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Aquaculture Pioneer and Arkansas Native, Jim Malone Jr. Dies

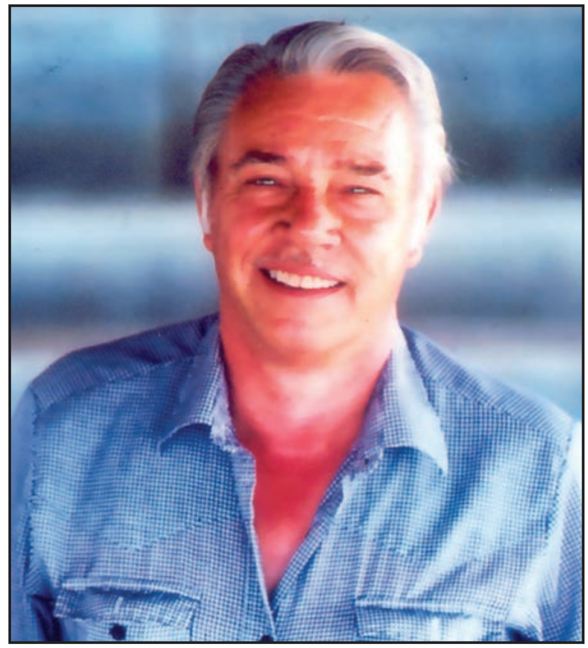
Anita M. Kelly, Extension Fish Health Specialist, UAPB

Arkansas aquaculture pioneer, **James Miller Malone Jr.** of Lonoke, Ark. passed away peacefully Sunday, April 27. He was born Sept. 30, 1926 in Little Rock, Ark. to Adele Willson Malone and James Miller Malone Sr.

Jim M. Malone Jr. is recognized as a pioneer of commercial warmwater fish production in the United States. Jim and his father, Jim M. Malone Sr., began J. M. Malone & Son Enterprises in 1952, a fish farming entity that still operates as a family business today. His achievements in the aquaculture industry were many. Jim was instrumental in many key pieces of legislation to further the aquaculture industry.

In 1956, Jim was elected president of the Arkansas Fish Farmers Association. This same year, he began his crusade to enable fish farmers in Arkansas to raise and sell game fish. Jim was ultimately successful when then Governor Faubus signed a bill permitting registered fish farmers the right to raise and sell game fish in Arkansas. In 1960, Jim was instrumental in persuading U.S. Senator J. William Fulbright to introduce legislation that created the United States Fish and Wildlife Service Fish Farming Experimental Station in Stuttgart, Ark., now known as the USDA Harry K. Dupree Stuttgart National Aquaculture Research Center. He engaged in numerous other legislative battles that positively impacted aquaculture.

Jim is best known as the first producer of 100 percent Triploid Grass Carp on a commercially viable scale. In 1974 Jim's wife, Doretta, joined the company full time and pioneered the use of the Coulter Counter for rapid identification and isolation of Triploid Grass Carp. Jim headed a successful effort to stock the Panama Canal in Central America with grass carp for vegetation control in 1977 by flying his fish hauling trucks on C130 Transport planes. By 1983, J.M Malone & Son Enterprises was the World's Largest Producer of Certified Triploid Grass Carp.



James Miller Malone Jr.

Jim was active in professional aquaculture organizations, serving as president of the Arkansas Fish Farmers Association and president of the American Fish Farmers Federation. In 1999, Jim was recognized for his efforts and received the National Aquaculture Association's Joseph P. McCraren Lifetime Achievement Award for his contributions to aquaculture. His family was named Lonoke County Farm Family of the Year in 2009.

Jim is survived by his wife of 62 years, Ruby "Doretta" Malone of Lonoke, Ark., his daughter, Beverly Malone Jones, his son, Jim B. Malone, their families, and by two sisters, Libby Campbell of Harrison, Ark. and Marian Latham of Shreveport, La.

