

## STUDENTS' PERCEPTIONS OF AQUACULTURE EDUCATION IN THE NORTHEAST REGION

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### Abstract

*The purpose of this research was to determine educational benefits, mathematics and science skills, life skills, and the future of aquaculture as perceived by agriculture students in 12 northeastern states. Respondents (N= 60) profoundly believed in their aquaculture programs because of the hands-on learning environment provided by such programs. Students found their aquaculture programs exciting, challenging, and fun. The process of learning scientific and mathematical concepts transcended age groups and geographic origination, especially for topics relating to chemistry and biology. Additional skills gained included problem solving, teamwork, responsibility, communication and leadership. Respondents viewed the care and maintenance of an aquaculture system as paramount to the success of an aquaculture program. Northeastern agriculture students were adamant in their belief that people (adults and youth) external to an aquaculture education program were not aware of and/or did not care about the educational benefits derived from such a program. Respondents stated that the aquaculture program was one of the best educational experiences they had acquired in high school, yet they did not have aspirations of working in the aquaculture industry. Respondents believed that increased collaboration between high school teachers and/or school districts will lead to an increase in aquaculture education program enrollments.*

### Introduction

Aquaculture can be considered as the aquatic complement to agriculture. Specifically, it is the husbandry of fish and/or other aquatic species in a controlled environment (Bardach et al., 1972; Lovell, 1979; Shell, 1983; Lindsay, 1985; Molnar et al., 1987). Molnar reported that the world catch of fish was approximately 4 million metric tons in 1900. Improved technologies helped increase this total to 20 million metric tons by 1930 and over 70 million metric tons by 1970. Currently, the total world supply of fish caught has increased to over 97 million metric tons during the year 1991 (MSU Aquaculture Center, 1994). It is estimated that future world demand and consumption of fish will necessitate a supply of approximately 115 million metric tons by the year 2000 (Stickney, 1994). Based on the annual global per capita consumption (18.4 pounds), population increases (over 6

billion), and wild fish caught (81 million metric tons/year), a considerable shortfall will be evident in the total world supply of fishery products. Will the aquaculture industry acquire sufficient personnel with adequate mathematics and scientific skills needed to perform the tasks in aquaculture production?

Given the likelihood that global supplies of wild aquatic plants and animals will not meet expected demands by the year 2000, state and federal entities have increased their support to advance the science of producing aquatic plants and animals in a controlled setting. At the most basic level of successful aquaculture production is the scientific and mathematical knowledge, as well as technological skills, needed to produce repeated crops of marketable aquatic products. Anecdotal evidence exists claiming the inherent value and benefits of incorporating and/or developing

“stand-alone” aquaculture curricula for an agricultural education program at the secondary school level. This evidence was derived from agriculture teachers’ perspectives, but did not include agriculture students’ perspectives (Conroy & Peasley, 1997).

### **Review of Literature**

Current and future demands of aquatic animals and plants have been determined to exceed the supplies available through traditional harvesting techniques employed by the world’s fishing industry. It is expected that aquaculture, the practice of producing aquatic animals and plants, will become a major global industry in the 21<sup>st</sup> century (McCraren, 1994). Due to expected supply shortages, aquaculture is considered to be one of the fastest growing industries in the U.S. agricultural sector. Although fishing and fish farming have been practiced since prehistoric times, the modern aquaculture industry is only beginning to develop as a global economic force. As such, the USDA has financially supported this growing industry with favorable policies since the Farm Bill of 1978.

The potential for increased job opportunities, rural development, and economic growth in the aquaculture industry has increased the awareness and teaching of aquaculture in secondary schools. In 1981, the California Aquaculture Association called for qualified [aquacultural] workers who were not college graduates; the contention was that aquaculture is labor intensive and that college graduates tend to be more interested in problem solving than in labor (Lindsay, 1985). It was not known how many secondary schools were teaching aquaculture or what types of skills were being learned during the early 1980’s. More recently, the National Council for Agricultural Education (1994) reported that after one year of testing an aquaculture curriculum at six high schools, there was a 400% increase in student enrollment for aquaculture classes during the 1992- 1993 school year. Additionally, it was found

the pilot aquaculture courses attracted nontraditional students of agriculture, women, and minorities.

