OHIO STATE UNIVERSITY EXTENSION

Buckeye Aquafarming

Ohio State University South Centers

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Upcoming Events

OH Fish and Shrimp Festival
Urbana, OH
September 15-17, 2017
fwfarms.com/festival

Farm Science Review
London, OH
September 19-21, 2017
fsr.osu.edu

Getting Into Urban Aquaponics
OSU Extension
Cleveland, OH
October 28, 2017

Aquaponics Association Conference
Portland, OR
November 3-5, 2017
aquaponicsassociation.org

OSU/OAA/NCRAC
Fish Health Workshop
Reynoldsburg, OH
November 11, 2017

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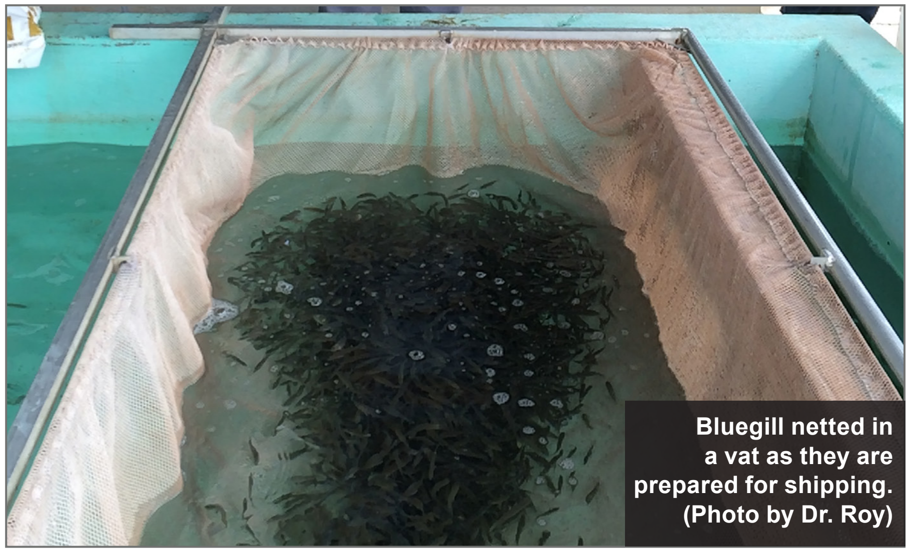

Bluegill netted in a vat as they are prepared for shipping. (Photo by Dr. Roy)

Feeding strategies for overwintering centrarchids in earthen ponds

By Luke A. Roy, PhD[1]; Matthew A. Smith, MS[2]

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Farmers raising centrarchids, such as largemouth bass, bluegill, hybrid bluegill, crappie, and redear sunfish in production ponds are often forced to hold juvenile fish over the winter months in order to meet market demand the following spring. This can be problematic as mortality of juvenile fish over the winter months is a phenomenon that has been documented in both farmed and natural systems. Juvenile fish often have higher winter mortality rates than their larger counterparts.

Mortality of juvenile fish over the winter can be due to many factors which include fish size, food abundance (winter feeding practices in farmed ponds), temperature, disease, water quality, and predation. Many fish species store energy over the summer for use during winter months, and if sexually mature, gonad growth the following spring. In an artificially supported ecosystem (farmed pond), it's necessary to provide extra energy in the form of feed to increase the likelihood of energy storage for winter months. *(continued on page 2)*

Feeding strategies... *(continued)*

Juvenile fish, particularly those less than 3 inches in total length, are particularly susceptible to winter mortality and should be fed over the winter in order to survive as they do not have sufficient energy reserves to last the colder months. There is even some literature that suggests that juvenile fish suffer more during mild winters, particularly when water temperatures are between 40-50 °F. Recent studies carried out on overwintering juvenile centrarchids (< 3 inch total length) in Arkansas (bluegill, hybrid bluegill, coppernose bluegill, hybrid crappie, and redear sunfish) revealed that regardless of feeding once per month, once per week, or twice per week, large weight loss was observed in all species when held at a constant low temperature during simulated winter months. Of the fish examined, hybrid bluegill lost the least amount of weight (14-18% body weight) over the winter, while redear sunfish lost the most (30-35% body weight).