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Upcoming Events

American Fisheries Society
August 17-21
Quebec City, Canada. For more information visit: www.fisheries.org

Tenth International Conference on Recirculating Aquaculture
August 22-24, Roanoke, Va.
For information, email: aquaconf@gmail.com

Aquatic Sciences Day (for high school students)
Sept. 18, UAPB
For information, email: thurmand@uapb.edu

Aquaculture/Fisheries Field Day
Oct. 2, UAPB
For information, email: byrdc@uapb.edu

Catfish Farmers of Arkansas
Jan. 21-22, 2015
Hot Springs, Ark.
For information, email Bo Collins at cfarkansas@sbcglobal.net

Arkansas Bait and Ornamental Fish Growers Association
Feb. 12, 2015, Lonoke, Ark.
For information, call Anita Kelly at 501-676-3124

Aquaculture America 2015
Feb. 19-22, 2015
New Orleans, La.
For more information: www.was.org

Catfish Farmers of America
Feb. 26-28, 2015
Natchez, Miss.

Seafood Expo North America
March 15-17, 2015
Boston, Mass.
www.seafoodexpo.com/north-america

World Aquaculture 2015
May 26-30, 2015
Jeju Island, Korea
www.was.org

Collection of Lesser Scaup on Arkansas Baitfish and Sportfish Farms in Early 2014

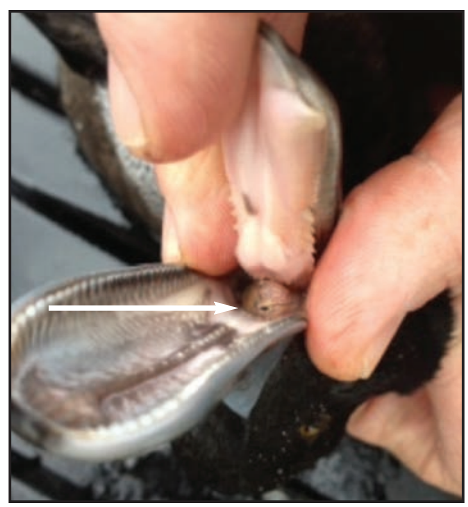
Luke A. Roy, Extension Aquaculture Specialist, UAPB
Anita M. Kelly, Extension Fisheries Specialist, UAPB
Micheal Kearby, Biological Science Technician, USDA APHIS Wildlife Services
Michael Hoy, District Supervisor, USDA APHIS Wildlife Services

Farmers in Arkansas experienced unusual winter fish losses during the winter of 2012/2013. Farmers have several different theories that might explain these losses including abnormally high temperatures in the fall of 2012, large fluctuations in pond water temperature observed in the fall of 2012, an abnormally long winter and increased predation by ducks (particularly diving ducks such as lesser scaup, Aythya affinis). Some farmers also speculate that reduced feeding at their farm during the fall months due to increased feed prices, coupled with a colder and longer than normal spring, could have been an additional contributing factor. Other farmers suspect that potentially fungicides could have contributed to increased mortality.

Currently, Extension personnel at the University of Arkansas at Pine Bluff (UAPB) are conducting several studies to examine unusual winter fish losses in Arkansas. To investigate the duck issue, in Feb., a study was initiated by UAPB and USDA Wildlife Services to examine the impact of lesser scaup on baitfish and sportfish operations in Arkansas. In the Fall of 2013, Migratory Bird Scientific Collection Permits were granted for Feb.–March 2014 from the U.S. Fish and Wildlife Service (USFWS) and the Arkansas Game and Fish Commission (AGFC). Efforts are underway to collect 200 lesser scaup during this period, which is immediately after the duck hunting season ends in Ark. (Figure 1).

In this preliminary study lesser scaup will be dissected in order to quantify the size and number of fish they are consuming. All ducks will be processed at the Lonoke Fish Disease Laboratory. Preliminary data generated from this work will also be used to pursue additional funding for this effort through extramural sources. Micheal Kearby, with USDA APHIS Wildlife Services, is leading the effort to collect scaup in the field assisted by UAPB Extension personnel. Fish farmers, as well as USDA Wildlife Services, have noted that there do not appear to be quite as many lesser scaup on Ark. baitfish and sportfish farms compared to Feb. and March of 2013 but they still represent a real problem.

Fathead minnow tail indicated by arrow.



Fathead minnow tail indicated by arrow.

Figure 1. Lesser scaup collected on Feb. 5, in the act of feeding on fathead minnows in a pond at a commercial fish farm in Prairie County, Ark. Ducks were collected by USDA Wildlife Services and UAPB Extension personnel under U.S. Fish and Wildlife Service and Arkansas Game and Fish Commission migratory bird scientific collection permits.

