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Cooperative Extension Program
UNIVERSITY of ARKANSAS AT PINE BLUFF
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Winter Golden Shiner Production in a Split-Pond System

Matthew A. Smith, Extension Fish Health Associate, UAPB (Lonoke) and Nathan M. Stone, Engle-Stone Aquatic$ LLC

The split-pond system is being adopted by some farmers as an alternative production method for catfish. This system was developed at the National Warmwater Aquaculture Center in Stoneville, Mississippi by Dr. Craig Tucker and was designed to utilize existing ponds. An additional earthen levee is erected to separate a traditional pond into two unequal zones (approximately 15-20% for fish culture and the remainder for waste treatment). Culverts through the levee allow water inflow and outflow between the two zones. During the daytime hours, a pump, often a slow-rotating paddlewheel, circulates oxygenated water from the waste treatment area through the fish area and back (Figure 1). At night, the pump is turned off and aerators located within the fish culture area are turned on to provide oxygen for the fish.

There is interest in using this system for other species. Our study focused on the feasibility of overwintering golden shiners in split ponds. Winter is of particular concern because of the potential for low survival of high-density small fish. Fish within the culture unit of a split pond are held at 2,000 to 5,000 lb/acre, five times the normal density. The study was conducted at the Aquaculture Research Station at the University of Arkansas at Pine Bluff in 12, 0.10-acre ponds (6 split ponds and 6 traditional) and ran from November 1, 2013, through March 20, 2014. Ponds were located within a netted enclosure to exclude birds. Instead of using an earthen levee to create the culture unit, a welded wire (0.5 inch x 1.0 inch mesh) fence overlain with fine-mesh polyester screening (0.04 inch x 0.06 inch) was used to separate the fish culture and waste treatment sections. A slow-rotating paddlewheel (5.4 rpm) turned by a 1.5 hp gear motor pushed approximately 58,652 gpm into

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Figure 1. Barrier between the fish culture area and the waste treatment area in an experimental split pond at the Aquaculture Research Station at the University of Arkansas at Pine Bluff.

Table 1. TRAD = traditional earthen pond; SPLIT = split-pond system; Low = stocked at 575 lb/acre (150,000 fish/acre); High = stocked at 1,150 lb/acre (300,000 fish/acre). Fish at stocking averaged 261 fish/lb (1.74 g) each. Values with the same letters in a row are not significantly different ($P \leq 0.05$). Values are reported as average ± standard deviation.

		System and density			
Production parameter	Unit	TRAD Low	TRAD High	SPLIT Low	SPLIT High
Gross Yield	lb/ac	737 ± 17[a]	1,378 ± 18[b]	689 ± 31[c]	1,277 ± 48[d]
Net Yield	lb/ac	160 ± 17[a]	226 ± 18[a]	113 ± 31[b]	126 ± 48[b]
Survival[1]	%	100* ± 21[a]	100* ± 12[a]	98 ± 10[a]	100* ±16[a]
Mean weight at harvest	g	2.07 ± 0.34[a]	1.92 ± 0.19[a]	2.15 ± 0.19[a]	1.72 ± 0.33[a]
FCR[2]	ratio	2.6 ± 0.3[a]	3.7 ± 0.3[b]	3.9 ± 1.2[c]	7.3 ± 2.6[d]
Fish per lb	ratio	224 ± 37[a]	238 ± 23[a]	213 ± 20[a]	270 ± 47[a]

[1] Asterisk indicates that survival rates estimated at over 100% were reported as 100%.
[2] FCR = feed conversion ratio. FCR was calculated as total feed fed divided by net yield.

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the 3,425 ft3 culture area, with 100% water exchange occurring approximately every half-hour.