Figure 1. Small juvenile fish (less than 3 inches in total length) that overwinter in earthen ponds, such as this coppernose bluegill, have a higher percentage of mortality than larger juveniles. (Photo by Dr. Luke A. Roy)

(Photo by Dr. Luke A. Roy)

In order to avoid losses due to cold winter temperatures farmers need to target a larger size juvenile fish prior to the arrival of winter. That is, avoid going in to the winter with a pond full of fish less than 3 inches in total length. While this seems intuitive, this situation unfolds on some commercial farms frequently. For farmers that are spawning their own fish on site, care should be taken to ensure that fish have food available in the pond (via natural productivity) or offered a quality commercial feed to achieve the growth necessary prior to the winter months. Many farmers raising centrarchids choose to feed train (feed habituate) centrarchids in order to be able to use a commercial feed to attain faster growth prior to the winter months. It might be worth using a feed with slightly higher fat content in the fall months to allow fish to build up reserves over the winter months. While the commercial feed will likely be more expensive, in some scenarios it could be worth the investment to avoid excessive winter fish losses.

For farmers that purchase fingerlings from hatcheries, purchasing a larger fingerling may have advantages if you are going to hold fish in ponds over the winter. If small fingerlings (1-2 inch) are to be purchased, they should be obtained as early as possible to allow time for growth over the late spring and summer months to achieve a larger size prior to winter.

While some level of winter mortality is unavoidable, appropriate farm management regimes can help minimize these losses and in some cases keep them from being catastrophic.

Winter mortality has always been a part of fish farming in temperate regions of the United States. While some level of winter mortality is unavoidable, appropriate farm management regimes can help minimize these losses and in some cases keep them from being catastrophic. While feeding a commercial feed over the winter when weather and water temperatures permit is a strategy employed by farmers, fattening fish in the summer and fall months may also be a good strategy to reduce weight loss and improve survival of centrarchids overwintered in earthen ponds.

As with many aspects of farming, there will be tradeoffs to consider with a change in management practices. An increase in length is also likely to occur when attempting to fatten a fish in the summer/fall months so that they will be hardier going into the Ohio winter months. The farm manager must decide which management practice would improve the business most, and there is likely to be a combination of practices on the same farm so that survival is increased in some ponds and desired length for the spring market is maintained in other ponds.

New integrated aquaponics system at BGSU

By Kevin Neves, PhD, Instructor of Biology, Bowling Green State University

The idea of growing multiple species of organisms together is not novel. This practice, often called polyculture, originated in China thousands of years ago. Polyculture typically relies on growing various species of fish that feed on different organisms in a fertilized pond. Phytoplankton utilize the nitrogen from applied fertilizer (organic or inorganic) and provides the basis for a diverse food chain, stimulating growth of multiple species of marketable products.

Aquaponics, the practice of growing fish alongside vegetables due to active bacterial communities, is an offshoot of polyculture. The ammonia produced from the fish is broken down by bacteria to provide nitrogen for the plants being grown. The plants remove the nitrogenous wastes, which can be toxic to fish at high levels, depending on the form. While the nitrogenous wastes are removed and other essential plant nutrients are further broken down, there are still solid wastes in the form of uneaten food and feces that often must be removed from these systems.

One way some farmers and hobbyists remove or limit solid waste accumulation in their systems is through the utilization of Integrated Multi-Tropic Aquaculture (IMTA) systems. First practiced by John Ryther at Woods Hole Oceanographic Institute in the 1970's and further refined and named by Thierry Chopin and Jack Taylor in the early 2000's, IMTA is the practice of using the byproducts of one species to feed other species, often on lower trophic levels. In saltwater, this is typically achieved by placing organic filter feeders such as mussels or scallops, around the perimeter of a salmon netpen. In addition to the shellfish that filter the water, kelps and other marine algae can be placed around the netpen to further bioremediate the water by reducing organic and inorganic nutrients produced by both the fish and the filter feeders.