Dr. Carole Engle Receives U.S. Aquaculture Society Distinguished Service Award

Anita M. Kelly, Extension Fisheries Specialist, UAPB

Dr. Carole R. Engle, director of the Aquaculture/ Fisheries Center of Excellence at the University of Arkansas at Pine Bluff (UAPB), has received the United States Aquaculture Society Distinguished Service Award.

The award recognizes individuals who have made outstanding personal contributions to the U.S. Aquaculture Society, a chapter of the World Aquaculture Society, and/or the U.S. aquaculture industry. It emphasizes significant leadership and overall impact in research, education, Extension or industry development in the field of aquaculture.

"Dr. Engle fit all of the categories for this award," Mike Freeze, owner of Keo Fish Farms and president of the National Aquaculture Association, said. "She has taken an unknown aquaculture program at a small university to a world class center of aquaculture excellence. She has increased the level of industry support for the UAPB Aquaculture Center from nonexistent to the highest level."

Dr. Kevin Hopkins, president, U.S. Aquaculture Society, presented the U.S. Aquaculture Society Distinguished Service Award to Dr. Carole R. Engle, Director of the Aquaculture/ Fisheries Center of Excellence, University of Arkansas at Pine Bluff. Photo courtesy of Fish Farming News/Rick Martin photos.

Under her leadership, the UAPB Aquaculture/Fisheries Center of Excellence developed the university's first research-based Master of Science program and its first doctorate program. She has taught 14 different graduate and undergraduate courses related to agricultural economics and aquaculture.

Dr. Engle's research focus is catfish production economics and farm management, catfish marketing, optimal management of catfish farms, aquaculture economics and marketing. She has published four books, 105 refereed journal articles, 46 book chapters and monographs, 19 proceedings and 78 Extension publications.

Her economic-based research related to effluent guidelines, food safety and inspection services, invasive species, federal assistance programs, and risk management programs, has been especially significant.

"Because of Dr. Engle's efforts, UAPB's Aquaculture Center has become 'the go to place' for numerous federal and state regulatory agencies whether they are dealing with disease outbreaks of Viral Hemorrhagic Septicemia (VHS) and Spring Viremia of Carp (SVC) or if they need economic data to justify their proposed actions," Ted McNulty, Director of aquaculture, Arkansas Department of Agriculture, said.

Dr. Engle serves on many advisory councils including the U.S. Secretary of Agriculture Advisory Committee, the Monterey Bay Aquarium Science Advisory Board, the Joint Subcommittee for Aquaculture's Task Force on Aquaculture Effluents, the U.S. Fish and Wildlife Service's Asian Carp Working Group, Steering Committee for the U.S. Department of Agriculture Catfish Forum, and Technical Committee for the Southern Regional Aquaculture Center.

She currently serves as the editor or lead editor for the leading journal in aquaculture economics, associate editor for two other journals, and as a reviewer for more than 20 different scientific journals and funding programs.

She is only one of two people to have twice received the Joseph McCraren Award from the National Aquaculture Association. She was the recipient of the Researcher of the Year Award from the Catfish Farmers of America, the Distinguished Service Award from the Catfish Farmers of America, Service Award from the from the Catfish Farmers of Arkansas, USDA Service Award for service on the Joint Subcommittee for Aquaculture Effluents Task Force, and the Harvey McGeorge Award of Distinguished Contributions to Agriculture.

Bauer Duke is New Extension Aquaculture Specialist

Bauer Duke is the new Extension Aquaculture Specialist with the Aquaculture/Fisheries Center of Excellence at the University of Arkansas at Pine Bluff. In this position, he will provide Extension educational programming to high school teachers who wish to integrate aquaculture into their curricula, to water gardening enthusiasts and to the commercial aquaculture industry.

Duke first joined the Aquaculture/Fisheries Department in 1997 as manager of the Aquaculture Research Station where he maintained 113 research ponds and several research buildings, coordinated research facilities and activities and provided public awareness through station tours and events open to the public. During that time he worked with the Department's teaching faculty, researchers and Extension specialists.

