

Project Title: [Educating a Workforce for the Aquaculture Industry: Matching Skill Needs of the Aquaculture Industry with US Career and Technical Education \(CTE\) \[Termination Report\]](#)

Total Funds Committed: \$188,036

Initial Project Schedule: July 1, 2017 to June 30, 2019

Current Project Year: July 1, 2017 to June 30, 2019

Participants: Evans, B.I., Lake Superior State University; Helal, H., Lake Superior State University; Hartleb, C., University of Wisconsin Steven's Point; Slemmons, K., University of Wisconsin Steven's Point; Pattillo, D. A. Iowa State University (replaced by Lambert, M., Iowa State University)

Extension Liaison: D. Allen Pattillo (replaced by Joseph E. Morris)

Industry Liaison: William B. West, Iris Fish Farm LLC, Black Creek, Wisconsin

Reason for Termination: Completion of project objectives.

Project Objectives

1. Assess the workforce needs for the aquaculture industry throughout the 12 states of the North Central Region (NCR). Identify which skills are needed in the workforce to promote industry growth.
2. Assess the level of youth focused aquaculture curricula/programs in the NCR. Identify schools with a Career and Technical Education (CTE) certification in the Agriculture, Food and Natural Resources career cluster that includes aquaculture. Identify other youth aquaculture related activities.
3. Integrate industry and high school/youth career center information through a web- based platform that:
 - a) creates awareness of the aquaculture industry skill needs
 - b) allows assessment of the level and distribution of aquaculture curricula
 - c) utilizes the web-based platform (ncrac-yea.org) to co-develop curricula to address industry needs
 - d) creates incentives for youth to pursue aquaculture skills training
4. Create and promote aquaculture workshops for educators and Extension professionals and provide access funding for them to attend existing workshops.
5. Identify community colleges or universities with aquaculture courses/programs, and create opportunities for interested students to be dual enrolled in existing college classes, or "less than class size" internship opportunities at fish farms and hatcheries.....

Project Summary

Advancement of the aquaculture industry requires recruitment of a workforce experienced with the many facets of aquatic farming. Although globally aquaculture is growing rapidly, the projected workforce in the US is insufficient to meet future demands for aquaculture. Our goal is to identify where the industry sees a need for skill development and then create career pathways to the aquaculture industry. Identifying the level of youth aquaculture engagement that currently exists throughout the North Central Region (NCR) will allow coordination of these efforts through an online aquaculture forum we have developed. Identification of what resources are needed to support current programs, and where aquaculture could be initiated, will allow academic institutions and private industry to co-develop the needed workforce. Aquaculture development is in the national interest, and providing training in aquaculture for the next generation, is essential to fostering the skills needed for this industry. Another key component of education is providing continuing education for the educators and extension professionals. We developed aquaculture and aquaponic workshops focusing on the needs of the schools and extension educators, as well as providing access funding for them to attend these workshops. A basic education in aquaculture opens the door for students to attend universities with potential careers in business, engineering and the life sciences, all vital skills required by the aquaculture industry. We engaged youth in aquaculture throughout the NCR and identified career pathways to the aquaculture and aquaponic industries with appropriate skill training opportunities.

Technical Summary and Analysis

Objective 1. — A survey was given to state and industry hatchery managers, and aquaculture extension in Michigan, who provided a list of skill needs/expectations for new aquaculture hires. We have summarized our expectations in Figure 1. For successful aquaculture, a basic understanding/expectation of "normal" fish behavior and compromised health (live) was identified as essential. Knowledge of major parasites, bacterial and viral diseases in the region, and a summary of how bacterial and viral disease are diagnosed, is needed for future culturists. They should understand cause-and-effect of stress, procedures and policies to control pathogens, invasive species, and non-target organisms (following HACCP procedure). Being able to perform basic necropsy and Gram-stain gill and skin smears for microscopic examination and being able to perform calculations for therapeutic chemicals used in a flow-through and static bath treatment should be required as part of aquaculture education. Understanding mortality and water quality monitoring, record keeping of tolerances (DO, pH, NH₃, NO₂, CO₂) as well as an understanding of mechanical systems commonly used in hatcheries, such as the basics of well field development, pumps, small engines, fish feeders, degassing theory and application is needed. Methods should also be identified for understanding effluent management.