"Pond-run" (mixed sizes) golden shiners were stocked at two rates, 575 and 1,150 lb/acre (approximately 150,000 and 300,000 fish/acre, respectively). Afternoon water temperatures determined when we fed, aerated, and circulated. If afternoon water temperature was 64°F or higher, water was circulated from 10 am to 10 pm and aeration supplied from 10 pm to 10 am. When water temperature was between 64 - 45°F, ponds were circulated from 10 am to 4 pm with no aeration. Circulation and aeration were not used when water temperature fell below 45°F. Fish were fed a 32% extruded crude protein commercial floating catfish feed (1/4th-inch diameter) once daily at 1.5% of their total body weight when afternoon water temperature was 72 - 64°F. For temperatures between 64 - 50°F, fish were fed 1% of body weight. When water temperature fell below 50°F, fish were not fed. The feeding rate was not adjusted during the study.

At harvest, traditional ponds had higher yields than split ponds (Table 1). We found very low levels of larger zooplankton during the winter in all ponds, and think that the higher yields in the traditional ponds resulted from fish having greater access to other natural foods (insect larvae, etc.). Survival rates were very high (above 87%) at both densities and systems. There were no differences in average fish weight (fish/lb) between either of the densities or systems. The SPLIT High fish/lb (Table 1) appears to be higher than the initial stocking (which would indicate a loss in weight); however, net yield was still positive. This would suggest in our random sampling efforts at harvest, we recorded lengths and weights on smaller fish than what represented the pond as a whole.

In general, the fish overwintered well in both types of systems and densities. The winter of 2013-2014 was colder than normal, and temperatures remained relatively cold throughout the winter. Warmer winters or winters with rapidly fluctuating temperatures could be more stressful for fish especially for fish confined to the split ponds. The major advantage of the split-pond system is that with minnows only grown in 15-20% of the total pond area, it may be feasible to string wires over the top of the culture area to reduce bird predation.

Upcoming Events

57th Western Fish Disease Workshop, AFS Fish Health Section Meeting and 22nd USFWS Aquaculture Drug Approval Coordination Workshop
June 7-10, 2016
Jackson Hole, Wyoming
The annual meeting includes disease and aquaculture drug approval workshops. For information visit http://www.afs-fhs.org/meetings/meetings.php

International Conference on Recirculating Aquaculture
August 19-20, 2016
Roanoke, Virginia
The conference features presentations and poster sessions from leading experts in recirculating aquaculture. For more information go to: http://www.recircaqua.com/

146th Annual meeting of the American Fisheries Society
August 21-25, 2016
Kansas City, Missouri
The Missouri Chapter and North Central Division of the American Fisheries Society are hosting the meeting. This year's theme is: Fisheries Conservation and Management: Making Connections and Building Partnerships.For more information go to http://2016.fisheries.org/

Aquaculture America 2017
February 19-22, 2017
San Antonio, Texas
The International Triennial Meeting of the National Shellfisheries Association, American Fisheries Society Fish Culture Section and the World Aquaculture Society. For information contact the Conference Manager at (760) 751-5505.

Beneficial Aquatic Plants for Fishing Ponds

Scott Jones, Small Impoundments Extension Specialist, UAPB

Encouraging the growth of aquatic plants is usually not recommended in private fishing ponds because they can greatly increase the cost and labor involved in properly managing the pond. However, when properly managed, aquatic plants can provide great benefits to the water, fish, and the overall aesthetics of the pond. It usually takes a few years for a new pond to begin naturally growing higher aquatic plants (basically anything other than the microscopic planktonic algae that turn water green). It is difficult to predict which plant species will take root first, and often the ones that do are not desirable. Owners of new ponds can be proactive by planting desirable plants from the beginning. Owners wanting to establish desirable plants in older ponds should first remove any undesirable plants from the pond.

Some common characteristics of beneficial aquatic plants include shoreline stabilization, cover for fish, and controlled spread. When selecting species to plant, try to stick with plants native to Arkansas. Also, plant a variety of species. Habitat diversity is one of the factors that separate great fisheries from mediocre ones. While there is no established “magic” number for vegetation coverage, many state agencies and publications suggest that around 20 to 30% vegetation coverage is most beneficial for fisheries.