Duke received his bachelor's degree in microbiology from Arizona State University. He began his career in aquaculture working with tilapia in the Central African Republic. He received a master's degree from the University of Oklahoma and worked for two years in Mali as an aquaculture consultant to various organizations including the Peace Corps, World Vision and Africaire. He returned to the United States to work on a tilapia farm in California in 1993 where he served as hatchery manager. He has also provided volunteer aquaculture services in Bangladesh, Haiti, Zambia and Kenya.

Duke is a member of the World Aquaculture Society, the Aquacultural Engineering Society and Catfish Farmers of Arkansas. His awards include the Catfish Farmers of Arkansas Service Award and the President's Volunteer Service Award.

eDNA: Implications for Aquaculture

Nathan Stone, Extension Fisheries Specialist, UAPB
Reprinted from the Colorado Aquaculture Association, April 2013, "The Fish Line", Volume XV, No.1.

Most everyone is familiar with DNA, or deoxyribonucleic acid, the genetic material within organisms that can be used to identify species (and individuals). In crime shows and in real life, DNA evidence from bodies and bodily fluids can identify the guilty party. DNA is also used to identify fish species, revealing that in many cases, the red snapper being served in restaurants is really a cheaper fish. DNA can even be used to identify the fish species that were used in making the fish meal in a fish feed.

So what is eDNA? eDNA is short for environmental DNA, DNA that can be extracted from soil, air or water, either within shed cells (e.g., dandruff, fish scales) or outside of cells (extracellular), such as dissolved DNA in water. While we may think of DNA as being fragile and easily destroyed, in fact extracellular DNA is common in freshwater and oceans, and can accumulate in sediment. Using polymerase chain reaction (PCR), fragments of DNA that are unique to a specific organism can be amplified, providing a method to detect the organism in the environment even if it is rare and hard to find using conventional methods. Fish shed DNA in slime, feces, urine and scales. DNA in the environment is degraded at varying rates depending upon numerous factors. The incredible part of eDNA is that this method can detect a relatively few segments of DNA from a particular species in a vast 'soup' of DNA from the many different organisms present in an environment.

Currently, sample collection and analysis using conventional PCR requires up to two weeks for test results. Use of quantitative PCR methods can reduce this by half or more. In the future, rapid methods for field testing may become a reality. Given the extreme sensitivity of this method, great care must be taken at every step to avoid contamination. False positives (test indicates that DNA is present when it actually is not there) and false negatives (test indicates that DNA is not present when it actually is there) are a reality. For example, a number of common substances in environmental samples can act as PCR inhibitors, leading to false negatives.

eDNA is being used for research and monitoring purposes, and has been proposed as a tool for regulation. An increasing number of research studies on various applications for eDNA are being published, ranging from invasive and endangered species detection, to estimating fish biomass, and for food habit studies. Detection methods for Asian carp eDNA were first developed by the Lodge lab at the University of Notre Dame. eDNA methods are currently being used for monitoring purposes, for example, to check for Asian carp in the upper Mississippi and Chicago Area Waterway, and for detection of zebra and quagga mussels in western reservoirs. Bait shops have also been checked for Asian carp using eDNA. Use of eDNA to monitor for didymo and New Zealand mud snails is also being studied. At least one state department of natural resources has proposed using eDNA to test aquaculture farms and hauling trucks for prohibited species.

Given harsh penalties possible under the Lacey Act, fish farmers are understandably concerned about premature use of eDNA for regulatory purposes. Three major concerns are: 1) detection of eDNA does not mean that a live organism is present; 2) false positives are to be expected, and 3) detection assays should first be stan-

continued on page 5

dardized and validated, laboratories should be accredited, and laboratory performance testing should take place.

Research results presented in a February 2013 interim report of the Environmental DNA Calibration Study (ECALS) highlighted the existence of numerous possible sources of eDNA other than live fish. This means that positive eDNA results do not always mean that the live organism is present. For example, vessel hulls were found to have considerable amounts of adhering DNA, even on boats that had been transported overland. Fishing nets were another major source, although additional testing is needed given some apparent contamination during testing. Fish-eating birds were shown to be potential sources of Asian carp eDNA; feces of birds fed a meal of silver carp had positive eDNA for up to a week afterwards. Silver carp DNA was detected for up to 30 days in bird droppings on metal sheets exposed to temperatures up to 140°F. Throat and cloacal samples from some cormorants collected for tagging tested positive for silver carp DNA. Positive hits were also obtained from sediment and river bank samples. Storm sewers outside of fish markets were also possible sources of Asian carp eDNA.