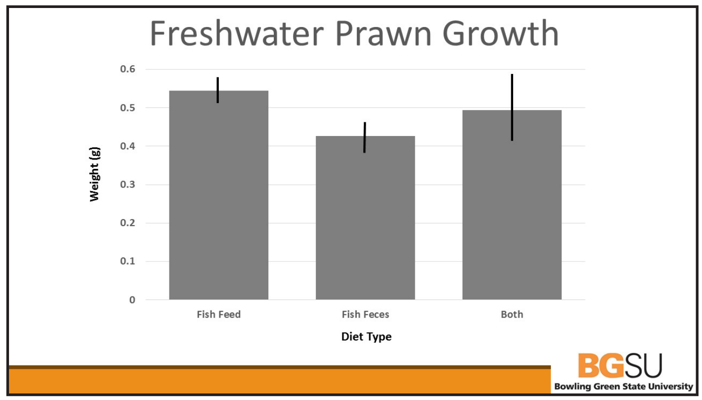

Figure 1. Freshwater prawn growth (in grams) when fed either fish feed, fish feces, or a combination of both source waters.

There are many benefits to incorporating other trophic levels of organisms into a single system. By creating a balanced system, it has been shown to improve economic stability, improve output, lower overall costs, diversify products, and reduce the risk of crop loss due to factors such as disease or equipment failure (Ridler et al. 2007). Additionally, there is often much less environmental impact, especially when compared to a traditional netpen or even a typical recirculating system. Sustainability is growing in importance both to farmers and consumers. The IMTA is a more environmentally conscientious production method that should also have higher social acceptability.

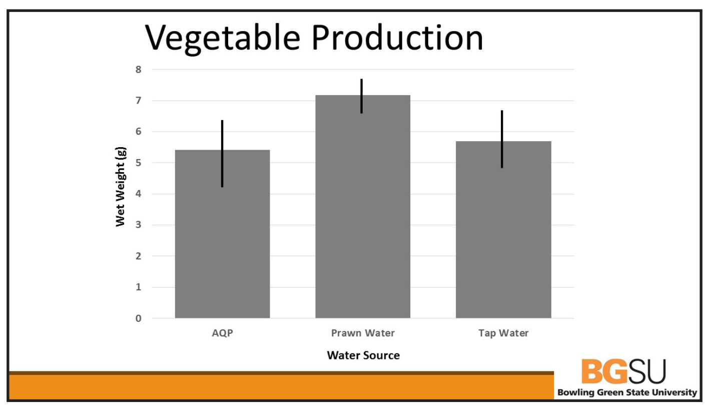

Figure 2. Growth (in grams) of green leaf lettuce grown in an aquaponics system (AQP), or grown in soil and watered with water from the prawn tanks or tap water.

With all of this in mind, we set out to set up a land-based IMTA system in the greenhouse on the campus of Bowling Green State University (BGSU). Smaller pilot trials in 2016 were successful in showing that freshwater prawns *(Macrobrachium rosenbergii)* will grow well on a diet of uneaten feed and fish feces (Figure 1). These trials also demonstrated after consuming the mixture of fish feed and feces there were sufficient nitrogenous wastes generated to support plant growth when compared to plants grown in soil and watered with tap water or water from the prawn tanks (Figure 2). *(continued on page 4)*

New integrated aquaponics system...*(continued)*

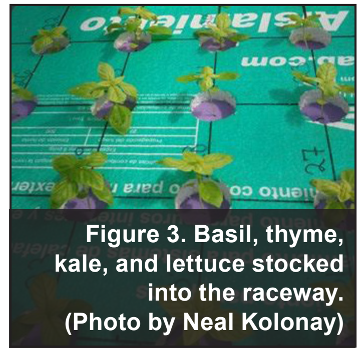

Figure 3. Basil, thyme, kale, and lettuce stocked into the raceway. (Photo by Neal Kolonay)