Funding from this program was leveraged with funding from Wisconsin Sea Grant to conduct surveys of Wisconsin seafood consumers and fish farmers to better understand workforce needs and barriers to industry growth. The WI Sea Grant project was, "Supporting Wisconsin aquaculture by assessing the marketing needs of producers and perceptions of consumers about eating locally farmed fish." Reports are available at: <https://www.uwsp.edu/cols-ap/nadf/Pages/Supporting-WI-Aquaculture-by-Assessing-the-Marketing-Needs-of-Producers-and-Consumer-Perceptions.aspx>

Objective 2. — A pilot project, "Youth Education In Aquaculture" funded through NCRAC, was completed with the development of the web platform www.ncrac-yea.org, with a five-year hosting contract. We compiled a list of all high schools throughout Michigan (@1100) and Wisconsin (@500) and identified the state of aquaculture education at each school. We created a newsletter and online survey that was sent to each school and we asked local intermediate school districts to provide information from their regions. The web platform was beta tested and survey results were obtained by April 1, 2017 using 8 schools involved with the Aquaculture Challenge competition. Increased exposure to aquaculture engages students and increases their interest in math and science (Wingenbach et al., 1999), as well as developing generic and occupation specific life skills (Pita et al., 2014). Our preliminary work in the K-12 system showed strong interest in aquaculture by young students, but their options for follow-up were limited.

During this project, we identified the schools in each of the following states that incorporated some form of aquaculture education at the secondary level: Michigan, Wisconsin, Ohio and Illinois. We also have some data on activity in Iowa and Kansas. The website domain is funded through 4/5/2022, so we will continue to go through each of the remaining 6 states in the NCR to complete our list. Once schools are identified and GIS coordinates determined, we are using a variety of methods (surveys, newsletters, social media) to ascertain the level of aquaculture engagement of youth in these regions. This information is available on the website we have developed www.ncrac-yea.org (Figure 2).

Objective 3. —

a) creates awareness of the aquaculture industry skill needs

The Home page of the website (ncrac-yea.org), introduces Youth Education in Aquaculture (YEA), and makes the case for the need for aquaculture education. The skill set needed is also identified on the home page. The domain name, ncrac-yea.org has been purchased through 4/5/2022.

b) allows assessment of the level and distribution of aquaculture curricula, and

c) utilizes the web-based platform (ncrac-yea.org) to co-develop curricula to address industry needs

The ncrac-yea.org Outreach page provides the visualization of the location of aquaculture businesses and surrounding high schools. This shows if there are local high schools with curricula that would provide the preliminary skills necessary to fuel their workforce needs. By providing this online resource, it allows schools to visualize the surrounding points of interest, whether it be a nearby aquaculture business or school with an active aquaculture curriculum, and presents them the opportunity to reach out and potentially collaborate with the surrounding aquaculture organizations. The website also contains a resource page which provides numerous links to assist with the understanding of aquaculture, including resources provided for the Aquaculture challenge, that could very well be utilized by schools not participating. Additionally, the site contains a secure forum for teachers and business owners to collaborate with each other, encouraging problem solving and school to business connections.

By providing this website, it creates opportunities for schools to access resources to utilize themselves, find local businesses and schools with aquaculture to connect with, converse with participating businesses and schools via the forum, and presented the opportunity for schools to register and participate in the aquaculture challenge. Teachers and businesses can use these resources to create opportunities for students to acquire the skills necessary for the industry, and create interest in their students to drive them to pursue further aquaculture education and training.

d) creates incentives for youth to pursue aquaculture skills training

Beginning in 2016, as part of the MiSTEM grant project, we started a competition for our local high schools, called the “Aquaculture Automation Challenge”. Students were given materials to design an aquaculture system and programmed micro-controllers with sensors to monitor the environmental parameters of their system. We were amazed at how motivated and engaged the students were with their projects for the competition. <http://www.sooeveningnews.com/news/20160520/sault-team-wins-aquaponics-challenge>.

The Youth Education in Aquaculture (YEA) website was used to host the competition online, and is now called the Aquaculture Challenge. Student teams were given materials and guidance to construct an aquaponics system, program a microcontroller for system monitoring, and develop an entrepreneurial business plan. The past 3 years have had a final showcase on 5/5/2017, 4/6/2018 and 4/25/2019.