Rates of false positives and negatives must be considered. An article by Frischer et al. in the December 2012 issue of “Lake and Reservoir Management” compared the accuracy and reliability of three methods for detecting zebra and quagga mussel larvae in plankton samples. Spiked samples (containing known numbers of actual larvae, not just eDNA) were sent to 11 participating laboratories for PCR detection. Overall, PCR was the least accurate method (compared to microscopy using cross-polarized light, and an automated method), with a 75.8% accuracy rate and 7.1% false positives. Darling and Mahon (2011) provide an excellent overview of the benefits and challenges in using eDNA for monitoring. They describe what is called the false positive paradox; when used for detecting very rare organisms, even highly specific DNA-based methods could give misleading results when the detection rate is near or below the false positive rate. The paper makes clear that managers should understand possible sources of error when using eDNA methods.

The Invasive Species Advisory Committee (ISAC), a team of nonfederal experts and stakeholders who provide advice to federal agencies through the inter-agency National Invasive Species Council (NISC), released a white paper in May 2012 on PCR-based assays for eDNA detection of aquatic invasive species [In the interests of full disclosure, I currently serve on the ISAC]. The white paper recommendations to NISC were:

1. Encourage and develop funding for the National Academy of Sciences to undertake a review of the reliability and effectiveness of PCR and other DNA-based applications for detecting AIS, focusing on establishment of appropriate validation processes and a framework and standards for this new and potentially invaluable tool in the early detection, eradication, prevention and control of AIS.
2. Establish and fund an ongoing independent performance testing program for laboratories utilizing DNA-based AIS detection methodologies such as that recently undertaken for evaluating laboratory performance in PCR detection of dreissenid mussel larvae (Frischer et al. 2011). Testing results should be made public so that managers may make informed decisions about the accuracy and reliability of a laboratory's performance when including an eDNA component in an AIS monitoring and early detection system.
3. Utilize lessons learned in establishing a laboratory performance testing system to fully develop a validation/accreditation program(s) for other invasive species eDNA methodologies and laboratories.

In summary, eDNA has tremendous potential as a research tool, and with appropriate safeguards, for monitoring purposes. However, research demonstrates the potential for positive eDNA results when live organisms are not present, and unknown rates of false positives and negatives. Therefore, before eDNA is used for regulatory purposes, methods should be standardized, test assays validated, and laboratories accredited and subject to independent performance testing.

Darling, J. A., and A. R. Mahon. 2011. From molecules to management: Adopting DNA-based methods for monitoring biological invasions in aquatic environments. Environmental Research 111(7):978-988.

Links for more information:
The U.S. Geological Survey has a 2013 fact sheet on eDNA at: http://pubs.usgs.gov/fs/2012/3146/

Results from the Environmental DNA Calibration Study (February 2013) can be obtained at: http://www.asiancarp.us/ecals.htm

EPA web page on: “Understanding and managing errors inherent in ever-evolving DNA-based methods”: http://www.epa.gov/nerl/features/dna.html

The Invasive Species Advisory Committee (ISAC) white paper on validation of PCR assays and laboratory accreditation for environmental detection of aquatic invasive species (May 2012) can be obtained at: http://www.invasivespecies.gov/ISAC/White%20Papers/ISAC_PCR_WHITEPAPER_FINAL.pdf

Update on Split Pond Catfish Production

Matthew "Rex" Recsetar, Extension Aquaculture Specialist, UAPB

We now have two years of data on commercial catfish production in split ponds. For anyone not familiar with the term "split pond:" A split pond is basically a hybrid of recirculating and pond aquaculture production systems that utilizes natural processes to provide improved water quality for the fish. The concept was first pioneered by Craig Tucker at the National Warmwater Aquaculture Center at Mississippi State University. His split pond system essentially involved taking an existing catfish pond and splitting it into two sections, where a small section was used for growing fish and the remaining large portion used for biological waste treatment processes.