El-Ghamrini (1996) stated that aquaculture education in U.S. high schools has a very short history. A lack of documented research substantiates this claim as no studies were found that described the benefits of aquaculture education as perceived by agriculture students. Conroy and Peasley encountered a similar situation while researching the literature for their report on the “National Aquaculture Curriculum” to the National Council for Agricultural Education. Historical accounts suggest more effort has been exerted in establishing research and education at the postsecondary level, than has been evident at the secondary school level.

Aquaculture education programs at the secondary school level integrate math and science concepts and provide hands-on practical experiences that complement theory (Conroy & Peasley, 1997). Mooring and Hoyle (1994; quoted in Conroy & Peasley, 1997) reported that one aquaculture program in North Carolina used chemistry, biology, and math in an integrated manner with their closed recirculation system, pond, and caged pond production methods. Also, Conroy and Peasley reported that although aquaculture programs can be costly, less-expensive alternatives have been explored and developed by agriscience teachers,

Dr. Garrison conducted a mail survey (1995; quoted in Conroy & Peasley, 1997) of all agricultural education supervisors for the 50 states and two territories. A total of 33 states and Guam were represented in the results. Respondents answered four open-ended questions that assessed the: 1) number of secondary programs offering a unit of aquaculture education; 2) number of students enrolled in the programs; 3) number of teachers who have attended aquaculture-related workshops; and 4) existent industry support for aquaculture programming at the secondary school

level.

Results from the Garrison survey revealed that 941 programs across the country offered units of aquaculture instruction providing 53,419 students with the opportunity to experience the curriculum either through agriculture or science course work. Survey participants indicated that approximately 1,278 teachers had participated in an aquaculture seminar or workshop during the years 1993 to 1995. A total of 21 state supervisors responded that aquaculture industry support was evident at the secondary school level in their respective states. Support was identified as contributions from state divisions of wildlife resources, land-grant universities, various commodity associations, and others.

El-Ghamrini identified potential barriers to maintaining an aquaculture program, as perceived by agriculture teachers ( $n=141$ ) in the North central region. The barriers included taking care of fish on weekends and holidays, facility limitations, low teacher knowledge, high equipment costs, limited administrative support, and the possibility of failure. Respondents rated the importance of instructional units for providing a quality aquaculture education program. The highest ranked topics were water quality, aquaculture management, fish nutrition, fish marketing, fish biology, fish diseases, and fish ecology.

A preliminary review of related research and literature produced a noticeable void of studies that had investigated the students' perceptions of the educational benefits, math and science skills, life skills, or future of aquaculture education in a secondary agricultural education program. A need existed for research that identified the educational benefits, mathematical and scientific benefits, and life skills attained by students who studied aquaculture.

### **Purpose and Objectives**

The purpose of this research was to determine

the educational benefits, math and science skills, life skills, and future of aquaculture as perceived by agriculture students in Connecticut, Delaware, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, Vermont, and West Virginia. The research objectives were.

1. Assess demographics of northeastern agriculture students studying aquaculture.
2. Determine math and science skills gained from studying aquaculture.
3. Examine life skills gained from studying aquaculture.
4. Determine selected students' beliefs about the future of aquaculture programs.

### **Methods and Procedures**

As part of a larger study, data were collected using structured interview methodology and an emergent design. The advantage in using this methodology was the accumulation of actual responses from students who had primary knowledge of the benefits derived from enrollment in an aquaculture class. The emergent design allows for the development of the qualitative research design as the inquiry progresses (Borg & Gall, 1989).