Emergent shoreline plants (those that grow up out of the water) are some of the easiest to manage because you can clearly see where they are, treat them with herbicide while walking the shoreline, and cut them down with weed-trimming equipment if the plants get too dense or if they grow in places where they are unwanted. For example, rushes (*Eleocharis spp.*) grow in tight, thick clumps near the shore and spread slowly. Additionally, most rushes do not grow very tall so they do not create a large obstacle for fishing from shore or observing the pond. Arrowhead (*Sagittaria latifolia*) is a large-leafed plant that can grow up to about 48 inches tall. Dwarf cattail (*Typha minima*), a smaller variety of its much larger cousin, only grows up to about 36 inches tall. Lizard’s tail (*Saururus cernuus*) grows up to about 48 inches tall and has a unique arching flower structure that gives off an orange-like smell. Pickerelweed (*Pontederia cordata*) grows up to about 36 inches tall and produces beautiful stems of violet-blue flowers. All of these shoreline plants help to stabilize soils which can reduce erosion and muddy water, provide a place for insects and other small organisms to live, and provide shade and cover for fish to utilize. Waterfowl will also often utilize shoreline emergent plants as nesting habitat and a safe place to forage for food. Keep in mind that waterfowl will eat some aquatic plants, arrowhead for example, so these plants may need protection until they become well established if waterfowl are frequent visitors to the pond.

Certain varieties of hardy water lilies (*Nymphaea spp.*) are bred specifically for beautiful flowers and slow spread, intended for use in small water gardens. These plants also work well in ponds. Since there are so many varieties of lilies, it is best to speak with aquatic plant retailers and Extension personnel to ensure that you are getting a slow-spreading variety that does not grow in more than a few feet of water. Avoid the similar-looking American lotus (*Nelumbo lutea*) because it spreads aggressively and can quickly overtake a pond.

Although submergent plants (those that do not grow above the surface of the water) can provide great benefits to fish, they are much more difficult to manage than emergent shoreline plants. A dwarf variety of sagittaria (*Sagittaria subulata*) has produced good results for some pond owners. This grass-like plant can create a blanket of vegetation across the entire pond bottom with sufficient light penetration. What separates the dwarf sagittaria from other submergent species is that it does not grow more than about 24 inches tall and it is usually much shorter. Other submergent species, like southern naiad, pondweeds, and coontail can grow several feet tall and create dense mats on the water surface that are nearly impossible to fish in.

Properly placing and protecting the plants will help them grow and survive to maturity. For immature seedlings, simply dig a small hole along the pond shoreline just deep enough for the roots to be covered with soil. Be sure that the plant is sitting in no more than 2 to 3 inches of water to keep from drowning it (larger more mature plants may be able to handle slightly deeper water). Piling a small mound of rocks around the base of the newly placed plant will provide some rigidity and help keep the plant from floating away. Space individual plants 12 to 18 inches apart. Closer spacing will fill in the shoreline more quickly, but will also require more plants and labor to complete. It is best to minimize water fluctuation while the plants are small to prevent drowning or drying out. Immature plants are also vulnerable to wind-driven wave action, hungry herbivores, grass carp, and common carp that like to disturb mud while feeding. It may be necessary to construct temporary wave barriers in front of newly-placed plants to give them time to secure themselves to the pond bottom. Also, rigid plastic or metal fencing may be needed to keep foraging critters and disruptive carp away from vulnerable plants. Planting can begin when water warms into the 50ºF to 60ºF range in the spring.

