EVALUATION OF ALTERNATIVE MANAGEMENT TECHNIQUES AND SYSTEMS TO IMPROVE PRODUCTION OF POND-REARED YELLOW PERCH (*Perca flavescens*): MODELING THE U.S. CATFISH INDUSTRY

TRA A-3 Culture Systems

Chairperson: Matthew A. Smith

Extension Liaison: Dr. Kwamena Quagrainie

Industry Liaison: William M. West

Funding Request: $30,838

Duration: 1 year (March 1, 2018 – February 28, 2019)

Objectives:

1. Evaluate water quality parameters, fish growth, condition, feed conversion, final length frequencies, survival, specific growth rates, and feeding rates of first-year yellow perch fingerlings (stocked at twice normal rate) provided with either intensive aeration or using an aerated split pond design.
2. Collect the economic data of producing first year yellow perch in either an intensively aerated or an aerated split pond design.
3. Compare these data to long-term historical pond data (stocked at the normal rate) available from both Millcreek Perch Farm and Brehm Perch Farm.
4. To immediately disseminate results to industry via final termination report, fact sheet, presentations, and other information technology transfer strategies.

Deliverables:

1. Education at an on-farm workshop in conjunction with the OAA for those interested in learning about the positives and negatives of intensification on their farms.
2. Cost of production data available for yellow perch in the two proposed systems
3. "Proof-of-concept" results disseminated to all of the Midwest and beyond via electronic methods, formal presentations, informal meetings, and any other practical means.

Proposed Budget:

Institution	Principal Investigator	Objectives	Year 1	Total
The Ohio State University	Matthew A. Smith	1 – 4	$30,838	$30,838
			Total	$30,838

Non-funded Collaborators:

Facility	Collaborator
Millcreek Perch Farm, LLC	William E. Lynch Jr.
Brehm Perch Farm, LLC	Matt Brehm

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PROJECT SUMMARY

There has been a recent increased interest in farm-raised yellow perch (*Perca flavescens*) filets by consumers that is being driven by the "Locally Grown Food Movement" and the perception that Lake Erie is once again polluted given the annual Harmful Algal Bloom occurrences. Inquiries by high-end restaurants and other consumers for farm-grown filets are becoming the norm rather than the exception. One on-farm processor in Wisconsin and one potential processor in Ohio have indicated a desire to provide processing to meet this increasing demand. In looking for perch to process, they have been told the unavailability of high-quality, feed-trained fingerlings is an impediment to availability. Consultation with OSU South Centers and Ohio's two yellow perch farms conveyed an immediate need to investigate possible strategies to greatly increase production of feed-trained perch fingerlings throughout the North Central Region (NCR) for grow-out into market-sized fish. The U.S. catfish industry encountered a similar need to be efficient and competitive and developed intensive aeration and split pond designs to increase production levels and ultimately bottom lines. Similar strategies may be applicable to NCR pond production but need to undergo "Proof-of-concept" on-farm trials prior to dissemination to the yellow perch industry and other NCR industries.

JUSTIFICATION

Yellow perch have long been considered a potential high-value aquaculture species for the NCR of the United States. Yellow perch fillets have been in high demand across the Great Lakes and Midwest since the mid-1900's due to its firm, sweet flesh, low fat content (but high in Omega-3), and long shelf life (Malison 2000). With the increase in demand across the Great Lakes and the Midwest, restaurants made the fillets a mainstay and they were the civic/church organizations' choice of fish for the Friday night fish fries.

Over the last 10 yrs pond and lake management companies throughout the Midwest have demanded more high-quality yellow perch of a variety of sizes from farmers as a direct result of their customer's requests. Undoubtedly, many of the pond and lake owners who wish to have their bodies of water stocked with yellow perch do so because they remember the delicious Friday night fish fries and being able to readily purchase a perch fillet meal at many restaurants throughout the Midwest. While fingerling perch for stocking is not new, the demand for immediately harvestable yellow perch has increased significantly in the 2010-2016 time period (William Lynch, Millcreek Perch Farm [MCP] – personal communication). The demand for large 20.3-25.4 cm (8-10 in) perch for stocking ponds and private lakes likely reflects the strict bag limits set by resource management agencies in the Great Lakes region, the cost of fishing trips to waters containing harvestable yellow perch as well as the high cost of fillets (retail prices of $10-16) on local market shelves. It is important to note that transporting live fish from wild populations to stock in nearby waters is illegal in nearly every if not all jurisdictions and thus, stocking demand cannot be met in this manner.

A key factor holding back expansion of a food-fish yellow perch industry is that processors who are used to paying less than $2.50 per pound (often much less) for Great Lakes commercially caught yellow perch have been unwilling to pay a price needed for aquaculture producers to be profitable. However, consumers (especially millennials) are demanding more and more locally grown food, free of chemicals and antibiotics which include aquaculture products and can assist in the feasibility of farm-raised yellow perch for the food market. In recent years, harmful algal blooms (HABs) have been at considerably high levels throughout much of Lake Erie, the primary source of commercially caught yellow perch, and have caused consumers to view fish products from the lake as unsafe. Restaurants have noted this trend and are now asking for sources of locally grown, non-Lake Erie yellow perch fillets.

