



Ledyard Agri-Science & Technology Program



Ag III & IV Aquaculture Systems Curriculum

Agri-Science III & IV

AQUACULTURE SYSTEMS (AQ)

Agri-Science III & IV students will focus on those areas of interest they have developed over the previous two or three years and concentrate on developing skills more specific to those areas of interest.

Aquaculture Systems (AQ): encompasses the study of content areas such as life processes, health, nutrition, genetics, management and processing of aquatic organisms, service and repair of aquaculture vessels, machines and equipment. Students completing a program of study in this pathway will demonstrate competence in the application of principles and techniques for the development, application and management of aquaculture facilities in Agriculture, Food, and Natural Resources (AFNR) settings.

Students are expected to follow a specific course of study related to their career interests and goals that will prepare them for further study after high school or direct entry into the workplace. Some students may elect to pursue study in two diverse areas. Course selection is developed with the assistance of the Supervised Agricultural Experience (SAE) advisors and classroom teachers. Agri-Science III & IV students will continue to have opportunities to further develop leadership skills through participation in the National FFA Organization. Students are encouraged to participate in FFA Career Development Events (CDEs) in order to further develop skills.

AQUACULTURE SYSTEMS COURSES

<u>Supervised Agricultural Experience (SAE)</u>
<u>Mariculture, Aquaculture and Commercial Fisheries: Products, Methods and Marketing</u>
<u>Aquaculture Research and Design</u>
<u>Aquaculture Systems and Production</u>
<u>Sustainable Aquaculture and Aquaponics</u>

Course Title	Supervised Agricultural Experience (SAE)
Agriculture Pathway	All agricultural pathways
Length of Course	On-Going
Ledyard High School Vision of the Graduate	<p>Demonstrate an ability to work effectively with others, sharing ideas, acknowledging one another's strengths, and collaborating to produce presentations, projects, performances, or events.</p> <p>Demonstrate an ability to solve problems of varying complexity across a variety of content areas.</p> <p>Demonstrate critical thinking skills to find solutions, support arguments, and overcome challenges in a variety of content areas</p>
Course Overview	<p>SAE is a vital aspect of agricultural education. During Agri-Science I students begin to develop a plan for supervised work experience relating to their interests and career goals. All Agri-Science students must have an approved SAE program in place by July 1 at the start of the Agri-Science II year.</p> <p>SAE advisors work with individual students, parents, work-site mentors, and employers to ensure student activities are appropriate, meet student needs, and are in compliance with state labor laws. All students work with their SAE advisors to complete the Universal Structured Work-Based Learning Plan. In addition, some students must complete the Connecticut Department of Labor forms LED 75-1 (Workplace Learning Experiences for Minor Students in Hazardous Occupations) or the LED 31-23 (Workplace Learning Experiences for Minor Students Ages 14 or 15 in Non-Hazardous Occupations), or Unpaid Work Experience forms.</p>
Units of Study	<ol style="list-style-type: none"> 1. Develop an Approved Supervised Agricultural Experience (SAE) Program 2. Record Keeping 3. Employability Skills

Unit 1	Develop an Approved Supervised Agricultural Experience (SAE) Program
Essential Questions	<ol style="list-style-type: none"> 1. What is an SAE and why is it important? 2. What are the benefits of gaining employability skills for career growth?

Priority Standards Assessed in Learning
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Connecticut Agriculture, Food, and Natural Resources Standards	<p>CRP.10.01.02.c. Match potential career opportunities in career clusters with personal interests, talents, goals and preferences.</p> <p>CRP.10.02.02.a. Identify methods for setting goals for personal improvement and continuous growth in a career area (e.g., SMART goals, training, professional development, etc.).</p> <p>CRP.10.03.02.a. Identify trusted individuals to consult with on setting and achieving career and personal goals (e.g., counselors, teachers, mentors, coaches, community leaders, etc.).</p> <p>CS.03.01.02.a. Summarize the importance of safety, health and environmental management in the workplace.</p>
Common Core State Standards	<p>WHST.11-12.4 Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose and audience</p> <p>SL.11-12.4 Present information, findings, and supporting evidence clearly, concisely, and logically such that listeners can follow the line of reasoning and the organization, development, substance, and style are appropriate to purpose, audience, and task.</p>