During the day, biologically-filtered, oxygenated water from the non-fish section is continually circulated through the fish section via a paddlewheel or pump. The original design had the fish contained in about 20 percent of the pond area via screen structures where they could efficiently be fed, harvested and aerated at night. Oxygen monitoring systems turn on water circulators when oxygen is above a set point temperature (ie. 4ppm) in the waste treatment area. Likewise, paddlewheel aerators are automatically turned on as oxygen levels drop below set points in the fish culture area (typically at night). By keeping the fish culture area relatively small, farmers are able to allocate aeration specifically to fish, without having to waste it on bacterial and algal respiration as would be the case with a larger pond area. A picture of two split ponds is to the right.

So far research verification has collected data on over 25 ponds over the last two years. All ponds in the study were stocked with hybrid catfish as single batch crops. It was quickly found out that overwintering of large biomasses of fish adversely affected survival of fish in these systems to the point that 10-20 percent of crops may have been lost. Stocking rates in split ponds have been between 9,000 and 15,000 head per acre and we are close to establishing a recommended stocking rate. Annual production has ranged from 9,000 to over 20,000 pounds per acre with an average of just over 15,000 lb/acre. Average survival has been just above 82 percent. Feed conversion ratios have averaged 2.35 and been as low as 1.88. Most split pond systems were fed an average of 200 pounds of feed per acre per day over the course of a growing season. There were many days where split ponds were fed over 300 pounds per acre and even as high as 500 pounds per acre in a single day. Water quality of these systems was measured weekly and ammonia was rarely present within the systems.

Although initial harvests have been met with some success, they have not come without drawbacks. Besides a large upfront cost, these systems can be costly to repair. In a few instances we have had paddlewheel shafts break, variable frequency drives (VFDs) burn up (sometimes due to lightening) and wing walls collapse. Maintenance can also take time. As water is circulated, various debris can get caught up against the screens and impede water flow. The debris is not limited to grass clippings and aquatic weeds as turtles and other animals often find themselves unlikely prisoners stuck up against the screens. Therefore screens must be cleaned periodically (biweekly) either by hand, rake or power washer (seems to work best). Power outages where backup generators were unavailable have proven catastrophic; there was over 50 percent mortality in one instance. Where it can take numerous aerators to keep fish alive in the late summer, a single tractor PTO likely will not be enough. Therefore it may be worth investing in backup generators for split ponds to mitigate the risk of oxygen kills due to power outages at night. It is also important to do regular maintenance on these systems which includes cleaning probes on the oxygen monitoring buoys, greasing bearings on water circulators and servicing paddlewheel aerators.

If proper steps are taken and recommendations are followed, the split pond system can be a viable option for catfish production today. Although some of the yields fell short of what we would like to see, we believe that with increased aeration in some of culture areas, production, survival and FCR may yet improve. Economic analysis of these systems has been ongoing and it is beginning to show the viability and best options of split ponds for catfish production in Arkansas. Research verification data are continuing to be collected and we continue to hone in on optimal pond size, stocking densities and circulation rates for split pond systems.

Hybrid Catfish Foodfish Production Strategies Using 5” and 7.5” Fingerlings

Patrick Rees, Graduate Research Assistant, UAPB and Carole Engle, Professor, Economics and Marketing, UAPB

Current farming practices for hybrid catfish are to culture 7” fish in a single-batch production system. Stocking a smaller hybrid catfish fingerling could possibly increase profits and reduce financial risk for farmers. This study was conducted to compare several management strategies relating to the use of smaller, less expensive hybrid catfish fingerlings.

The study was conducted in 0.25-acre earthen ponds at the Aquaculture Research Station on the University of Arkansas at Pine Bluff campus from March to October of 2012. All treatments stocked hybrid catfish as either: 1) 7.5” single-size at 4,000 head/acre; 2) 5” single-size at 4,000 head/acre; or 3) a multi-size treatment consisting of both 5” and 7.5” fish at 4,000 head/acre each (8,000 head/acre total). There were five replicate ponds of each treatment, totaling 15 study ponds.

A 28 percent protein floating catfish feed was fed once daily to satiation with a tractor type blower. Two half-horsepower floating electric paddlewheel aerators were run from dusk until dawn in each pond; this aeration was equivalent to 4 hp/acre.

Enterprise budgets were created for each treatment using average farm values from survey data reported by Engle (2012). Monthly cash flow budgets and a risk analysis were conducted using Microsoft Excel spreadsheets. Breakeven prices above total costs ($/lb) were used to compare costs of production and show relative economic benefits for each treatment. Risk analyses showed the probability of losing money for each management strategy.