Although pond production of yellow perch appears to be the most viable method to grow this species in the foreseeable future, the technique is not without a major challenge. In any culture system, nitrification of ammonia waste limits the kilograms that can be grown per liter or hectare of water. In typical NCR ponds using the typical strategy of aeration only at night when dawn oxygen levels approach 4 mg/l, the pond's ability to nitrify ammonia in nitrite and ultimately into harmless nitrates is often inadequate once daily feeding rates reach 28.25 kg/ha/d (25.00 lb/ac/d) and higher (William Lynch, MCP). Whether the elevated levels of ammonia become problematic for fish growth and survival depends on the fraction of total ammonia that is in the toxic, un-ionized form. Water temperature and pH determine actual levels of toxic ammonia, with increases in either, especially pH, can raise toxic ammonia levels. For yellow perch, un-ionized ammonia levels of 0.06 mg/l will stress the fish and reduce feeding and by 0.10 mg/l all feeding ceases. In order for these types of proposed culture techniques to be successful, adequate dedication to fish husbandry and water quality will be essential.

The U.S. catfish industry (*Ictalurus punctatus* and ♀ *Ictalurus punctatus* X ♂ *Ictalurus furcatus*) suffered a severe industry constraint as costs of production increased (primarily feed) and cheaper catfish-like species were imported at a substantially higher rate. The adoption of intensively aerated ponds and split ponds has led to approximately a three-fold increase in production per hectare of water. These novel culture methods/systems have been thoroughly vetted by U.S. aquaculture economists and have proven to lead to an increase in profitability as long as the farm was financially stable prior to the adoption and farmers also converted their traditional ponds into split ponds when renovations of the pond were already scheduled. Even doubling production of yellow perch fingerlings would not only provide more product for producers to sell or use themselves, but could significantly reduce cost of production per fingerling. Using their 2016 farm data, MCP developed an enterprise budget in which double the amount of fingerlings achieved per hectare of water reduced the cost of production per fingerling by 36%; even after accounting for all production costs (including the increase in labor, electricity, feed, etc. required). This is potentially significant for NCR aquaculture and could lead to increased profit for not only the fingerling producers, but also buyers of fingerlings if prices can be reduced to some degree. This project's research will ultimately document not only increases in production but also how those increases affect fingerling cost of production.

RELATED CURRENT AND PREVIOUS WORK

Over 15 years ago Malison (2000) reported nearly 70% of yellow perch sales and consumption in the U.S. occurs within 50 miles of the Great Lakes, a region holding about 40-45 million residents. No consistent, reliable estimates of demand potential are available, but Malison (2000) did note that Great Lakes Marketing, Inc. (a large food distributor) has suggested in the past that existing markets could absorb 22,680,000 – 45,360,000 kg (50-100 million lbs) of yellow perch per year. Current commercial harvest of yellow perch is substantially below those estimates, often not even attaining 20% of the 22,680,000 kg. The inability to meet demand has led to the illegal marketing of European pikeperch (zander; *Sander lucioperca*) and European perch (*Perca fluviatilis*) in the U.S.

Yellow perch culture has not increased to levels expected by most industry culturists, agency scientists, or university academics. However, a 2014 survey of these groups within the North Central Region (NCR) still indicates continued strong support for yellow perch as a priority focus culture species. Survey participants were given a list of 17 fish and crustacean species and asked to check three that they felt offered the best potential to substantially increase NCR aquaculture in the next 5-10 yrs. Industry and academics respondents listed yellow perch as their second overall priority species while agency respondents felt perch was the highest priority species.

While many biological and economic factors play a role in determining the success of a cultured species, perhaps the most critical is the availability of high quality, feed trained fingerlings from which to grow food size yellow perch. Considerable husbandry research has been accomplished, that allowed for the publication of the NCRAC Yellow Perch Culture Guide by Hart et al. (2006). Techniques for broodstock management, egg collection, incubation, feed training and grow-out are documented and have been successful by many culture facilities. Not well documented are the real world economics of growing yellow perch in a variety of production systems. The best available data is work completed by University of Wisconsin Steven's Point Northern Aquaculture Demonstration Facility (NADF) in both levee pond and RAS systems. Substantial effort on recirculating aquaculture system (RAS) culture of yellow perch has been attempted, but Hart et al. (2006) noted that nearly all yellow perch RAS facilities since the 1970's have closed, and cited high start-up costs, labor costs, and availability of feed trained fingerlings as the primary reasons. Held et al. (2008) documented a breakeven cost of $11.75/lb for food fish, far greater than any reasonable market value for whole, market-sized yellow perch. The U.S. federal government has funded 44 yellow perch awards between 1990 and 2015 at a value of $13 million (Love et al. 2017) and many of the aforementioned techniques were readily adopted by yellow perch farmers as a result of this research.