Supporting Standards

Connecticut Agriculture, Food, and Natural Resources Standards	<p>CRP.04.02.01.a. Research and summarize the purpose of different forms of written and visual communication in formal and informal settings (e.g., letters, emails, reports, social media, graphics, diagrams, etc.).</p> <p>CRP.10.02.01.a. Categorize career advancement requirements for potential careers (e.g., degrees, certification, training, etc.).</p> <p>CS.03.03.04.c. Create a plan to mitigate the level of contamination or injury identified as a risk in the workplace.</p>
Common Core State Standards	<p>RST.11-12.4 Determine the meaning of words and phrases as they are used in text, including analyzing how an author uses and refines the meaning of a key term over the course of a text.</p>

Learning Objectives	Activities	CT AFNR, NGSS, CCSS
Identify local agricultural work experiences	<ul style="list-style-type: none"> ● Research and identify local 501(c)3 non profit organizations ● Locate local agricultural businesses ● Determine qualifications needed for employment ● Call to inquire about agricultural position 	CRP.04.02.01.a. CRP.10.02.01.a. CRP.10.03.02.a. SL.11-12.4 RST.11-12.4
Develop an appropriate SAE work experience	<ul style="list-style-type: none"> ● Identify agricultural interests ● Develop work experience activities/projects in line with career goals ● Write SMART goals for SAE growth and improvement ● Obtain approval from parents/guardians and SAE advisor ● Meet with SAE advisor during the school year and at least once during the summer 	CRP.10.01.02.c. CRP.10.02.02.a. CS.03.03.04.c. WHST.11-12.4 RST.11-12.4 SL.11-12.4
Complete appropriate work experience forms utilizing AFNR standards	<ul style="list-style-type: none"> ● Identify key skills necessary to complete the Structured Work-Based Learning Form ● Complete appropriate CT Departments of Labor and Education forms for student work experience 	CS.03.01.02.a. WHST.11-12.4 RST.11-12.4

Unit 2	Record Keeping
Essential Questions	<ol style="list-style-type: none"> 1. Why is record keeping essential to an SAE experience? 2. Why is documenting SAE experiences beneficial to a student?

Priority Standards Assessed in Learning

Connecticut Agriculture, Food, and Natural Resources Standards	<p>CRP.03.02.01.a. Research and examine components in a personal financial management plan (e.g., income, expense, budgeting, savings, credit, etc.).</p> <p>CRP.09.02.01.a. Identify and summarize personal management skills necessary to function effectively in the workplace (e.g., time management, planning, prioritizing, etc.).</p> <p>CRP.13.03.01.c. Apply for a chapter, state and national proficiency award that corresponds with an SAE program.</p>
Common Core State Standards	<p>RST.11-12.4 Determine the meaning of words and phrases as they are used in text, including analyzing how an author uses and refines the meaning of a key term over the course of a text.</p> <p>WHST.11-12.4 Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose and audience</p> <p>MP4 Model with mathematics</p>

Supporting Standards

Connecticut Agriculture, Food, and Natural Resources Standards	<p>ABS.02.02.01.a. Compare and contrast the different types of financial reports (e.g., income statements, cash flow statements, equity statements, etc.) and their frequency of use (e.g., daily, weekly, monthly, quarterly, annual) for monitoring AFNR business performance.</p>
Common Core State Standards	<p>MP6 Attend to precision</p>