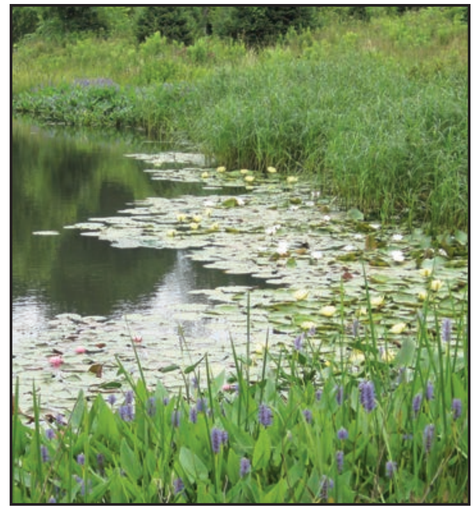

Photo courtesy of Rod and Elizabeth Herman

Ponds can be made to fit any owner’s vision of paradise. The key is diligent management and control. The beautiful lawns and landscaping around mansions, golf courses and public gardens do not fall into that condition naturally; they are constantly monitored and cared for to allow plants to grow within reasonable limits. The same is true for aquatic plants in ponds. Plant a variety of manageable native species and keep a watchful eye out for overgrowth and you can enjoy a vibrant and natural-looking pond that also fishes great!

Considerations When Using Variable Frequency Drive Technology for Pond Aquaculture

Travis W. Brown, Research Fish Biologist, USDA-ARS Stoneville, Mississippi and Matthew "Rex" Recsetar, Extension Aquaculture Specialist, UAPB

Commercial catfish farmers are intensifying production by retrofitting ponds with variations of the partitioned aquaculture system and split-ponds are the most common variation used commercially. The split-pond consists of a small fish-culture basin connected to a waste-treatment lagoon by two conveyance structures. Water is circulated between the two basins with high-volume pumps to remove fish waste and provide oxygenated water to the fish-culture basin. Some farmers have decided to use variable frequency drives (VFDs) to control pump speed and water flow rate to reduce operational cost and costs associated with repairs and maintenance. Mixed performance issues with VFDs and electric motors have been reported. Examples include frequent drive failure due to lightning strikes, overheating, and water damage to name a few.

Over half of VFD failures in industrial applications are from improper installation and start-up, and many of these problems can be avoided by reading the manual and carefully planning installation. Typically, a quick start guide is supplied with most VFDs and the main manual is located on a CD or can be downloaded from the manufacturer's website. It's highly recommended that at least one copy of the complete manual is on hand. These materials provide valuable information about the VFD before the equipment arrives to allow for careful planning. In addition, the proper start-up procedure must be followed.

Two important considerations include cooling and supply line power quality. Most VFD manufacturers do not recommend installing drives in environments where ambient air temperature is greater than 104ºF. Equipment in pond aquaculture applications is exposed to high temperatures during summer months in the south and internal temperatures of electrical enclosures can exceed the maximum. One way to reduce the temperature is to install a cooling fan with a filtered venting system (Fig. 1).

The supply line voltage to drives should not vary more than 10% for most drives. Most drives will have a protective safety feature that trips if too little or too great of a line voltage is detected. VFDs will display an error message when this occurs. Unfortunately, this is due to mass fluctuations in voltage from the power company and cannot be avoided without special electronics. However, programming the drive to automatically start-up after such an event will alleviate the manual start-up procedure in most cases. The VFD should be installed as close as possible to the supply power and the electric motor the drive will operate. It is important to use proper wire sizes based on the estimated voltage drops on each end. There are voltage drop calculators online and pocket reference manuals that make these calculations easy to perform in the field as needed.

One major concern with using VFDs in pond aquaculture applications is humidity and moisture. VFDs should be installed in a non-corrosive environment and proper electrical enclosures should be used to provide protection from the elements. NEMA 4 type enclosures are highly recommended (although more expensive than NEMA 3 type) because they are constructed for indoor or outdoor use to provide protection inside the enclosure against foreign objects (dirt, dust, rain, sleet, snow, splashing water, hose directed water, and formation of ice).