Conversely, in the same time frame, Love et al. (2017) reported 210 rewards at approximately $48 million for catfish research. Some of this funding directly and indirectly resulted in what is now considered the future of the catfish industry: split pond system and intensively aerated ponds. These alternative intensive production systems have led to an increase in kg per hectare of water and have been rapidly accepted on many commercial catfish farms in the southeast U.S. (Tucker and Kingsbury 2010; Brown and Tucker 2013; Tucker et al. 2014). In the last two years, economic research on the split pond system and intensively aerated ponds are economically feasible for the catfish industry as long as recommendations are followed (Kumar et al. 2016; Kumar and Engle 2017). While the systems may be more expensive to construct (split ponds) and/or operate (splits ponds and intensively aerated ponds), the harvest per hectare offsets the costs and can lead to a higher profit margin. In the split pond system, the waste water is pumped away from the where the fish are constructed and reliant upon a dense microbial community to nitrify ammonia and breakdown the solid waste from the catfish. Flushing the culture area likely decreases the stress on the catfish which promotes better growth. Additionally, confining a fish to a small portion of the pond can decrease feed waste which may improve feed conversion ratio (FCR), improve inventory control, and facilitate in easier harvesting (Tucker and Kingsbury 2010; Brown and Tucker 2013; Tucker et al. 2014). In recent years, many catfish farmers have divided up their large ponds (>20 ac; >8.1 ha) into much smaller ponds. This increases the farmer's control. With smaller ponds, intensively aerated ponds are becoming more prominent. High dissolved oxygen levels, along with an increase in microbial activity, have also lead to an increase in production per hectare of water (Torrans 2005; Tucker et al. 2014; Torrans and Ott 2016). A split pond system will only be able to be ran in the warmer months so there is not any damage to the system once ice and snow accumulates on Midwest ponds. However, the catfish industry does not overwinter any fish in split ponds and all fish are all removed before winter sets in.

Largemouth bass (*Micropterus salmoides*), fathead minnows (*Pimephals promelas*), and golden shiners (*Notemigonous crysoleucas*) have all been at least investigated as a candidate for culture in a split pond system. The University of Arkansas at Pine Bluff has conducted replicated research with golden shiners (Smith and Stone 2016) and largemouth bass. A small business innovation research grant was also submitted and funded for investigation of culturing fathead minnows and other species by a minnow farm in Arkansas.

Given an immediate industry need to increase perch production during the first year in ponds, a similar strategy used by the catfish industry or at least similar forethought is critical to increase first year production of perch, which ultimately should allow more ponds to be used for production of second year, food fish production of perch. Note, the same techniques tested for first year production, if successful, could be applied to second year production ponds to increase biomass per hectare of food size yellow perch. On-farm research is needed to determine if this catfish strategy can indeed prove applicable and beneficial to the NCR's yellow perch culture industry. Additionally, OSU and the Ohio Aquaculture Association have become known for their high-quality workshops and will utilize the knowledge gained from previous workshops to ensure that this workshop will be as of equally high-quality; thus increasing our ability to transfer knowledge gained to interested farmers, researchers, and Extension personnel.

STATEMENT OF DUPLICATION OF RESEARCH

The USDA Current Research Information System (CRIS or REEport) was accessed to review any related or relevant research and that the proposed work is original research and does not duplicate any previously funded projects in the CRIS. The following NOAA databases of previously funded projects were also accessed to ensure that the proposed work does not duplicate previous research: 1) National Sea Grant Office Funding Page (http://www.seagrant.noaa.gov/funding/rfp.html); 2) website of state Sea Grant Program (http://www.seagrant.noaa.gov/other/programsdirectors.html); 3) NOAA Office of Aquaculture Funding Opportunities Page (http://www.nmfs.noaa.gov/aquaculture/funding/funding.html).

ANTICIPATED BENEFITS

If either intensive aeration and/or split pond production systems proves beneficial in increasing the production of yellow perch fingerlings, the benefits to NCR's culture industry would be dramatic and immediate.

Short term

- Yellow perch culturists will immediately adopt one or both of the proposed techniques with the following economic benefits:
    - Greater fingerling production per acre of water, providing increased sale revenues.
    - Lower cost of production per fingerling stocked or harvested, providing for increased profit margin.
    - Fewer ponds required for yellow perch fingerling production, allowing adjacent ponds to be used for other purposes, thereby diversifying on-farm production and reducing risks.
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- Production of food size yellow perch should be enhanced.
    - Fingerlings prices should be lowered, thereby reducing cost of production for culturists growing food fish yellow perch.
    - Techniques will likely be applicable to ponds used for production of food size yellow perch, thereby enhancing per hectare production of large perch. More kilograms per hectare reduces cost, increases revenues, and maximizes profit for food fish culturists.

- Impacts on culture of other species.
    - Results of this study are not likely to be yellow perch specific, but with on-farm trials, could increase production of fingerlings and larger fish of a variety of species in ponds, such as bluegill and bass.

<u>Medium term</u>

- Impacts on NCR aquaculture industry.
    - Increased knowledge of the positives and negatives of pond intensification in the Midwest through the on-farm workshop.
    - Enhanced awareness of alternative pond production systems for significantly increasing production per hectare.
    - Better management of ponds to improve survival, fish health, water quality, and ultimately production in the near future.
    - Increased production of yellow perch, a highly desired species in the NCR, as well as other species.
    - Increased availability of NCR farm raised aquatic products for consumers.