Objective 4. – Create and promote aquaculture workshops for educators and Extension professionals and provide access funding for them to attend existing workshops.

Throughout the design and build phase of the Aquaculture Challenge competition, the educators mentoring the teams indicated they needed more aquaculture training for themselves. This appears to be a common occurrence (Duncan et al., 2006), and was also observed in a survey of high school aquaculture programs in the mid 1990’s in the northeastern U.S. (Wingenbach et al., 2000).

We are seeing progress in aquaculture education with successes in programs such as the UWSP-Northern Aquaculture Demonstration Facility and Aquaponics Innovation Center. In addition to offering aquaculture workshops to industry personnel to help educate, train and provide updated knowledge, UWSP has also introduced an Aquaponics Certificate Program that allows students to use coursework from other institutions and does not hold them back with institutional residency requirements. UWSP’s aquaculture educational programs have educated over 400 students from 12 states and 4 countries since 2011. The programs have also placed more than 25 interns with private industry partners (<http://www.uwsp.edu/cols-ap/nadf/Pages/Past-Interns.aspx>) and that has led to a 90% success rate in student job placement in the aquaculture industry. In Michigan, Michigan Sea Grant is also working to establish an aquaculture technician program; however, to facilitate these efforts, we need to make our youth aware of the potential for careers in aquaculture.

While popularity in aquaponics continues to grow, most educators are ill prepared and lack the formal training required to properly integrate aquaponics into their curriculum. The UW-Stevens Point Aquaponics Innovation Center (UWSP- AIC) was built to assist both educators and businesses in learning science-based aquaponics and for integrating this culture method into school programs and new businesses. UWSP and Nelson & Pade staff developed an aquaponics curriculum component that was used to educate and train twenty educators/extension professionals at the UWSP-AIC on August 13-15, 2018. In 2019, thirty-five

educators/extension professionals attended the workshop July 11-13.

During the 3-day Aquaponic Master Class for Teachers, participants were trained in the science of aquaponics, with particular reference to STEM components, as well as ways that school aquaponic programs can provide safe, sustainable seafood and vegetables to the schools while preparing students for careers in aquaculture. Educators and extension professionals were provided access funding for attending the workshop to help defray costs. Fully hands-on training was provided with example exercises (available at: <https://www.uwsp.edu/cols-ap/nadf/Pages/Current-Projects-At-The-Facility.aspx>).

Curricula for a similar 3-day workshop were held in Muskegon MI (August 6-8, 2019) at the Annis Water Resources Institute.

Objective 5. – Identify community colleges or universities with aquaculture courses/programs, and create opportunities for interested students to be dual enrolled in existing college classes, or "less than class size" internship opportunities at fish farms and hatcheries.

A list of community colleges and universities with aquaculture courses/programs was obtained from the U.S. Aquaculture Society and was cross checked for accuracy and updated (given it was ten years old). Twenty-four programs were identified in the U.S. (Table 2). UWSP offers two college-level courses in aquaponics, one is online and the other is offered as a 3-day short course so that students at any university can enroll in the courses. UWSP also offered NINE summer internship opportunities to students at aquaculture/aquaponic facilities (<https://www.uwsp.edu/cols-ap/nadf/Pages/Past-Interns.aspx> and <https://www.uwsp.edu/cols-ap/aquaponics/Pages/AIC-Staff.aspx>).

LSSU has added an aquaculture minor beginning in Fall 2019. They have also introduced an Introduction to Aquaponics course Fall 2019 as a pilot towards adding an aquaponics minor.

West Shores Community College (WSCC) was proposed as a model for developing the Aquaculture CTE program, however the faculty member at WSCC has now retired, and the college has hired a botanist to replace them. There is no longer an aquaculture program at West Shores Community College.

Principal Accomplishments

Our results were disseminated through our websites www.ncrac-yea.org; and the University of Wisconsin Steven's Point sites for aquaponics education <https://www.uwsp.edu/cols-ap/aquaponics/Pages/default.aspx>, and their Northern Aquaculture Demonstration Facility (NADF) website <https://aquaculture.uwsp.edu>. We also created a website page for this project that has photos, links and handouts we can share from the workshops. It is located at: <https://www.uwsp.edu/cols-ap/aquaponics/Pages/AIC-Projects-.aspx>. We also share information through the Superior AquaSystems Facebook page <https://www.facebook.com/superioraquasystems/?ref=bookmarks>.