Electrical connections are also important when using VFDs and proper sizing and installation should follow recommendations made in the operator's manual, the National Electric Code, and other appropriate local codes to reduce the likelihood of drive failure. In addition, VFDs

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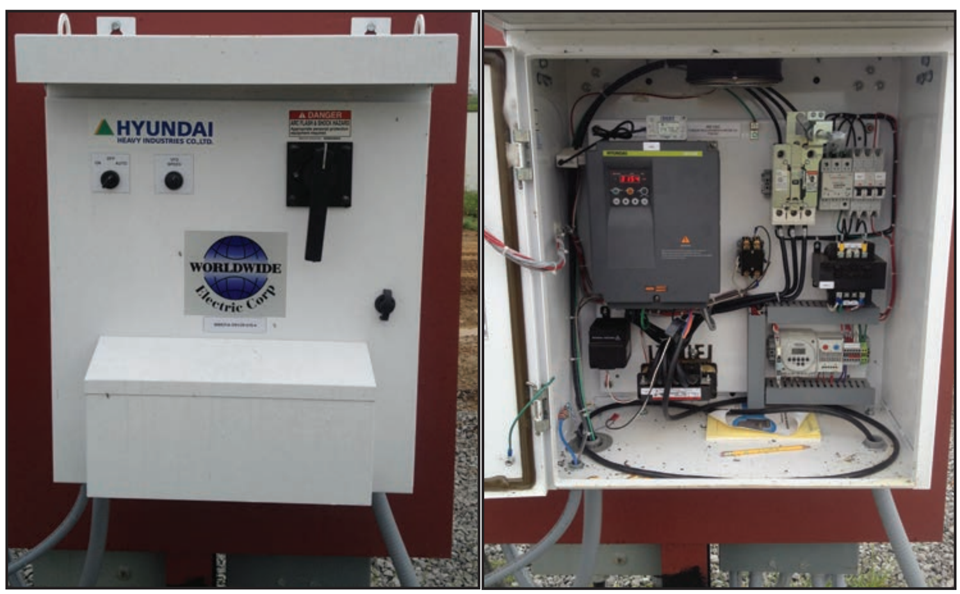

Figure 1. A complete variable speed drive package with cooling fan (top right) and filtered venting system (center to bottom left) assembled by WorldWide Electric Corporation, Pittsford, New York. The variable frequency drive is a Hyundai (Model N700E) capable of operating a 15-hp, three-phase electric motor. Mention of trade names or commercial products in this publication is solely for the purpose for providing specific information and does not imply recommendation or endorsement by the U.S. Department of Agriculture.

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should be grounded properly for safe and dependable operation. In general practice, a grounding conductor is brought back to a single point grounding location (usually at the service). In addition, a grounding conductor must be brought back from the electric motor to the VFD's internal grounding terminal. Grounding minimizes interference between the VFD and electric motor, and allows the ground-fault protection function of the drive to operate properly.

Fault and motor protection are other important variables to consider when using VFD technology. All electric motors should have overload protection via a motor overcurrent relay system. In the case of using three-phase power, these systems will protect all three phases and prevent single-phasing, which can damage motors. This system will also protect against over-current conditions if a motor is overloaded, but it will not detect over-temperature conditions. Since overheating due to inadequate airflow can result in thermal breakdown of the motor windings insulation, VFD manufacturers recommend a minimum speed of 30% of rated motor speed (18 Hz) for standard electric motors controlled by VFDs. However, inverter duty motors can operate at slower speeds (~20 % of rated speed or 12Hz). If even lower speeds are required, then the motor manufacturer should be consulted.

In summary, there are many important considerations when using VFDs in pond aquaculture such as location and environment, supply voltage, electrical connections, grounding, and protective devices. VFD technology offers many advantages to the commercial aquaculture industry. The only way to ensure proper operation and reduce the likelihood of failure of VFDs is to properly install all electrical and electronic components, and become familiar with the correct start-up procedure in the operator's manual.