In our setup, the A in IMTA stands for Aquaponics. Construction started May 2017 and was completed by June. It is a simplistic system design with three 250-gallon polyethelene tanks, connected to a common side drain line. The drain line gravity feeds the raceway which was constructed from a plywood frame and a custom-made vinyl pool liner via ½" polyvinyl chloride (PVC) valves to ensure even distribution of water (Figure 4). A drain at the end of the raceway leads to a sump composed of polyethelene rain barrels. The water is then pumped from the sump to the tanks via a ½ HP centrifugal pump. A Delta Star DS-7 inline air-cooled ¾ HP chiller, on a separate loop, is used to keep the water temperature in our desired range.

Figure 4. System setup with 250 gallon tanks, the side drains, and raceway with inlets delivering water to the plants. (Photo by Neal Kolonay)

Figure 5. Lana Neff (left) and Neal Kolonay (right) stocking juvenile yellow perch into the system. (Photo by Dr. Kevin Neves)

In early June 2017, the system was stocked with 200 juvenile yellow perch *(Perca flavascens)* in the first two tanks and 100 juvenile freshwater prawns in the last tank. Fifty seedlings of four different crops (green leaf lettuce, kale, basil, and thyme) were stocked into the raceway using 2" foam discs set within a 2" Styrofoam sheet (Figure 3). The perch are fed twice daily with a commercially available diet (Zeigler, 40% protein; 10% lipid) and each afternoon, the feces and uneaten feed are purged from a bottom drain on each of the first two tanks, measured volumetrically, and fed to the prawns. The trial is scheduled to run for one year to assess feasibility.

Of interest in the development of this project is to track how water quality parameters, particularly ammonia, nitrite, phosphorus, and pH change over time compared to a standard aquaponics system. To assist in the data collection, there are two undergraduate students working on the system over the summer. BGSU Marine Biology Juniors Neal Kolonay and Lana Neff were recipients of two Center for Undergraduate Research and Scholarship (CURS) Summer Grants (Figure 5). Neal and Lana are monitoring water quality over the summer, as well as measuring the growth of the perch, prawn, and vegetables to assess biological feasibility.

The IMTA system at BGSU provides an excellent opportunity to demonstrate the basic principles of aquaculture and aquaponics.

The IMTA system at BGSU provides an excellent opportunity to demonstrate the basic principles of aquaculture and aquaponics. It will be a cornerstone of a BGSU course being developed on sustainable food production. Additionally, the greenhouse is host to hundreds of students of all ages from grade school to BGSU students and serves as a functional demonstration facility. Lastly, the system will be run the entire academic year, which will provide undergraduate students with hands-on work experience in aquaculture, which will give BGSU Marine Biology students additional work skills and make them more qualified when they graduate and enter into the workforce.

For more information, or to schedule a tour of the BGSU IMTA system, please contact Dr. Kevin J. Neves at (419) 372-4835 or at kneves@bgsu.edu.

Suggested Readings and References:

Ridler, N., Wowchuk, M., Robinson, B., Barrington, K., Chopin, T., Robinson, S., Page, F., Reid, G., Szemerda, M., Sewuster, J., and Boyne-Travis, S. 2007. Integrated Mutli-Tropic Aquaculture (IMTA): A Potential Strategic Choice For Farmers. Aquaculture Economics and Management 11:99-110.


(Photo by Matthew A. Smith)

Temperature effects on growth and metabolism of fishes

By Matthew A. Smith, Extension Aquaculture Specialist, The Ohio State University

Many factors affect the growth and metabolism of fishes and there are species dependent considerations, although only temperature in a general sense will be addressed here. Humans are homeotherms, meaning we have the ability to self-regulate our body temperatures independent of the environment. However, fishes are referred to as poikilothermic animals; having body temperatures dependent on the environment.