<u>Long term</u>

- Impacts on seafood in the Midwest.
    - Farm-raised aquatic products in more restaurants and market shelves.
    - Increased public awareness of the necessity to support local farmers and east locally grown protein.
    - Increase in number of aquatic farmers, limiting the Midwest seafood deficit and continually supporting wild caught fisheries through sustainable practices.

Kelly (2010) shared a vast amount of reasons for the lack of farm-raised yellow perch available for the food fish market. Some of the concerns addressed have previously been answered through research; although some production and economic constraints still exist. The benefits of the proposed project on the yellow perch industry could be significant.

OBJECTIVES

The overall objective of this project is to rapidly increase pond production of yellow perch to meet the increasing demands of high-end restaurants and fish processors through improvements in alternative management techniques and/or systems.

1. Evaluate water quality parameters, fish growth, condition, feed conversion, final length frequencies, survival, and feeding rates of first-year yellow perch fingerlings (stocked at twice normal rate) provided with either intensive aeration or using an aerated split pond design.
2. Collect the economic data of producing first year yellow perch in either an intensively aerated or an aerated split pond design.
3. Compare these data to long-term historical pond data (stocked at the normal rate) available from both Millcreek Perch Farm and Brehm Perch Farm.
4. To immediately disseminate results to industry via final termination report, fact sheet, presentations, and other information technology transfer strategies.

DELIVERABLES

1. Education at an on-farm workshop in conjunction with the OAA for those interested in learning about the positives and negatives of intensification on their farms.

2. Cost of production data available for yellow perch in the two proposed systems
3. "Proof-of-concept" results disseminated to all of the Midwest and beyond via electronic methods, formal presentations, informal meetings, and any other practical means.

PROCEDURES

Current Protocol – NCR perch culture facilities typically stock feed trained fingerlings at a rate of 98,800/ ha (40,000/ac) for first year grow-out. MCP and Brehm Perch Farm, LLC (BP) begin the feed training process by harvesting 18-20 mm TL fry, feed training for 21 d, and then re-stock fingerlings (30-35 TL; 0.75-1.00 g) back into levee ponds. Historical data from MCP in Ohio indicates that once daily feed levels approach 28.25 kg/ha/d (25.00 lb/ac/d) the pond's ability to nitrify total ammonia nitrogen (TAN) into ultimately harmless nitrates becomes insufficient under typical management practices. In Ohio ponds stocked with 40,000 fingerlings, insufficient conversion can occur as early as late July but more typically in August. Whether this scenario results in fish mortality or reduced growth is largely dependent on the fraction of total ammonia that is in the un-ionized (toxic) form. The toxic fraction of TAN present depends on pH and water temperature. Increases in either, especially pH, results in higher fractions of TAN in the harmful form. Occurring concurrently during this period are lower oxygen levels due to accumulation of organics due to feeding, reduced photosynthesis as seasonal daylight declines, and overall lower oxygen saturation with warmer temperatures. Facing similar production constraints, the U.S. catfish (*Ictalurus punctatus* and ♀ *Ictalurus punctatus* X ♂ *Ictalurus furcatus*) industry and catfish researchers recognized the need for alternative management techniques and systems to enhance the waste degradation process to increase kilograms grown per hectare of water. Rather than dig more ponds, the catfish industry focused on increasing production per hectare of existing water. Given an immediate industry need to increase perch production during the first year in ponds, a similar strategy is critical to increase first year production of perch, which ultimately should allow more ponds to be used for production of second year, food fish production of perch. Note, the same techniques tested for first year production, if successful, could and should be applied to second year production ponds to increase biomass per hectare of food size yellow perch.

Project design –MCP will be the facility to evaluate intense continuous (24 hrs/7 d) and semi-continuous (12 night hrs/7 d) aeration as a management technique to double first year production following stocking fingerlings at 80,000 (twice the normal rate) per pond. Two 0.40 ha (1.00 ac) ponds will be used for the proposed project. Each pond will be equipped with two, 1 hp paddlewheel aerators that will function continuously or semi-continuously post-stocking until October 31 to provide intensive aeration and water circulation throughout the growing season. Currently, a single aerator is used only when early morning oxygen levels approach 4 mg/L; which historically has been approximately 21 nights per growing season. Additionally, each pond will be equipped with air lifts in the deeper section of the pond to prevent pond stratification and maximize bottom surface area available for colonization by nitrifying aerobic bacteria.