Update on the Final Clean Water Act Rule

George Selden, Extension Aquaculture Specialist, UAPB

The Clean Water Act (CWA), or technically the Federal Water Pollution Control Act Amendments of 1972, is the primary federal law governing water pollution in the U.S. Within the first section, one of the goals of the law was that "the discharge of pollutants into the navigable waters be eliminated…" The CWA also contains language defining "navigable waters" as "waters of the United States."

Since its passage, the term "waters of the U.S." has led to controversy and differing legal interpretations. In 2006, the Supreme Court took up the case of Rapanos v United States involving a landowner who filled in a wetland 20 miles from any "navigable" water, but which the EPA claimed jurisdiction as waters of the U.S. The court was split without a majority of justices agreeing on a definition. There were four justices that agreed on one definition, four justices that agreed for the most part on another definition and there was one other definition posited by Justice Kennedy. The plurality opinion states that the CWA confers federal jurisdiction over non-navigable waters only if they exhibit a relatively permanent flow, such as a river, lake, or stream. In addition, a wetland is jurisdictional if there exists a continuous surface water connection between it and a relatively permanent waterbody, such that it is difficult to determine where the waterbody ends and the wetland begins. Justice Kennedy's concurrence took a different approach, holding that a wetland or non-navigable waterbody falls within the CWA if it bears a "significant nexus" (link) to a traditional navigable waterway. Such a nexus exists where the wetland or waterbody, either by itself or in combination with other similar sites, significantly affects the physical, biological, and chemical integrity of the downstream navigable waterway.

Unfortunately, this ruling did not clarify the CWA for the regulatory community. There have been seven appellate cases with different takes on the Rapanos definitions, and to date, the Supreme Court has declined to hear any of those cases. As a result, in an effort to clarify the rules, in April of 2014 the EPA/US Army Corps of Engineers proposed a draft rule to more accurately define the "waters of the U.S.," which has replaced "navigable waters" in regulatory parlance. Under the proposal, waters that have a "significant nexus" to navigable waters, interstate waters or the ocean would be subject to EPA regulation. The comment period ended in November 2014, with the number of public comments totaling more than one million. The final rule was published in the Federal Register on June 29, 2015 and was to become effective on August 28, 2015.

So, how will the new rule potentially impact Arkansas fish farmers and land owners? According to the EPA summary fact sheet, it will have little effect. The fact sheet states that the new rule does not protect "any types of waters that have not historically been covered by the Clean Water Act." It also states that no new requirements for agriculture have been added and will not interfere with or change private property rights. The new rule does not regulate most ditches or change policy on irrigation. The new rule is also said to exclude from jurisdiction "artificial lakes or ponds constructed in dry land and used for purposes like rice growing, stock watering, aesthetics, or irrigation." The new rule also claims to exempt from permitting; normal farming practices, return irrigation flows, farm or

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stock pond construction and maintenance of drainage ditches. Not exempted are ditches that are constructed out of streams or function like streams.

In the old rule, tributaries were not defined. The new rule defines tributaries of traditionally navigable waters for the purpose of regulating them. A tributary is now defined to be "water features with bed, banks and ordinary high water mark, and flow downstream." Also redefined are adjacent wetlands/waters. In the past, wetlands had to be adjacent to jurisdictional waters. In the new rule, adjacent wetlands/waters include "waters adjacent to jurisdictional waters within a minimum of 100 feet and within the 100-year floodplain to a maximum of 1,500 feet of the ordinary high water mark. Wetlands and open waters without beds, banks and high water marks will be evaluated for significant nexus."

This "significant nexus" term has led to criticism and apprehension. Remembering the Rapanos case, a wetland or non-navigable water body falls within the scope of the Clean Water Act if it bears a "significant nexus" to a traditional navigable waterway. The nexus exists where the wetland or water body, either by itself or in combination with other similar sites, significantly affects the physical, biological, and chemical integrity of the downstream navigable waterway. While the agencies largely base their "significant nexus" interpretation on peer-reviewed publications, they also admit that the term is not purely scientific. Under the Final Rule, the agencies are authorized to rely on their "technical expertise and practical experience" to determine the existence of a significant nexus.

