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The Potential Uses of Drones in Aquaculture

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Unmanned Aerial Vehicles (UAV), popularly known as “drones,” are highly versatile tools. With drone and camera technology rapidly advancing, their potential seems limited only by the user’s imagination. In agriculture, hyperspectral cameras and long-range drones used in conjunction with automation software have promising capabilities that could result in fewer man-hours in the field, increased surveillance and faster response time to potential issues which conceivably will result in financial benefits on the farm level. Technology, however, tends to outpace the laws to regulate it. Several federal and state regulations regarding where, when and who can fly drones can be confusing and limit the potential uses of the technology.

How Can we use UAVs in Aquaculture?

Drones have already demonstrated their usefulness in row crop agriculture. By using different types of camera sensors (near-infrared, infrared, multispectral, hyperspectral) that sense light in different wavelengths, farmers can cross reference drone images to indexes to evaluate the health of their crop. They can then treat only the affected parts of a field, rather than wastefully treating the whole field. This technology has given rise to the field of “precision agriculture” and helps farmers produce more crops for less money.

Similar technology is thought to have potential for managing phytoplankton blooms on large fish farms. Kislik et al. (2018) proposed that a drone with the correct camera combined with the correct indices has the potential to identify concentration, health and even species of phytoplankton in ponds without microscopy or water samples. There are also several pieces of software available that can automate flight and image capture, as well as stitching images together to form an orthomosaic map of an entire property. If a drone could automatically take off, collect data, return to its home base, upload and analyze data to a computer, and create a map of the ponds with meaningful data, it could substantially streamline a farm manager’s task of managing phytoplankton blooms across the entire farm. Farms could even go a step further by using drones equipped with chemical applicator rigs to apply fertilizer or herbicide where needed; tasks that currently come with staff labor, safety and liability costs.

What are the Technical Limitations?

While most of this technology already exists for row crop agriculture, computer programs and indices would most likely need recalibration for use in aquaculture. Furthermore, glare and reflection from the surface of the water can interfere with imaging. Mitigating this issue through camera filters, spectrum type or simply what time of day to capture images will need investigation.

Battery life is also a potential problem, as most consumer level drones only have about a half hour or less of flight time before they either need a battery swapped or recharged. While fixed-wing drones can cover more ground in a single charge than most rotor type drones, farms that are hundreds or thousands of acres will still most likely not be able to image the entire farm in one flight. Another similar issue is transmission range, with most consumer-level drones only able to fly two or three miles away before losing contact with the remote control.

What are the Regulatory Limitations?

Perhaps the most challenging limitations to overcome for the widespread practical use of drones in aquaculture are the federal and state laws and regulations regarding drone use. Since drones can cause potentially deadly situations with manned aircraft, the FAA restricts their use to within specific parameters:

- The pilot must have FAA Part 107 Commercial UAV license
- Cannot fly above 400 feet above ground level
- Cannot fly at night
- Cannot fly in class B, C, D or E airspace (basically within about 5 miles of anything but small municipal airports) without permission from Air Traffic Control
- Must fly within Visual Line-of-Sight (must be able to see the drone at all times)

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- Must immediately land when in the vicinity of manned air traffic
- The drone must always have a pilot that can take control if necessary
- The drone must weigh less than 55 pounds

While the FAA is changing some laws and granting waivers to large companies like Amazon, it is unclear whether smaller businesses will be eligible, or if the technology necessary to obtain similar waivers from the FAA will be made available to the general public.

Drones have excellent potential in aquaculture but there are substantial hurdles yet to overcome. Fortunately, technological advancements in this field are developing rapidly and it is reasonable to expect drones to become viable tools on the fish farm in the relatively near future.

References

Kislik, Chippie, et al. "UAVs in Support of Algal Bloom Research: A Review of Current Applications and Future Opportunities." Drones, vol. 2, no. 4, 2018, p. 35., doi:10.3390/drones2040035.

Treatment Considerations for Ponds with the Catfish Trematode (*Bulbophorus sp.*)

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Extension Aquaculture Specialist

Brief History of Catfish Trematode in Arkansas

Aquaculture specialist and fish disease diagnosticians agree that there is a rise in the number of fish disease cases attributed to the catfish trematode. Fish producers question how the disease is spread and the want to know the best treatment. Unfortunately, there is no magic treatment, but there are some management tools that can be implemented to mitigate the problems associated with the disease.