The target population consisted of students in a secondary agricultural education program in the northeastern region that included an aquaculture component in the total curriculum during 1996-1997. Schools' names and addresses were obtained from inquiry letters, electronic mail, and telephone conversations with state supervisors of agricultural education, teacher educators, and state aquaculture specialists. From these communiques, the population of northeastern secondary agricultural education programs was 115. All students who were enrolled in at least one of the 115 programs identified, served as the target population.

A proportional stratified sample of

northeastern secondary agricultural education programs was drawn from the target population. A minimum of one agricultural education program per state was drawn in the stratified sample. Proportional stratified sampling was based on geographical location of schools for each state in the population. At least one aquaculture program from every state (some states only had one to four programs per state) in the study was randomly selected for the sample so students' views on aquaculture education for that state could be recorded. Northeastern states that reported having five to fifteen aquaculture programs per state had two or more programs randomly selected for the interview group. Researchers contacted agriculture teachers from the selected programs to gain permission for conducting an on-site structured interview with students who participated in the aquaculture curriculum. All students from each respective program drawn in the stratified sample were present and included in the face-to-face interviews. Sixty students (43 males, 17 females) from 13 schools were included in the stratified sample.

Data were collected via the structured interview technique. Using this technique, a set of open-ended questions about aquaculture directed each interview session. Selected students were asked a series of fixed-order questions, along with transitional phrases and probes (Ary, Jacobs, & Razavieh, 1996). All interviews were tape-recorded, analyzed, and transcribed verbatim. The following general questions provided a basis for each structured interview session. Each question was phrased in the simplest form possible.

#### Objective One:

- Please state your grade at the time of this interview.
- Please tell me if you live on a farm, in town, or in a city.
- What attracted you to enroll in the aquaculture class?

- Do you “like” being in class to learn about aquaculture? Why? Why not?

#### Objective Two:

- How has the aquaculture class affected your science and/or math abilities?
- Specifically, what mathematical concepts or skills were affected by studying aquaculture?
- Specifically, what scientific concepts or skills were affected by studying aquaculture?
- How is learning about science or math in an aquaculture program different from learning about those subjects in regular science and math classes?

#### Objective Three:

- What practical skills have you gained by participating in this aquaculture class?
- What do the terms “problem solving” (from previous question) mean to you?
- What do the terms “leadership skills ” mean to you?
- What does the term “responsibility” mean to you?
- What does the term “teamwork” mean to you?
- How might you use these other skills () in adulthood?
- Would you like to work in the aquaculture industry after high school? Why? Why not?
- Do you have plans to attend college? Do you think studying aquaculture influenced this decision? Why? Why not?

#### Objective Four:

- What do your parents think about your aquaculture program?
- What do other teachers think about your aquaculture program?
- What do local community members think about your aquaculture program?
- What is the future of aquaculture education programs?

Content and face validity were established by developing the open-ended questions in collaboration with state aquaculture specialists, West Virginia University agricultural and extension educators, secondary agricultural education teachers, and researchers investigating a similar project at Cornell University. Validity was addressed through the research design, which included gathering data at several sites. The lack of extended time spent in each interview site helped to establish credibility (Lincoln & Guba, 1985). Since no serious threats to validity existed, results may be generalized to the larger population of northeastern secondary agricultural education students who had enrolled in an aquaculture class during 1996-1997.

Data collection occurred during May 1997. Confidentiality and anonymity were assured to all respondents prior to beginning each interview. Following the methodology of Ary, Jacobs, and Razavieh (1996) and Lincoln and Guba (1985), all structured interviews occurred in a natural setting such as the selected students' respective classrooms, aquacultural facility, or agricultural education shop. Each interview lasted from 30 minutes to two hours. Upon completion of each interview, the researcher analyzed and transcribed the tape-recorded sessions before beginning another interview. Responses were categorized by question.

Data were analyzed following the methodology of Ary, Jacobs, and Razavieh (1996), Glesne and Peshkin (1992), Borg and Gall (1989), and Lincoln and Guba (1985). Emergent themes evolved through inductive analysis (Patton, 1980), reducing the raw data to the formation of relationships that supported development of grounded theory in the phenomena known as aquaculture education.