An extensive curriculum was developed for the Aquaponic Master Class for Teachers (Table 1). A total of 55 educators and extension professionals attended the Master Class for Teachers held at the UW-Stevens Point Aquaponics Innovation Center in 2018 and 2019. Nearly half of those who attended (27) already had classroom aquaponic systems but were not properly trained on their operation or how they may incorporate the systems into classroom curricula. The other educators/extension personnel did not have aquaponic systems and were interested in purchasing/constructing a system and incorporating it into their curriculum. All 55 educators/extension personnel will have aquaponic systems in their classroom by 2022 and will use the curriculum created/provided by this project to enhance the Science, Technology, Engineering and Mathematics (STEM) curriculum in their school. One of the industry partners, Nelson & Pade, plan to continue offering the Master Class for Teachers for years to come, further reaching educators throughout the U.S.

Objective 1. — We have surveyed agency, academic and extension personnel for gaps in the knowledge base of the existing workforce.

Objectives 2 & 3. — We continue to refine our website (www.ncrac-yea.org) and are well underway to fully populating the databases for aquaculture outreach. We have held three rounds of the Aquaculture Challenge and are in the process of hosting another competition beginning January 2020.

Objective 4. — To date we have held two aquaponic 3-day workshops, one in 2018 for 20 educators, and in 2019 held another aquaponic 3-day workshop for 35 educators. A third 3-day workshop is planned for August 6-8, 2019 for 10 educators.

Objective 5. — We have identified 24 aquaculture focused programs in the US and are encouraging universities and colleges to do more to make these skills more available.

Impacts

Increasing awareness of the level of youth engagement in aquaculture allows targeted responses for making resources and expertise available. We have been encouraged to find more aquaculture activity in the schools than we expected. We also found the educators to be extremely receptive to our workshops and asked how more of this type of learning can be obtained. A total of 55 educators and extension professionals attended the Master Class for Teachers held at the UW-Stevens Point Aquaponics Innovation Center in 2018 and 2019. Nearly half of those who attended (27) already had classroom aquaponic systems but were not properly trained on their operation or how they may incorporate the systems into classroom curricula. The other educators/extension personnel did not have aquaponic systems and were interested in purchasing/constructing a system and incorporating it into their curriculum. All 55 educators/extension personnel will have aquaponic systems in their classroom by 2022 and will use the curriculum created/provided by this project to enhance the Science, Technology, Engineering and Mathematics (STEM) curriculum in their school. One of the industry partners, Nelson & Pade, plan to continue offering the Master Class for Teachers for years to come, further reaching educators throughout the U.S.

By adding our findings to the www.ncrac-yea.org website, we are revealing the landscape of aquaculture engagement. Our immediate knowledge of the resource needs has increased, and we are confident this will accelerate as we continue with the project. In particular, the enthusiasm of the educators in the workshops was infectious and will no doubt be passed on to their students and colleagues.

The 2016-17 Aquaculture Webinar Series fostered a partnership among NCRAC, the National Aquaculture Association, and the United States Aquaculture Society. This partnership broadened the scope and participation in these webinars nationwide. This 18-part series covered timely and relevant aquaculture topics for the NCR and the overall US aquaculture industry.

We anticipate, as we near the end of this project, the aquaculture industry will benefit from detailed interactive maps of aquaculture education throughout the NCR. These maps will identify regions where future skilled workers can likely be found. The maps utilize updateable fusion tables that give detailed information on a variety of metrics including extent of curricula and what may be lacking for the schools to move their program forward. The web platform is also accessible by the schools listed on the map. Cost of travel is a major barrier for schools to interact. Using ncrac-yea.org, they will now be able to locate other programs in their geographic area, as well as link to schools across the state and region. By sharing their struggles and successes, they will be able to advance their education more quickly than by working alone. We also envision this web platform continuing to host competitions such as the “Aquaculture Challenge”, with minimal cost. Each year, teams could be challenged to address a problem facing aquaculture. Teams could pitch their solutions using a video meeting, and judges would evaluate how well they solved the problem.