By relying on a list of scientific factors to evaluate the presence of a significant nexus — including factors such as "sediment trapping," "nutrient recycling" and "pollutant trapping"— anyone that wants to develop or use a parcel of land may justifiably fear that each significant-nexus determination will require a detailed and expensive scientific study. Even after such a study, the agencies are able to apply their discretion, "experience and expertise" to make broad jurisdictional determinations.

The new rules definition of "adjacent" waters and wetlands could increase the EPA's jurisdiction to include new categories of "other waters" and "neighboring waters" and potentially entire regions and watersheds. Another criticism is that the new rule essentially eliminates the "Waters of the State" by incorporating them in the regional or watershed approach in the proposed definition.

And finally, according to the Congressional Research Service, the agencies will claim jurisdiction over an additional 3-5% more waters than previously. Federal and state governments would likely experience roughly $1 million annually in additional costs to administer and process permits. The agencies also estimate indirect costs associated with the final rule to range between $158-465 million/year, depending on the scenario used. The agencies also estimate the benefits of the final rule will range from $339-572 million/year, again, depending upon the scenario used.

In total, 29 states, along with business interests representing energy, developers, farmers and others, sued to prevent implementation of the new rule. On August 27, the District Court of North Dakota granted the request of 13 states. On October 9, the U.S. Court of Appeals for the 6th circuit issued a nationwide stay of the new Clean Water Act rule. So, for the time being, things will stay as they have been in the past, but this story is far from over.

Subject	Old Rule	Proposed Rule	Final Rule
Navigable Waters	Jurisdictional	Same	Same
Interstate Waters	Jurisdictional	Same	Same
Territorial Seas	Jurisdictional	Same	Same
Impoundments	Jurisdictional	Same	Same
Tributaries to the Traditionally Navigable Waters	Did not define tributary	Defined tributary for the first time as water features with bed, banks and ordinary high water mark, and flow downstream.	Same as proposal except wetlands and open waters without beds, banks and high water marks will be evaluated for adjacency.
Adjacent Wetlands/Waters	Included wetlands adjacent to traditional navigable waters, interstate waters, the territorial seas, impoundments or tributaries.	Included all waters adjacent to jurisdictional waters, including waters in riparian area or floodplain, or with surface or shallow subsurface connection to jurisdictional waters.	Includes waters adjacent to jurisdictional waters within a minimum of 100 feet and within the 100-year floodplain to a maximum of 1,500 feet of the ordinary high water mark.
Isolated or "Other" Waters	Included all other waters the use, degradation or destruction of which could affect interstate or foreign commerce.	Included "other waters" where there was a significant nexus to traditionally navigable water, interstate water or territorial sea.	Includes specific waters that are similarly situated: Prairie potholes, Carolina & Delmarva bays, pocosins, western vernal pools in California, & Texas coastal prairie wetlands when they have a significant nexus. Includes waters with a significant nexus within the 100-year floodplain of a traditional navigable water, interstate water, or the territorial seas, as well as waters with a significant nexus within 4,000 feet of jurisdictional waters.
Exclusions to the definition of "Waters of the U.S."	Excluded waste treatment systems and prior converted cropland.	Categorically excluded those in old rule and added two types of ditches, groundwater, gullies, rills and non-wetland swales.	Includes proposed rule exclusions, expands exclusion for ditches, and also excludes constructed components for MS4s and water delivery/reuse and erosional features.