<u>The split-pond system (Figure 1 and Figure 2) designed by scientists in Stoneville, Mississippi is the most commercially adopted (>404 ha; >1,000 ac) partitioned pond aquaculture system.</u> BP will be the facility to evaluate a split pond design technique to double first year production following stocking fingerlings at twice the normal rate. A 0.10 ha (0.25 ac) pond will be used as the production pond, while two connected adjacent ponds (total water surface area of 0.75 ac or (0.30 ha)) will function as the biological filters necessary to nitrify ammonia received from the fish culture pond. Combined surface area is 0.40 ha (1.00 ac), meaning the total stocking rate for the three ponds normally would be 40,000 fingerlings. For this project, twice the normal rate equates to 80,000 fingerlings where all will be stocked in the 0.10 ha culture pond. Water will be pumped from the biological filter ponds into the production pond at a rate of approximately 1,700 L/min (450 g/min), and returned from the production pond to the biological filter pond via a 0.30 m (12.00 in) diameter pipe. This rate equates to approximately two full volume exchanges per day in the 0.10 ha production pond. Each pond will be equipped with air lifts in the deeper water to prevent pond stratification and maximize bottom surface area available for colonization by nitrifying aerobic bacteria. Paddlewheel aerators will be operated in the ponds if dawn oxygen levels approach 4 mg/L.

Fingerling production and stocking – Feed trained fingerlings at both facilities will be produced using general techniques described by Hart et al. (2006) with refinements specific to each facility. Stocking will be calculated by determining the number of fingerlings per kg and stocking the appropriate number of kg to attain the needed stocking density.

Feeding – Feeding will follow the protocols developed and used by both farms the last 5 yrs. Post-stocking, fingerlings will be fed with Ziegler Salmonid Feeds, starting with #1 crumbles (55% protein;15% fat) and proceeding up to 3.0 mm (40% protein; 10% fat) by October. Initial daily feeding rate will be 20% body weight but will transition to dawn and dusk satiation feeding by week three post-stocking to accommodate yellow perch's crepuscular feeding habits and also due to difficulty in accurately accounting for mortality rates. During the initial three weeks, approximately 50% of the feed will be hand delivered and the remaining half in automatic belt feeders on rafts on day one. All hand feeding will commence by day 21. Total amount of feed fed will be recorded daily for accurate feed conversion ratios (FCR = total amount fed / by the net yield) upon cessation of the project.

Water quality monitoring – Water quality will be monitored and recorded regularly in both aerated ponds at MCP and the fish culture pond and waste management treatment pond at BP. Temperature and dissolved oxygen readings will be recorded at dawn each day thru October 31 using a YSI Oxygen – Temperature Meter. TAN, nitrites, carbon dioxide, and pH will be tested every third day at dawn using a YSI pH meter and a LaMotte, or similar, colorimetric meter. Recorded water temperature, pH, and TAN data will be used to calculate un-ionized (toxic) ammonia levels. Alkalinity and hardness will be tested monthly. If data indicates potential concerns about water quality and its effect on fish health, more frequent testing will be performed. Because un-ionized ammonia levels are often elevated in late-afternoon due to higher pH levels, TAN, water temperature, and pH will be monitored additionally in late afternoon if dawn un-ionized ammonia levels exceed 0.05 mg/L. Recorded project water quality data will be compared to the historical data as is available.

Fish sampling – Fish sampling will occur just prior to stocking and approximately every 30 days thereafter to monitor growth and condition (relative weight: Wr; Fulton's condition factor: K). Monthly samples, 100 fish per sample, will be recorded from both aerated ponds at MCP and the production pond at BP. Condition factors will be calculated after measuring and recording length (nearest mm) and weight (0.1 g). Length data will also be used to generate length frequency distributions for all ponds at each sampling date. Subsamples will be collected using a 25 m long seine, 2 m tall, with 4 mm mesh. In November as harvest and sales commence, total numbers and weight of fish harvested will be recorded. Numbers will be needed in the comparison of current data with historical data from both farms.

Economics – All annual variable and operating costs will be recorded for each pond at MCP and the split design system at BP. Manpower will recorded in hours and will be quantified at a rate of $15 p/hr. Examples of other annual variable costs to be recorded include feed, water quality supplies, electric, gasoline for mowing, and insurance. These data, when combined with harvest numbers, will allow calculation of cost of production per fingerling (or by the kg) for each farm. It is estimated that intensively aerated and split ponds represent >1,214 ha (>3,000 acres) of catfish production and a few years ago it was estimated that although these systems represented only approximately 5% of the total pond area, the production of these ponds exceeded 10% of the total catfish production (C.S. Tucker, USDA ARS, personal communication), which indicates that good record keeping will be imperative to assessing the successes of these systems.

Historical data – Optimally, research trials would simultaneously compare the management strategies of interest with control ponds on the same farm but to achieve the replication necessary would require more ponds than available. Therefore, historical data sets from MCP and BP will be made available to allow comparison of project results in both intensive aeration ponds and the split pond to assess if yellow perch production can be enhanced using either one or both of the management techniques. Multi-year, multi-pond harvest data available includes:

- Length, weight, survival
- Total production (kg/ha)
- Feeding rates
- Common water quality parameters
- Cost of production inputs; cost per fingerling

Farmers are not being paid to participate in this study and are providing what can be considered in-kind support. Much of the provided materials and supplies requested for this study will remain at each respective farm following the cessation of this project. Additionally, farmers will receive reimbursement for 50% of the feed costs for the study ponds. Other than materials and supplies gained as a result of this project, we hope to train the farmers to be more familiar with understanding the all of the costs of production as well as comfortable with recording water quality parameters routinely to improve management on the farm. Obviously, the ultimate goal is to improve production per hectare of water while decreasing the costs through economies of scale. Achieving this goal could provide economic gains for the participating farmers in the future.