Before discussing treatment options for the trematode, one needs to understand the life cycle of that organism.

Trematode Life Cycle

- Adult fluke lives in the digestive tract of pelicans.
- Pelicans defecate in ponds. Feces containing eggs from the adult fluke are released.
- Eggs hatch into an infective form known as miricidia.
- Miricidia infects the Ram's horn snail.
- Within the snail, many reproductions occur.
- Infective units known as cercariae are released from the snail.
- Cercariae are free swimming and seek out catfish to infect.
- Ceracraie infects catfish by penetrating organs or muscle and changes to a form known as metacerariae.
- Catfish are eaten by pelicans, then metacercariae mature into adult fluke.

Treatment Options

There are no chemicals that can treat the infected catfish. Efforts to control the trematode are directed at controlling the Ram's horn snail population. In the past few years there were only two treatment options. These included shoreline treatment with hydrated lime or hydrated lime slurry, and shoreline treatment with a copper sulfate solution.

Hydrated lime is applied as a dry powder or in a slurry form along the edge of the pond, extending about 4 to 6 feet out into the pond. The dry lime is dispensed at a rate of 50 pounds per 75 to 100 feet of levee. An auger-equipped hopper mounted on a tractor is useful for this purpose. The lime slurry treatment is usually performed by a commercial service. Four to 4.7 pounds of hydrated lime is dissolved per gallon of water. A 20 gallon slurry of the concentration will treat 100 feet of shoreline. Note, it is not easy to locate a vendor who does this service.

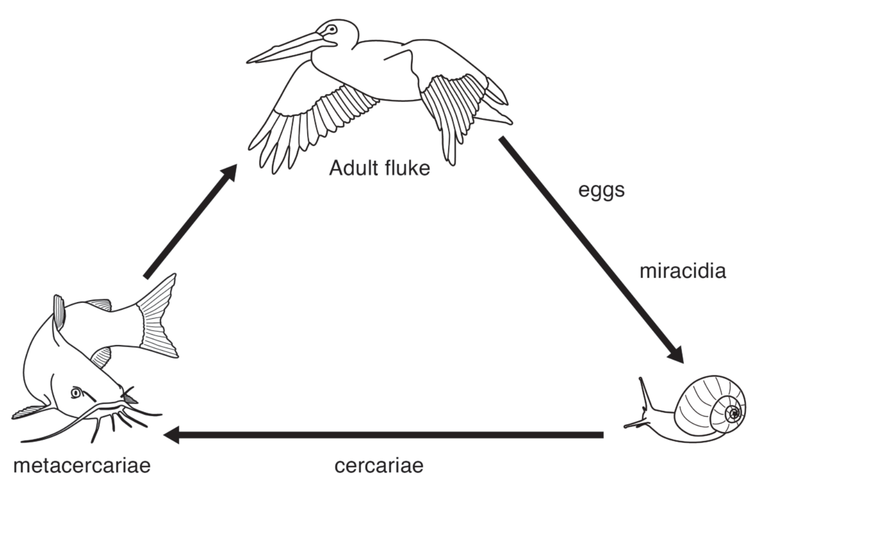
The copper sulfate treatment rate is 10 pounds of copper sulfate dissolved in 70 gallons of water. This amount treats about 250 feet of shoreline. This solution is sprayed into the pond from a large aerated tank which is usually drawn by a tractor.

Stocking black carp may again become a viable option to help control the Ram's horn snail. The courts ruled on how the Lacey Act is enforced. As a result, black carp can be shipped from Arkansas to Mississippi without issue. This presents a good economic opportunity for some fish producers to hatch triploid (sterile) black carp.

If black carp can be located, they can be stocked at 20 per acre. Producers should replace about one-third of the black carp each year. Escape from the ponds still must be considered.

Regardless of the treatment option one uses, do not overlook the importance of a bird scaring program. Also remember that a bird depredation permit is also needed.