### **Findings**

Sixty students (43 males and 17 females) representing 13 schools throughout the

northeastern region were in the sample. Of those students, there were 20 seniors, 28 juniors, and 12 sophomores. A mix of rural and urban students made up the total group. Using descriptions of each student's place of residence, no majority existed between rural and urban sub-groups.

### Objective One

The first research objective sought to determine student demographics of those who were enrolled in a northeastern aquaculture program. The respondents were characterized as individuals who enjoyed outdoor experiences, especially fishing. During the interviews, students exhibited a sincere interest in studying natural resources, environmental or marine sciences, and showed a genuine curiosity of fish growth and development. The students expressed particular interest in aquaculture system maintenance.

Northeastern agriculture students were attracted to the aquaculture program because it was being taught as part of the agricultural education or natural resources program. They found aquaculture "interesting, new, or different" from what was expected from the normal curriculum for those programs. Also mentioned were the advantages of participating in a class with "hands-on experience and problem solving" skills. Generally, students liked being in the aquaculture program because they could earn "college credit" or "learn how to do pH" tests.

### Objective Two

Students' participation in the aquaculture program had affected their science and/or math abilities. The general consensus was that students' involvement in an aquaculture program provided them with more scientific skills than it did mathematical skills. The most cited increase of skills involved studies in chemistry and biology, with particular importance placed on pH testing and water quality. Also, students repeatedly talked about "hands-on" experience that facilitated their

learning in science and math. One student stated, "I've never really liked science until now, it's really interesting now because it's hands-on." Another student reiterated this by stating, "it helps a lot to do the different types of math cause it's easier when you're working with hands-on examples."

Mathematical and scientific concepts were easier to understand and grasp for students in the aquaculture program because of the practical nature of the experience. Students were involved in weighing and measuring feed or fish. These activities strengthened their understanding of fractions, growth rates, and conversions between metric and standard measurements. They participated actively in performing pH and dissolved oxygen tests. The application of these scientific activities in a "live" situation generated new interests in chemical reactions and the process of balancing chemical equations.

#### Objective Three

Students were asked what practical life skills they had gained from participating in an aquaculture program. Students responded that "teamwork, responsibility, and problem solving" were the skills gained. In addition, "leadership and communication (verbal and written)" skills were discussed during the interviews. Other skills included engineering, system design and maintenance, and the scientific research process. One notable statement was "I'll go out on a limb and say we're learning something about parenting skills, because they're [fish] depending on you and you have to do something when it's wrong or they'll die."

Northeastern students were asked if they had considered working in the aquaculture industry after graduation from high school. Less than ten students had thought about working in the aquaculture industry after high school, but as a part-time job only and mostly with fish hatcheries. The respondents stated that an aquaculture system

was too expensive to establish and maintain as a small business venture.

When asked if they planned to attend college and if their decision was influenced by their aquaculture experiences, about one-half of the students said they were planning to attend college, but that the aquaculture program had not influenced their decision. However, several students mentioned that their aquaculture experiences had reinforced previous decisions to major in agriculture, wildlife biology, animal and veterinarian sciences, and fisheries.

#### Objective Four

Northeastern agriculture students were asked what their parents thought about aquaculture being taught at the high school level. Students responded that their parents were very supportive of the aquaculture program because it provided "hands-on" learning, responsibility, and because of the scientific topics. Also mentioned was that most parents were envious that an aquaculture program did not exist when they had attended high school, but that they would like to learn more about it as adults. A few students stated that they had not talked with their parents about the aquaculture program because "it would take too long for them to understand."

When asked what other (nonagriculture) teachers thought about aquaculture being taught in high school, responses were split between those teachers who were aware of the aquaculture program and those who did not "know/care" about it. Respondents stated, "it's half and half because some know what we do, but others don't and they don't care; they choose not to know what we do." The teachers mentioned most often as supportive of the aquaculture program were biology and/or science instructors.