EVALUATION OF ALTERNATIVE MANAGEMENT TECHNIQUES AND SYSTEMS TO IMPROVE PRODUCTION OF POND-REARED YELLOW PERCH (*Perca flavescens*): MODELING THE U.S. CATFISH INDUSTRY

Goal: To rapidly increase pond production of yellow perch to meet the increasing demands of high-end restaurants and fish processors through improvements in alternative management techniques and/or systems.

Objective: Develop and provide hands-on learning programs to enhance information transfer for both newcomers to the aquaculture industry and established growers

Inputs	**Outputs**		**Outcomes**		
	Activities	***Participation***	***Learning***	***Actions***	***Conditions***

Inputs

- Staff from OSU South Centers
- Collaborating yellow perch growers
- Other aqua farmers
- Fish processors
- Ohio Aquaculture Association
- Regional Aquaculture Specialist
- Historical data from the yellow perch farms
- Data comparison
- Restaurants
- NCRAC/ USDA

Activities

- On-farm trials at two yellow perch facilities in Ohio, train farmers on water quality and record keeping
- Workshop, presentations at the OAA and NCRAC, social media updates, Buckeye Aquafarming newsletter article, dissemination of results however possible or realistic
- State Association and NCRAC collaboration
- Farmer, processor, restaurant collaboration

Participation

- Aquaculture growers, fish processors, restaurants, OAA, industry leaders, rural and urban citizens

Learning

- Awareness of alternative systems, knowledge gained, attitudes changed, skills learned, and incentives created for intensifying production, marketing of products for the foodfish market
- Identification of farmers as role models & mentors for those interested in intensifying pond production systems to increase profit margins

Actions

- Yellow perch farmers will rapidly adopt one or both of the proposed techniques if successful
- Knowledge gained will be utilized to implement better decisions by farmers
- Farmers of other products in the NCR can utilize the information learned to decide if they have interest in adopting the propose techniques
- Field visits for those interested
- Basic economics evaluated for feasibility

Conditions

- Processors acquire farm-raised yellow perch and ideally other species
- More Midwest farm-raised aquatic products on the shelves at stores and restaurants
- Better management of ponds to improve survival, fish health, water quality, and production
- Better managers of risk on farms
- More careful consideration of economics by farmers interested in intensification

Assumptions:

- Growers are interested in learning to intensify their systems to potentially improve their margins
- Each system is successful in producing twice the number of fish p/ha

~~- The systems are economical and worth the increased risk~~

External Factors

- The system is not economical and is not worth the risk
- Fish do not survive due to poor water quality at twice the stocking density
- The processors could change their mind and decide they did not want to purchase yellow perch

FACILITIES

Millcreek Perch Farm, LLC (Marysville, OH) has four 0.40 ha (1.00 ac) and two 0.20 ha (0.50 ac) levee ponds. All six ponds are drainable via bottom drains. The facility is equipped with a well to fill ponds. Aeration is provided either by a 0.75 kW (1 hp) paddlewheel or Aireo-II aerators. Ponds are equipped with air lifts to inhibit pond stratification. A building on site is equipped with four 3,780 L (1,000 gal) tanks and six 2,268 L (600 gal) tanks used for feed training (May) and for sorting and sales in spring and fall. Tank water source can be pond, well, or a combination. The building is equipped with a small emergency generator to insure water flow during power outages. An ATV with an attached blower is used for efficient pond feeding. The facility is completely equipped with harvest equipment, including seines, transport tank with oxygenation, and weigh scales.

Brehm Perch Farm, LLC (West Liberty, OH) has six ponds, ranging in size from 0.10 ha (0.25 ac) to 0.50 ha (1.25 ac). All six ponds are drainable via bottom drains. The facility is equipped with a well to fill ponds. Aeration is provided either by a 0.75 kW (1 hp) paddlewheel or Aireo-II aerators. All ponds are equipped with air lifts to inhibit pond stratification. The farm is equipped with six 5,292 L (1,400 gal) tanks used for feed training (May) and for sorting and sales in spring and fall. Tank water source can be pond, well, or a combination. A small emergency generator is available to insure water flow during power outages. An ATV with an attached blower is used for efficient pond feeding. The facility is completely equipped with harvest equipment, including seines, transport tank with oxygenation, and weigh scales.

The Ohio State University (OSU) South Centers has conducted aquaculture research, Extension, and outreach for 26 yrs in southern Ohio. The South Centers has historically focused on several species of fish important to the NCR, including yellow perch. Principal Investigator (PI) Matthew Smith will oversee the project to ensure all timelines are met, data is recorded and analyzed and compared, and project reports are completed. PI Smith has worked at The OSU South Centers as an Extension Specialist for the last year and a half and also conducted farm-driven research in Arkansas prior to his appointment in Ohio. Smith also has the necessary computer and software for the project.