Winning teams could be invited to present at the biennial NCRAC conference, and other aquaculture venues.

We created aquaculture/aquaponic content for workshops to train educators and extension personnel in STEM (Science, Technology, Engineering and Math) related fields and other industry-related concepts such as business operation, marketing, and financial management. Now that development is complete, these workshop materials could be used in the NCR and throughout other RAC's. With undergraduate enrollment declining at most universities, the addition of more applied courses/programs such as aquaculture and aquaponics could help reverse this trend by identifying a clear career pathway that shows how college education coupled with internship programs can lead to career opportunities in aquaculture. Ultimately, the

aquaculture industry will benefit from an educated, skilled, young workforce that will help the U.S. aquaculture industry prosper and be ready to “carry the torch” for the industry as a generational change takes place. This can be best accomplished by the co-development of the aquaculture workforce.

Recommended Follow-Up Activities

The benefits of online and in-person workshops and learning activities are the immediate response and feedback you receive from participants. Like many of these programs, follow-up activities include continued feedback from participants as they continue to use the knowledge gained and resources used in their own programs. Also, continued funding is necessary to keep online information available and to continue offering the workshops to additional new educators and extension professionals.

Publications, Manuscripts, Workshops, and Conferences

See the Appendix for a cumulative output for all NCRAC-funded Education activities.

Table 1. Aquaponic curriculum developed and provided to educators as part of Aquaponic Master Class for Teachers.

Source	Chapter	Topic
Nelson & Pade	1	Introduction & History of Aquaponics
	2	Establishing & Maintaining the Fish Tank
	3	Seed Germination & Planting
	4	Plant Selection & Care
	5	Plant Nutrient Requirements
	6	Photosynthesis, Transpiration and Light
	7	Fish Anatomy
	8	Fish Nutrition & Health
UWSP	9	Plant Physiology & Light
	10	Fish Physiology
	11	Water Quality & Chemistry
	Appendix A	Additional Information Sources & Pertinent Websites
	Appendix B	Project & Experimental Ideas
	Appendix C	Other Products & Multimedia
	Appendix D	Argument Driven Approach Rubric

Table 2. List of higher education institutions where aquaculture or a related field is offered as part of curriculum (list provided by the US Aquaculture Association).

Auburn University
Brunswick Community College
Carteret Community College
College of Southern Idaho
Florida Institute of Technology
Gadsden State Community College
Hillsborough Community College
Hocking College
Kentucky State University
Lake Superior State University
Mansfield University
Roger Williams University
Southern Illinois University
State University of New York, Cobleskill
Texas A&M
Trinidad State Junior College
University of Arkansas at Pine Bluff
University of California Davis

University of Hawaii
University of Idaho
University of Maine
University of New England
University of Rhode Island
University of Wisconsin-Stevens Point

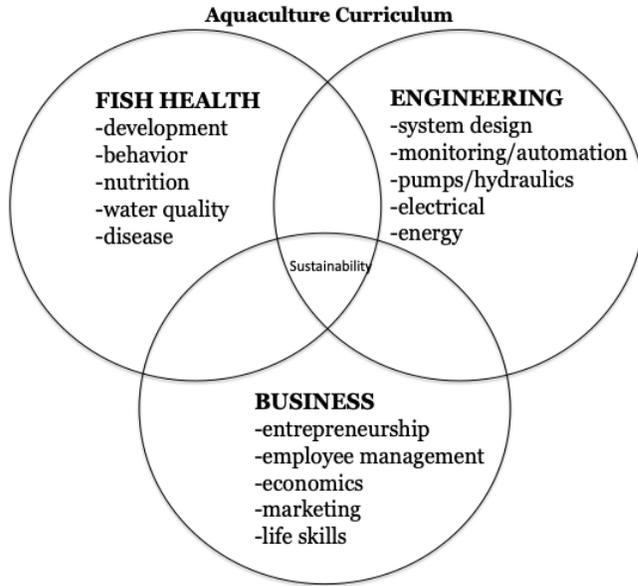


Figure 1: Workforce Skill Needs for the Aquaculture Industry