For any concerns about the catfish trematode presence on your farm, contact your Extension specialists at the following numbers:
George Selden at 870-540-7805
Herbert Quintero at 501-676-3124
Larry Dorman at 870-265-5440



The Use of Stem-Cell Based Technologies in the U.S. Aquaculture Industry

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Genetic enhancement and selective breeding programs and technologies have existed for many years within the agriculture industry. In aquaculture, there are some recorded practices of genetic enhancements via selective breeding dating as far back as the 1800s used by koi breeders. However, the real emergence of fish genetics programs became prevalent in the 1900s with better understanding of Mendelian genetics and inheritance.

In the 1900s aquaculture producers employed the most basic form of genetic enhancement, which was domestication. This was followed by intraspecific (breeding between individuals of a single species) and interspecific (breeding between different species) cross breeding programs designed for strain selection and the production of interspecific hybrids in the 1960s. These techniques were further improved upon in the 1970s and 80s. In the 1980s ploidy manipulation techniques were developed. This led to the production of triploids, tetraploids, androgens and gynogens in the aquaculture industry. The 1980s also saw the emergence of molecular based technologies that greatly helped advance research-based enhancement programs in the field of aquaculture.

The 21st century brought about revolutionary techniques in genetic manipulation and genomics, which lead to the production of transgenic animals. The first transgenic animal introduced and commercially sold in the U.S. market was from the aquaculture industry. GloFish☆ are transgenic fish that were developed and introduced to the U.S. aquarium trade. GloFish are genetically modified to exhibit a variety of different fluorescent colors. Transgenic GloFish include genetically modified zebrafish, tetras, barbs and rainbow sharks. Although not originally developed for the ornamental fish trade, GloFish were the first genetically modified animals to become publicly available to the commercial market. The next progression of technology in aquaculture reproductive physiology was stem-cell isolation and interspecific transplantation, known at xenogeneics.

Xenogeneic transplantation is defined as the transfer of cells or tissue from a donor to a host of a different species. A xenogeneic organism is composed of elements typically foreign to its species. However, xenogenesis can also be accomplished intra-specifically, and the resulting individuals would be allogenic. Research on xenogeneics in aquaculture began in the mid 2000s and has steadily progressed since. Most aquaculture xenogeneic research is conducted in Japan. Early trials included zebrafish, loach, medaka and goldfish. However, more recent studies have been focused on food fish such as salmon, trout, flounder and several other marine species.

In 2010 the initial trials on the production of xenogeneic channel catfish were conducted in the United States. The motivation for the production of this xenogen derived from the production of the channel X blue hybrid catfish. Primordial Germ Cells (PGC's), a form of stem cell, from blue catfish donors were extracted and isolated. The isolated blue catfish stem cells were then introduced onto the gonads or the gonadal ridge of a triploid male channel catfish host. The result of the stem cell transplantation lead to the production of fertile, triploid channel catfish males that produced blue catfish sperm (Figure 1). The ultimate goal was to naturally pond spawn these xenogeneic individuals with normal channel catfish females, resulting in hybrid catfish egg masses

Current research on xenogeneic technology and stem cell transfer has been focused on the bait, sport and aquarium fish industry in Arkansas. Ongoing research is focused on the development of xenogeneic black crappie (Pomoxis nigromaculatus) and white crappie (Pomoxis annularis). The primary objectives of this project include the production of xenogeneic white crappie males implanted with black crappie stem cells, and black crappie females implanted with white crappie stem cells. The final goal of this project is the production of xenogeneic brood-stock that can be used for the production of black crappie male X white crappie female hybrid offspring. This will be done by pond spawning the xenogeneic white crappie males with non-xenogeneic white crappie females.

Similar pond spawning will be done with the xenogeneic black crappie females, where they will be allowed to spawn with non-xenogeneic black crappie males. The resulting offspring from both these spawns should be the desired hybrid offspring. Future studies will be focused on the spawning efficiency of each of the