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PROJECT LEADER

State	Name/Institution	Specialization
Ohio	Matthew A. Smith, The Ohio State University (OSU)	Aquaculture Extension/water quality

UNITED STATES DEPARTMENT OF AGRICULTURE OMB Approved 0524-0039
COOPERATIVE STATE RESEARCH, EDUCATION, AND EXTENSION SERVICE

BUDGET

ORGANIZATION AND ADDRESS The Ohio State University 1864 Shyville Road Piketon, OH 45661 PROJECT DIRECTOR(S) Matthew A. Smith				**USDA AWARD NO.** **Years 1: Objectives 1-4** Duration Proposed Months: 12 **Total Funds Requested by Proposer**	Duration Proposed Months: ____ **Funds Approved by CSREES** (If different)	Non-Federal Proposed Cost-Sharing/ Matching Funds (If required)	Non-federal Cost-Sharing/ Matching Funds Approved by CSREES (If Different)
A. Salaries and Wages	**CSREES FUNDED WORK MONTHS**						
1. No. of Senior Personnel	Calendar	Academic	Summer				
a. ___ (Co)-PD(s)							
b. ___ Senior Associates							
2. No. of Other Personnel (Non-Faculty) a. __ Research Associates-Postdoctorates							
b. _1__ Other Professionals	1			$4,161			
c. ___ Paraprofessionals							
d. ___ Graduate Students							
e. __ Prebaccalaureate Students							
f. ___ Secretarial-Clerical							
g. ___ Technical, Shop and Other							
Total Salaries and Wages				$4,161			
B. Fringe Benefits (If charged as Direct Costs)				$1,473			
C. Total Salaries, Wages, and Fringe Benefits (A plus B)				$5,631			
D. Nonexpendable Equipment (Attach supporting data. List items and dollar amounts for each item.)							
E. Materials and Supplies				$22,945			
F. Travel				$2,259			
G. Publication Costs/Page Charges							
H. Computer (ADPE) Costs							
I. Student Assistance/Support (Scholarships/fellowships, stipends/tuition, cost of education, etc. Attach list of items and dollar amounts for each item.)							
J. All Other Direct Costs (In budget narrative, list items and dollar amounts and provide supporting data for each item.)							
K. Total Direct Costs (C through I)				$30,838			
L. F&A/Indirect Costs. (If applicable, specify rate(s) and base(s) for on/off campus activity. Where both are involved, identify itemized costs in on/off campus bases.)							
M. Total Direct and F&A/Indirect Costs (J plus K)							
N. Other							
O. Total Amount of This Request				$30,838			

P. Carryover -- (If Applicable) **Federal Funds: $** **Non-Federal funds: $** **Total $**

Q. Cost Sharing/Matching (Breakdown of total amounts shown in line O)		
Cash (both Applicant and Third Party)		
Non-Cash Contributions (both Applicant and Third Party)		

NAME AND TITLE (Type or print)	**SIGNATURE** (required for revised budget only)	**DATE**
Project Director		
Authorized Organizational Representative		
Signature (for optional use)		

Form CSREES-2004 (12/2000)

BUDGET EXPLANATION FOR SMITH

(OSU)

Objectives 1-4 and Deliverables

A. SALARIES AND WAGES:
Salaries and wages: $4,161
Other Professionals (A&P Staff) PI/PD: Smith $4,161 (8.3% effort, 1 month) requested for 12 months to assist with the development, coordination, and implementation of the on-farm research, hands-on workshops, Extension publications, and web-based deliverables.

B. FRINGE BENEFITS:
Fringe: $1,473

- Fringe rate would be 35.4% ($1,473) for the PI.

E. MATERIALS AND SUPPLIES:

Items	Year 1	Total
Supplement feed cost for the farmers (they will pay half [total of $14,000 estimated])	$7,000	$7,000
Water quality supplies (reagents, meters, and misc.)	$2,999	$2,999
Automated oxygen monitoring systems (multiple units)	$4,989	$4,989
Renovation of split pond (dirt moved, pumps, piping, metal supplies, etc.)	$2,657	$2,657
Additional aeration at both farms (multiple units)	$5,300	$5,300
Total	$22,945	$22,945

F. TRAVEL (DOMESTIC):
Travel: $2,259

- Transportation for PI to make a total of 14 trips to both farms throughout the duration of the project. Each trip to Brehm's Perch Farm from the OSU South Centers is $123 in an OSU university vehicle and each trip to Millcreek Perch Farm is $98.
- Travel is also requested for a total of 15 trips throughout the duration of the project for the farmers to travel to and from each other's farms. Round trip from one farm to the other is $45.