Objectives	Activities	CT AFNR, NGSS, CCSS
Develop and maintain SAE records	<ul style="list-style-type: none"> ● Document time spent in SAE & FFA activities, skills learned, income, and expenses ● Utilize online record keeping program (AET) to document records ● Provide evidence of work using photographs, videos, and journals 	CRP.03.02.01.a. CRP.09.02.01.a. ABS.02.02.01.a. RST.11-12.4 WHST.11-12.4 MP4
Apply for SAE and FFA awards	<ul style="list-style-type: none"> ● Research SAE and FFA awards applicable to SAE experiences ● Calculate SAE hours worked, income and expenses ● Complete local, state, and national degree and award applications as applicable 	CRP.13.03.01.c. RST.11-12.4 WHST.11-12.4 MP6

Unit 3	Employability Skills
Essential Questions	<ol style="list-style-type: none"> 1. Why is it important to develop agricultural employability skills? 2. What types of skills are needed for an entry level agricultural position?

Priority Standards Assessed in Learning
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Connecticut Agriculture, Food, and Natural Resources Standards	<p>CRP.08.02.02.b. Apply decision-making processes to generate possible solutions to solve workplace and community problems.</p> <p>CRP.09.03.02.c. Model respectful and purposeful behaviors that contribute to positive morale and culture in the workplace and community (e.g., effectively communicating, recognizing accomplishments of others, etc.).</p> <p>CS.03.04.01.a. Identify and differentiate the appropriate protective equipment for the safe use and operation of specific tools and equipment (e.g. PPE, etc.).</p> <p>CS.03.04.02.a. Identify standard tools, equipment and safety procedures related to AFNR tasks.</p> <p>CS.03.04.03.a. Read and interpret operating instructions related to operation, storage and maintenance of tools and equipment related AFNR tasks.</p> <p>CS.05.01.03.a. Research and summarize specific tools (e.g., resumes, portfolios, cover letters, etc.) and processes (e.g., interviews, applications, etc.) needed to pursue a career in an AFNR pathway.</p>
Common Core State Standards	<p>WHST.11-12.4 Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose and audience</p> <p>SL.11-12.4 Present information, findings, and supporting evidence clearly, concisely, and logically such that listeners can follow the line of reasoning and the organization, development, substance, and style are appropriate to purpose, audience, and task.</p>

Supporting Standards

Connecticut Agriculture, Food, and Natural Resources Standards	<p>CRP.01.01.02.a. Distinguish personal levels of responsibility, which can be applied in the workplace and community.</p> <p>CRP.10.03.01.a. Summarize ways that input and/or advice from career area experts could assist in planning personal career goals.</p> <p>CS.05.01.01.b. Create a personal plan outlining goals and steps to obtain a career in an AFNR pathway.</p>
Common Core State Standards	<p>RST.11-12.4 Determine the meaning of words and phrases as they are used in text, including analyzing how an author uses and refines the meaning of a key term over the course of a text.</p>

Objectives	Activities	CT AFNR, NGSS, CCSS
Demonstrate effective and appropriate agricultural employability skills	<ul style="list-style-type: none"> ● Work safely and effectively in an SAE experience ● Select and use appropriate PPE for SAE experiences ● Report broken, chipped or cracked PPE to manager ● Select and use appropriate tools and equipment for SAE experiences according to manufacturer's directions ● Maintain professionalism and confidentiality in the workplace ● Model listening and problem solving skills 	CRP.01.01.02.a. CRP.08.02.02.b. CRP.09.03.02.c. CS.03.04.01.a. CS.03.04.02.a. CS.03.04.03.a. WHST.11-12.4 RST.11-12.4 SL.11-12.4
Demonstrate improvement and growth in career skills	<ul style="list-style-type: none"> ● Provide evidence of work using photographs, videos, and journals ● Write an annual summary of activities ● Create quarterly and yearly SAE goals to grow or improve SAE experience ● Share SAE experiences to educate others about additional options for SAE projects 	CRP.08.02.02.b. CRP.09.03.02.c. CRP.10.03.01.a. CS.05.01.01.b. WHST.11-12.4 RST.11-12.4 SL.11-12.4
Complete job application documents	<ul style="list-style-type: none"> ● Research agricultural job openings ● Create a cover letter and a resume ● Complete a job application ● Participate in a job interview 	CRP.09.03.02.c. CRP.10.03.01.a. CS.05.01.03.a. WHST.11-12.4 RST.11-12.4 SL.11-12.4