This differentiation is why water temperature, at least partially, dictates how much feed can be added to a system and readily consumed by fish. If given time to equate, the temperature of the fish will be the temperature of the water. Standard metabolism in fish is the minimum energy required to stay alive. Maintenance ration is the minimum ration required to cover all costs in their energy budget (the energy required to swim, digest food, excrete waste, reproduce, etc). Maximum ration is the highest % body weight of feed that will be consumed at a given time. All three (standard metabolism, maintenance ration, and maximum ration) change according to the temperature. Growth will be maximized when there is the largest gap between the maintenance and maximum ration.


(Photo by Dr. Luke A. Roy)

Water temperature that is too low (species dependent) will cause a decrease in standard metabolism and maximum ration and will result in lower feeding activity, resulting in slower growth. Water temperature that is too high (species dependent) will cause a sharp increase in standard metabolism and maintenance ration, resulting in severely stressed animals. If an optimal situation is desired then the temperature of the water should be warm enough that the metabolism of that fish is high but not so high that the fish will become severely stressed. If water temperature is optimal (assuming all other factors are optimal as well), the increase in metabolism will increase the amount consumed and lead to an increase in growth.

Consistent optimal situations are not generally found in culture ponds in Ohio due to the shallowness of the culture environment and the diurnal and seasonal fluctuations (i.e. temperature changes). Considerable tradeoffs can be found between pond culture and indoor recirculating aquaculture systems. One reason recirculating systems have expanded in interest is due to the ability to keep temperatures optimal for a particular species throughout the culture period. Decreasing a fishes' time to market by consistent feed consumption in an indoor system is often compared to the additional expenses of keeping the temperature, and all other biological factors, optimal. While the outdoor environment is not optimal year-round or even daily, costs of production are often viewed lower in culture ponds. *(continued on page 6)*

Temperature effects on growth and metabolism of fishes *(continued)*

In an aquaponic system, plants bring in the greatest revenue and best assist with positive cash flow compared to the fish. It is not uncommon to have the temperature of the water slightly less than optimal for the fish so that there is optimal plant and bacteria growth. In order to be more economical, a tradeoff often seen is sub-optimal water temperatures for the fish in order to have optimal water temperatures for the bacteria and plants; which decreases the time to market for the plants. Sub-optimal for the fish does not mean that the fish are stressed or that there cannot be substantial fish growth as well but instead means that growth could occur more efficiently at the optimal temperature. Temperatures too far away from optimal can lead to stress, which would impact plant growth and could impact food safety in an aquaponic system.

Commonly cultured species outdoors in Ohio include several species of centrarchids (which include largemouth bass and bluegill), yellow perch, and rainbow trout; all of which have their own optimal growth temperature and preferred temperature ranges (Coutant et al. 1977). It is also generally understood that a species may have optimal and preferred temperatures different than the same species from a higher or lower latitude or even longitude. One example would be largemouth bass, which are now currently found throughout North America and numerous generations in a specific location have led to preferences different depending upon the location.

Largemouth bass are listed as having an optimal growth temperature of 79.9 °F based on several Canadian studies compiled by Hasnain et al. 2010. However, several studies from the United States (Coutant 1977) have listed the final preferred temperatures of largemouth bass to be 80.6 – 86.0 °F. Due to adaptation over time, it appears beneficial to source high-quality fingerlings that are preferably from a location similar to the purchasing farm's location.

While constant optimal temperatures lead to the greatest growth, substantial growth will still occur within the larger preferred range. However, rapidly fluctuating temperatures, especially those that are outside of the preferred range, are stressful and can lead to chronic stress and poor growth. The fishes' metabolism fluctuates concurrently with the changing temperatures, which complicates feeding practices for farm managers. Temperature should still be monitored during the winter months in Ohio. Warm stretches overwinter are believed to be crucial moments that fish should be fed due to the increased maintenance requirement that follows warmer temperatures.

Understanding a species' metabolism and temperature preferences is imperative to achieving optimal growth.

Like humans, fish have energy debts that must be paid prior to growth. Optimal temperatures can contribute to the greatest amount of revenue (leftover energy after paying all debts) available for growth. Stress due to water pollution, swimming activities, predators, poor diets, etc. are all additional factors that can affect growth.

