish that weighed <3.0 g (<0.1 oz) (and apparently did not remain "on feed" after stocking into ponds) averaged 28% for the low-density ponds and 47.5% for the high-density ponds.

UW-Milwaukee

Auditory conditioning trials were conducted on early life stage yellow perch. Auditory signals of low frequency (35−300 Hz) were presented to 12-day post hatched (dph) yellow perch in conjunction with a commercial fish starter diet. The initial response was recorded as an estimate of the numbers of fish remaining in the feeding area over time. Young fish were exposed to a sound/feeding regime for up to 30 dph. From 30−50 dph, their behavioral response to the auditory signal was measured as a function of time response to the target area involving the food. The auditory signal was presented to the fish when they were randomly distributed in the tank.

Following a brief acclimation period, researchers found that more than 90% of the fish responded to the auditory signal associated with food in 2−3 sec. Diets were changed so as not to bias the response to food. Based on these results, it appears that yellow perch can be conditioned to food using an auditory signal.

The feeding response of yellow perch as a function of an auditory signal was observed for a range of life stages from sac-fry to adults. A series of five different foods were presented in conjunction with sound, enhanced light, and movement. The onset of first feeding was observed for yellow perch sac-fry (6.0 mm; 0.23 in) as a function of live food (green tank water [GTW]). No auditory signal was used for the first seven days of yellow perch sac-fry and larval feeding of live foods. Between days 8 and 10, a commercial starter diet was presented to the perch larvae, which also included one live food item. Sound, enhanced lighting, and food particle movement was correlated with the observed feeding response. The mean body length of the larvae at this time was 9.3 mm (0.37 in). Between 8 and 24 dph, the young perch elicited a feeding response as a function of sight and food particle movement and, to a lesser extent, sound. Between 30 dph (25.0 mm [0.98 in] length) and 40 dph (32.0 mm [1.3 in] length), the auditory signal appears to play a more important role in the young perch feeding response to a commercial diet.

It appears that training to an auditory signal only partially influences their feeding behavior for the first 30 days. However, sight and food particle movement are more important cues for early life stage feeding. The transition of their feeding response to sound was observed at about 50.0–60.0 mm (2.0–2.4 in) body length. The fingerling perch were observed to elicit a feeding response in less than two seconds. In most cases, when post fingerling perch are introduced into a production system, sight and food particle movement remain the primary cue for 12 to 24 h.

Feeding trials were continued during 2010 to describe behavioral responses to feeding and assess methods for describing and managing transitions from one food type to another during development of intensively cultured larval yellow perch. Observations of feeding movement and whether or not food was visible in the gut for a sample of 100 individuals showed promise for describing the timing of transition from GTW prey to feeding on brine shrimp nauplii (BSN). The orange pigmentation of BSN was visible to the naked eye from above the tank. The presence of food in the gut seemed to be more useful than the incidence of feeding movements because it integrates feeding over a wider time period (related to food passage through the gut) rather than quantifying individual feeding movements of fish.

Visual observation from above was ineffective for assessing the transition from live prey to formulated feed (8–24 dph) due to the body walls of the fish becoming more opaque and active avoidance of observers by fish. At this point, fish response to auditory signals of feed provided by automatic feeders becomes more relevant for assessing transition to and acceptance of formulated feed. Beginning at 24 dph, there was a gradual increase in the number of fish that showed an orientation and swimming in the direction of the autofeeders when food was dropped. At about 30 dph, 10–20% of the fish moved toward the feeder when it dropped feed during morning observation. At 35 dph, the fish gradually began to exhibit a feeding behavior relative to the commercial feed as a function of sight and sound. Beyond 40 dph, 100% of the fish responded immediately to the sound and sight of food on the surface of the water.

IMPACTS

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

Studies have also provided valuable information to largemouth bass fingerling producers with respect to stocking densities, size of fish at feed training, light intensity during feed training, and the utility of using bird deterrent devises to reduce labor cost and increase the number of fish that are feed trained.

RECOMMENDED FOLLOW-UP ACTIVITIES

A video on the feed-training of pond-reared yellow perch fingerlings is being prepared by the extension staff of the University of Wisconsin-Stevens Point Northern Aquaculture Demonstration Facility. All of the footage needed for this video was shot in 2008 and 2009, and the video should be completed sometime in late 2010. An extension publication on yellow perch fingerling production is scheduled for early in 2011.

These studies have developed methods and provided recommendations for yellow perch fingerling producers to improve the efficiency of fingerling production. Despite these improvements, current economic models for yellow perch culture show that fingerling costs remain a high percentage of the overall cost of producing food-size yellow perch. Therefore it is recommended that future studies be aimed at reducing fingerling production costs.

SUPPORT

NCRAC has provided $300,000 which is the entire amount of funding 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

Publication 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.

Paper 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.