The State of Aquaculture in the Classroom

Bauer Duke, Extension Aquaculture Specialist, UAPB

Over 20 years ago Dr. Nathan Stone began working with high school teachers, assisting them with recirculating aquaculture systems they were using in their classrooms, greenhouses and vocational shops. The Aquaculture/Fisheries Center at UAPB has continued this effort to present day. The goal of the program is to train teachers to successfully use animal husbandry to teach agricultural concepts using a variety of subjects, including math, biology, chemistry, physics, marketing, economics and engineering. As some teachers wryly put it, agriculture turns STEM into STEAM. Until 2013, the main thrust of the program was to distribute fish in early fall, conduct an annual workshop for teachers in summer, answer questions by phone and e-mail year-round and restock systems where fish had been lost. In November of 2013 a monthly e-mail newsletter was established and more visits were scheduled with teachers to help with system problems in person.

In June 2015 two half-day workshops were held in Alpena through the Ozarks Unlimited Resource Educational School Cooperative and in July the same two workshops were offered in Bay via the Crowley's Ridge Educational School Cooperative. Attendance at the four workshops totaled 39 compared to 6-10 at previous UAPB workshops.

In July, I attended the Agriculture In-service Training at the FFA Camp Couchdale site near Hot Springs. This three day affair with many presentations is designed to help and inspire agriculture teachers in their quest to stimulate and motivate students during the coming year. I presented tips on using aquaculture in the classroom.

August and September have been targeted as fish distribution months. Teachers may request fish from UAPB free of charge. Generally, we provide tilapia, but this year, pellet-fed largemouth bass were also available and two schools are raising them. In the past, carp, catfish and goldfish have also been offered. So far this school year, Alpena High School, Augusta High School, Bakersfield (Missouri) High School, Bay High School, Guy Berry College and Career Academy, Nevada High School, Paragould High School, Riverside High School, Riverview High School and Westside High School, have received fish. I have visited teachers at Marked Tree, Tuckerman and White Hall High Schools to help them decide how best to compile programs and systems for the next semester. Fish are available for stocking year round and there is no limit to the number of fish a teacher may order.

Topics covered in recent newsletters include: how to order fish, flow rate calculation, math in aquaculture, fixing leaks, ammonia chemistry and adding a sump to a recirculation system. Aquatic Sciences Day on September 24 was a success with 159 students in attendance. Topics covered by demonstrations included angling, aquaponics, art, comparative anatomy, engineering, fish physiology, marketing, nutrition, physics, river sampling, and water chemistry.

Teachers are faced with interesting boundaries. They need to be able to complete an experiment or demonstration within 45-50 minutes (one class period). Occasionally they also need to be able to break the class into small groups to carry out projects that are predictable, engaging and cover agriculture principles. With administrators cutting programs to stay within budget, they also need to bring in as many other disciplines as possible to justify their existence. They need to show administrators this is not just an easy class to lighten a student's course load while they convince students that agriculture is engaging, fun and uses concepts from their other classes. For some students, this may be the only time they study subjects such as physics or marketing.

Demonstrations introduced to teachers include 1) osmosis using potatoes, distilled and salt water 2) speed of pH change by sodium bicarbonate versus calcium hydroxide 3) aeration rates in water and 4) a pH and alkalinity demonstration that works by blowing bubbles into water laced with wide range pH indicator and adding sodium bicarbonate and/or calcium hydroxide to the water. This demonstrates how recirculating systems lower pH, additives restore pH, and how the chemical equation for carbon dioxide plus water works, in about 10 minutes.

Throughout the year, the Aquaculture Research Station hosts local elementary school classes to tour the station and learn about fish in the

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University of Arkansas
Division of Agriculture
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2301 South University Avenue
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environment and in their classroom aquariums. This effort is led by Dr. Herbert Quintero. He, his staff and volunteers from the Department of Aquaculture and Fisheries team up to provide inspirational and memorable events for these young school children. Any school teacher is welcome to talk to Dr. Quintero about such opportunities at 870-575-8121.

If you have a school nearby that needs assistance teaching science principles through aquaculture, please have the instructor contact Bauer Duke: work 870-575-8143; cell 870-718-7998; email dukeb@uapb.edu.

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The purpose is to advance aquaculture production in Arkansas by providing reliable, practical, timely information.