Northeastern agriculture students were asked what local community residents thought about aquaculture being taught at the high school level.

Again, respondents stated that community support could be likened to the support of nonagriculture teachers in high school. That is, only those who were aware of the program supported it. Students responded that community members who did not know or care about the aquaculture program thought it was “just a waste of money.”

Students stated that the future of aquaculture education depended upon more people becoming aware of local aquaculture programs and the skills these programs provided to high school students. Also, students stated that establishing and maintaining an aquaculture system was “hard work” and required a “dedicated teacher” who would seek “lots of help from other schools” that already had a system. Students believed the aquaculture program was one of “the best educational experiences” they had acquired in high school. One student summed up the sentiments of the group by stating, “I would encourage any school without an aquaculture system to get one because the kids really enjoy it.”

### **Conclusions**

Selected northeastern agricultural education students profoundly believed in their aquaculture programs because of the hands-on learning environment provided by such programs. Students found their aquaculture programs exciting, challenging, and fun. The process of learning scientific and mathematical concepts transcended age groups and geographic origination. This was especially true for topics relating to chemistry and biology.

Additional skills gained from enrolling in an aquaculture course included problem solving, teamwork, and most notably, responsibility. Students discussed how important it was to be an active learner in such a program. Northeastern agriculture students viewed the care and maintenance of an aquaculture system as paramount to the success of an aquaculture program. Communication and leadership skills

were discussed also as benefits gained from participation in an aquaculture education program.

On another note, northeastern agriculture students believed that increased awareness and support from other (nonagriculture) secondary school teachers and their communities would assure the continued successes of northeastern aquaculture education programs. The students concurred with perceptions of northeastern agriculture teachers (as found in the larger study) in terms of the time required for an aquaculture program. That is, an aquaculture education program requires considerable amount of time, dedication, and hard work for it to be successful.

### **Implications to Agriculture/ Aquaculture Education**

The evidence in this study implies that a concerted effort is needed to increase the awareness of aquaculture education programs within the communities they represent. Greater collaboration is needed with nonagriculture teachers, other than science and/or biology, at the secondary school level. The integration of aquaculture into disciplines such as industrial arts, nutrition, marketing, and health are a few of the programs that could benefit from collaboration with an aquaculture program. Until sufficient numbers of aquaculture programs are established in the northeastern region, linkages for sharing facilities and/or teachers between school districts are needed.

The results of this project showed that more males than females were enrolled in an agriculture/aquaculture program. Northeastern agriculture teachers and students both agreed that the educational benefits of an aquaculture program increased students’ knowledge and skills in areas outside the aquaculture curriculum. If this is true, then agricultural educator at all levels need to encourage more female students to enroll in an agriculture/aquaculture education program. One method of accomplishing this goal could be

realized by inviting high school principals, superintendents, guidance counselors, and parents to participate in the aquaculture education program.

The future of aquaculture education in the northeastern region will depend upon the attitudes and actions of the present. Agricultural educators must think futuristically about students, pedagogy, and content of agriculture/aquaculture education beyond the year 2000.

### **Recommendations**

Additional research, congruent with the aspects of this research project, is needed to determine the current status of secondary aquaculture education programs at the national level. Research studies are needed to ascertain the community impact of teaching aquaculture and to examine the linkages between education and the aquaculture industry.

In the larger portion of this study, northeastern agriculture teachers perceived that teaching aquaculture motivated students, yet teachers did not believe an aquaculture program would encourage students to seek a postsecondary education. Northeastern agriculture students stated that the "aquaculture program was one of the best educational experiences they had acquired in high school," yet they did not have aspirations of working in the aquaculture industry after graduating high school. Why is there a discrepancy between present and long-term benefits of enrolling in an aquaculture education program? A longitudinal study of agriculture students and teachers involved with an aquaculture program will provide a more accurate understanding of the long-term benefits of an aquaculture program.

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