Understanding a species' metabolism and temperature preferences is imperative to achieving optimal growth. There are additional considerations for weathering harsh Ohio winters with small fish that are discussed in "Feeding strategies for overwintering centrarchids in earthen ponds", a Buckeye Aquafarming article found in this volume. Contact the OSU South Centers Extension Program for more information on metabolism and how temperature affects specific species.

Suggested Readings and References:

Biology and Ecology of Fishes. 2nd edition. ed. James S. Diana.

Coutant, C.C. 1977. Compilation of Temperature Preference Data. Environmental Sciences Division Publication. No. 998. pp. 739-745.

Hasnain, S., Minns C.K., and Shuter, B.J. 2010. Key Ecological Temperature Metrics for Canadian Freshwater Fishes. Climate Change Research Report CCRR-17.

Nutritional Bioenergetics in Fish. Chapter 2. Food and Agriculture Organization.

Wismer, D.A. and Christie A.E. 1987. Temperature Relationships of Great Lakes Fishes: A Data Compilation. Great Lakes Fish. Comm. Spec. Pub. 87-1. 165 p.

OSU/OAA/NCRAC fall workshop on fish health

By Matthew A. Smith[1], Jordan Maxwell[1], Bill Lynch[2]

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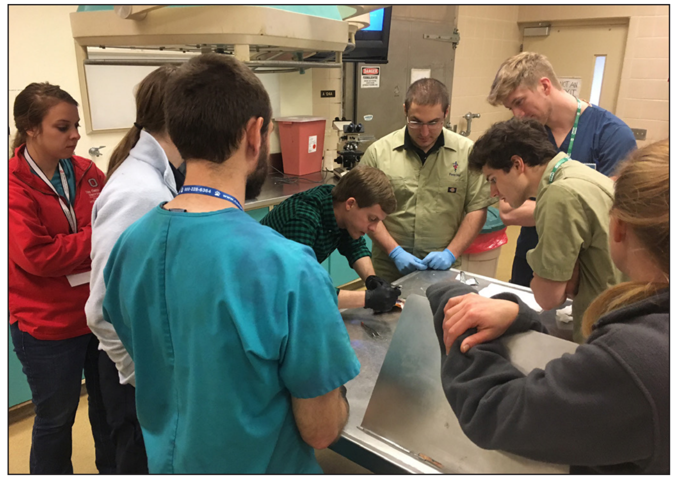
*[2]Millcreek Perch Farm,
President of the Ohio Aquaculture Association*



Veterinarian students from around the country learning basic fish anatomy in Ohio from Dr. Stephen Reichley earlier this year. (Photo by Matthew A. Smith)

The Ohio Aquaculture Association and Ohio State University South Centers' Aquaculture Boot Camp will be co-hosting the fall Fish Health workshop in Reynoldsburg, Ohio at the Ohio Department of Agriculture. November 11th, a Saturday, will consist of both formal presentations and hands-on experience. Fish dissection and the information all farmers should know, best management practices in fish health and biosecurity, disease prevention, and fish stress management will be some of the topics covered. The OAA has secured Dr. Kathleen Hartman, Aquaculture Program Leader for USDA-APHIS, Dr. Mark Flint, Clinical-Assistant Professor in the College of Veterinary Medicine at OSU, and Dr. Stephen Reichley, Directory of Fish Health at Clear Springs Foods in Buhl Idaho for the fall workshop. This combination of veterinarians should prove useful to not only new and beginning farmers, but also to those with substantial experience in the industry. With their enthusiasm and diverse background (state, federal, and private industry) we believe they will champion a successful educational workshop that will prove beneficial both intellectually and financially for the farmers present. Agenda specifics are still being finalized but the date and location have been secured. We hope to see you all there.

Many thanks to Miss Sarah Strausbaugh, Program Assistant, for her design skills on this newsletter. Thanks also to Mrs. Joy Bauman, Publication Editor, for assisting me with article reviews.

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