BUDGET SUMMARY

	NCRAC Funds		
	Objective #	OSU (Smith)	Project Total
Salaries and Wages	1,2,3,&4	$4,161	$4,161
Fringe Benefits	1,2,3,&4	$1,473	$1,473
Total Salaries, Wages, and Fringe Benefits	1,2,3,&4	$5,634	$5,634
Nonexpendable Equipment		$0	$0
Materials and Supplies	1,2,3,&4	$22,945	$22,945
Travel	1,2,3,&4	$2,259	$2,259
All Other Direct Costs	1,2,3,&4	$0	$0
Total		$30,838	$30,838

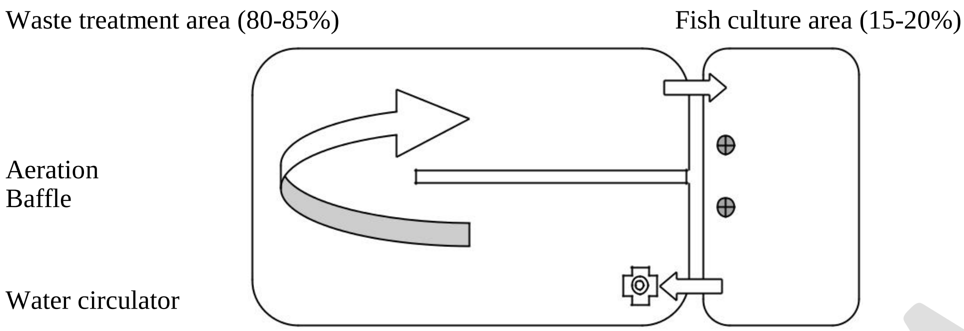

Figure 1. Schematic of a typical split-pond system used for commercially producing hybrid catfish and experimentally used for producing largemouth bass (*Micropertus salmoides*), fathead minnows (*Pimephals promelas*), golden shiners (*Notemigonous crysoleucas*).

Google Maps

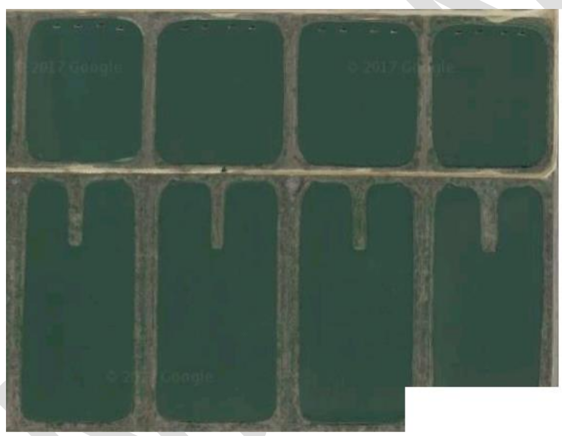

Figure 2. Aerial picture of commercial split ponds for used for culturing hybrid catfish.

SCHEDULE FOR COMPLETION OF OBJECTIVES

Start date: March 1, 2018
End date: February 28, 2019

Objectives, Tasks, and Deliverables		Year 1					
		M A	M J	J A	S O	N D	J F
Objective 1: Evaluate water and growth parameters							
Tasks	Modify BP ponds into split pond	■					
	Purchase aeration/water quality equipment	■					
	Create water quality record sheets/standardize samplings	■					
	Record water quality data	■	■	■	■		
	Sample fish in ponds	■	■	■	■		
	Harvest					■	
Objective 2: Collect the economic data of producing first year yellow perch in a split pond and intensively aerated ponds		■	■	■	■	■	■
Objective 3: Compare the collected economic data from this study with historical data available for the two farms in the project						■	■
Objective 4: Disseminate results to the industry							
Tasks	On-farm workshop regarding intensification of ponds			■	■		
	News article in Buckeye Aquafarming					■	
	Presentation at OAA conference						■
	Presentation at a regional conference or to NCRAC IAC/Board/TC-R/TC-E						■
	Final report						■

PARTICIPATING INSITUTION

The Ohio State University

Matthew A. Smith

VITA

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The Ohio State University
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EDUCATION

M. Sc. Aquaculture & Fisheries, University of Arkansas-Pine Bluff, Pine Bluff, Arkansas, 2015
B.S. Fisheries Management, Auburn University, Auburn, Alabama, 1972

POSITIONS

2016 – present	Extension Aquaculture Specialist, Ohio State University, South Centers
2015 – 2016	Extension Fish Health Associate, University of Arkansas at Pine Bluff, Lonoke Fish Disease Diagnostics Laboratory
2013 – 2015	Graduate Researcher, University of Arkansas at Pine Bluff

SELECTED PROFESSIONAL ORGANIZATIONS

North Central Regional Aquaculture Society, *Technical Committee – Extension* (>1 year)
Ohio Aquaculture Association, *Ex-officio member* (>1 year)

PUBLICATIONS

Peer Reviewed Journal Articles

Smith MA and Stone NM. 2017. Split ponds effectively overwinter golden shiners. Journal of the World Aquaculture Society. in press. doi: 10.1111/jwas.12398

Peer Reviewed Journal Articles (in Preparation)

Smith MA, Roy LA, Kelly AM, Thompson M, Quintero H, Lochmann R, and Park J. Feeding regimes for largemouth bass at high summer temperatures.

Selected Extension Newsletter Articles

Smith MA. 2017. Temperature effects on growth and metabolism of fishes. *Buckeye Aquafarming*. 2(2) 5-6.

Smith MA. 2016. Testing your water quality and maintaining good records. *Buckeye Aquafarming*. 1(1): 7-9.

Smith MA and Stone NM. 2016. Winter Golden Shiner production in a split-pond system. *Arkansas Aquafarming*. 33(1): 1-2.