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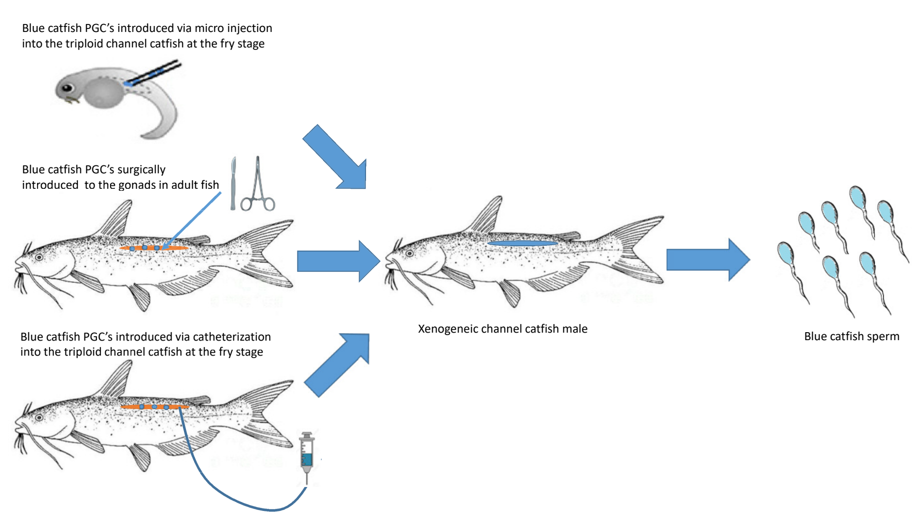
Figure 1: The transplantation of blue catfish primordial germ cells (PGC's) into larval, and adult sterile (triploid) channel catfish males for the production of blue catfish sperm. PGC transplantation at larval stage is done via microinjection of the fry. Surgical implantation and catheterization is used to transplant PGC's into the adult triploid channel catfish males.



Letter from the Editors

Greetings, *Arkansas Aquafarming* Readers,

Arkansas Aquafarming has been delivering applied research updates, practical recommendations and industry news relevant to Arkansas fish growers for nearly 40 years. Like the industry, this publication has evolved over time. We are currently undergoing another transition with *Arkansas Aquafarming* as our mailing database has become exceedingly outdated and our production process inefficient and cumbersome.

In response, we will be moving towards a mostly digital format that will increase our flexibility in article length and formatting, the speed at which we can publish time-sensitive information and reduce financial costs which can be reallocated to other aquaculture research and Extension efforts.

We intend to continue publishing enough hard copies to mail each subscribing fish producer in the state, county Extension offices and selected libraries. We will be reaching out to all Arkansas fish producers soon to ask if you would like to subscribe to this entirely free newsletter. Otherwise, you will be able to find our digital versions by following University of Arkansas at Pine Bluff School of Agriculture, Fisheries and Human Sciences, and Department of Aquaculture and Fisheries social media accounts, and by searching "*Aquafarming*" at the UAPB Department of Aquaculture and Fisheries website.

Thank you for reading *Arkansas Aquafarming* and we hope it continues to benefit you as we streamline and refine our process. If you have any questions or thoughts, please contact the editors.

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developed xenogeneic brood-stocks. This will be done prior to developing recommendations on the use of xenogeneic crappie in aquaculture.

In addition to the production of hybrids, stem cell transplantation and xenogeneic technologies can also be used to enhance and increase the production of gametes, through surrogacy. A hypothetical instance would be the use of common carp as a surrogate to produce goldfish eggs or sperm. Common carp production has been thoroughly investigated, and the induced strip spawning and fertilization process is well established. If goldfish stem cells can be transplanted into common carp and a brood stock of common carp can be used as surrogates for the production of eggs and sperm that would give the farmer or fry producer significant control over the timing of spawning. It would also mean fewer numbers of brood stocks to house, maintain and manage.

Furthermore, this technology would make it possible to artificially induce and spawn species that do not easily spawn in a hatchery environment. All of these possibilities are currently being evaluated for the production of several commercially important aquaculture species in the U.S. It is also noteworthy to mention that stem cell transplantation technologies and xenogeneics have been considered as tools to possibly resurrect endangered or threatened species in natural fisheries.

In closing, it is important to strike a note of caution. Just because a technology exists, it does not mean that it can be, or should be, applied on a commercial scale. There is a tendency of scientists and researchers to sometimes get "lost in the science" and forget the practical aspects and situation faced by farmers and producers. Therefore, it is important to weigh in the economic and practical feasibility, the availability of skilled labor and other pertinent information prior to recommending or switching to stem-cell based spawning technologies.