Gross and net yield were significantly greater in the multi-size treatment than in the 5” and 7” single-size treatments (Table 1). However, the two single-size treatments did not differ from each other in gross and net yield. The multi-size treatment had the highest gross and net daily yield, while the 5” single-size treatment had the lowest.

Total feed fed was significantly greater for the multi-size treatment; however the quantities of feed fed in the two single-size treatments were similar. The feed conversion ratio (FCR) was not different among treatments and ranged from 1.52 to 1.61. Growth rates were 3.0-4.0 g/d and were highest for the 7.5” single-size fish and lowest for the multi-size treatment. None of the treatments were significantly different in terms of survival.

Eighty-seven percent of the 5” single-size treatment and over 25 percent of the 5” fish in the multi-size treatment reached market size in one growing season.

The per-pound cost of production (calculated based on total yield) was lowest for the multi-size treatment, and highest for the 7.5” single-size treatment. When calculated with marketable yield, the 5” fish raised in single-batch had the lowest per-pound cost of production. Cash flow analyses showed that all treatments generated enough cash to meet cash obligations, even though the 7.5” fingerlings reached market size a month before the 5” fingerlings.

The 7.5” single-size treatment had the greatest probability of losing money of the three treatments. Risk simulations showed that the 5” single-size and the multi-size treatments were less risky than the 7.5” single size treatment. Changes in yield and feed cost

continued on page 8

Table 1. Yields, mean weight, feed, and survival of single-and multi-size hybrid catfish. Values with the same letters in a row are not significantly different (P ≤ 0.05). Values are reported as mean ± SD.

Production parameters	5” single-size	7.5” single-size	Multi-size
Yields			
Gross (lb/ac)	6,308 ± 566a	6,819 ± 314a	10,521 ± 859b
Net (lb/ac)	6,158 ± 566a	6,408 ± 314a	9,958 ± 859b
Gross daily (lb/ac/d)	25.6 ± 2.3a	32.7 ± 1.5b	42.7 ± 3.5c
Net daily (lb/ac/d)	25.0 ± 2.3a	30.6 ± 1.5b	40.4 ± 3.5c
Marketable (lb/ac)	5,827 ± 578a	6,675 ± 409a	9,207 ± 840b
Percent market size (%)	87 ± 2a	98 ± 2b	77 ± 2c
Feed			
Total feed (lb/ac)	9,817 ± 565a	10,330 ± 397a	15,156 ± 1,218b
FCR	1.60 ± 0.06a	1.61 ± 0.02a	1.52 ± 0.04a
FYR	1.56 ± 0.05a	1.52 ± 0.05ab	1.45 ± 0.03b
Growth rate (g/d)	3.4 ± 0.1a	4.0 ± 0.2b	3.0 ± 0.2c
Final mean weight (lb)	1.85 ± 0.11a	1.94 ± 0.09a	1.68 ± 0.10b
Survival (%)	83 ± 5a	72 ± 4 a	75 ± 7a

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contributed the most to economic risk for all treatments.

Five-inch hybrid catfish fingerlings can be grown economically in both single and multi-size stocking strategies. A high percent of the 5” fingerlings in the single-size treatment and over 25 percent of the 5” fish in the multi-size treatments reached market size in one growing season. Smaller 5” fingerlings showed lower costs of production and risk as compared to the 7.5” single-size fingerlings. A 2013 follow-up study is underway at UAPB to determine if it is possible to harvest three or more crops over a period of two years with the multi-size stocking treatment.

Table 2. The percent chance of losing money for each treatment at three different catfish market prices.

	5” single-size	7” single-size	Multi-size
$ 0.70/lb			
Total yield	37%	72%	21%
Marketable yield	54%	83%	64%
$ 0.85 /lb			
Total yield	1%	12%	0%
Marketable yield	13%	22%	8%
$ 1.00 /lb			
Total yield	0%	0%	0%
Marketable yield	0%	1%	0%

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Arkansas Aquafarming is published quarterly. Web address: www.uaex.edu/aqfi/newsletters
The purpose is to advance aquaculture production in Arkansas by providing reliable, practical, timely information.