Vocabulary:

501 (c) 3	Paid Placement
Community Service	Placement
Entrepreneurship	SAE
Expenses	Scope
Hazardous Occupations	Structured Work-Based Learning Plan
Income	Volunteer
Liability	Work-site Mentor
Non-Profit Entity	

Assessments:

Record checks
Annual summaries
[On-site visits by advisor](#)
[SAE rubric](#)

Connections to College/Career Readiness:

Hands-on agricultural skills and knowledge for job placement

Resources/Materials:

[SAE Manual](#)
Online record keeping program- www.theaet.com
SDE/SDOL employment forms [LED 75-1](#), [LED 31-23](#), [Unpaid](#)

Course Title	Mariculture, Aquaculture and Commercial Fisheries: Products, Methods and Marketing
Agriculture Pathway	Aquaculture System Career Pathway
Length of Course	One Semester
Ledyard High School Vision of the Graduate	Demonstrate an ability to communicate information clearly and effectively through a variety of media, including written, oral, visual, musical, and/or video productions. Demonstrate an ability to solve problems of varying complexity across a variety of content areas. Demonstrate critical thinking skills to find solutions, support arguments, and overcome challenges in a variety of content areas.
Course Overview	This unit will explore methods of aquaculture and commercial fisheries as they apply to the seafood industry. Aquaculture students will study various species of aquatic organisms to gain knowledge of their source, method of aquaculture/capture, processing and marketing. This unit also covers saltwater aquaculture or mariculture. Students will integrate aquaculture and marine biology by creating saltwater ecosystems to support life for the aquatic organisms collected and studied in class. This will also introduce the laws and regulations relative to Long Island Sound, its fisheries and its current aquaculture practices.
Units of Study	<ol style="list-style-type: none"> 1. Commercial Fisheries Methods and Products 2. Aquaculture Methods and Products 3. Mariculture 4. Seafood Products and Marketing

Unit 1	Commercial Fisheries Methods and Products
Essential Questions	<ol style="list-style-type: none"> 1. What are the methods of commercial fisheries capture? 2. Which species are targeted in commercial fisheries?

Priority Standards Assessed in Learning
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Connecticut Agriculture, Food, and Natural Resources Standards	<p>AQ.01.01.03.a. Research and summarize major components of aquaculture (e.g., oyster farming, and commercial kelp beds, etc.).</p> <p>AQ.02.01.01.a. Explain the implications of animal welfare and animal rights for aquaculture production.</p> <p>AQ.04.02.05.b. Evaluate and select products from aquatic animals based on industry standards.</p> <p>AQ.09.01.02.a. Identify equipment and handling facilities used in modern aquaculture production.</p> <p>AQ.12.01.02.b. Evaluate different methods to keep processed aquatic species fresh.</p> <p>AQ.12.01.03.b. Evaluate the process of preparing an aquaculture product from harvest to final packaging.</p> <p>AQ.13.01.01.b. Describe the function of the following agencies as related to aquaculture: NOAA, DEEP, EPA, World Aquaculture Society, SeaGrant, FDA, USDA, Army Corps of Engineers, and United States Coast Guard.</p> <p>FPP.02.02.02.b. Explain the implementation of the seven principles of HACCP.</p> <p>FPP.02.04.01.a. Explain safety standards that must be observed in facility design and equipment use.</p> <p>FPP.04.03.06.b. Select methods and conditions for storing raw and processed food products.</p>
Common Core State Standards	RST.11-12.4 Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 9-10 texts and topics

Supporting Standards	
Connecticut Agriculture, Food, and Natural Resources Standards	AQ.03.01.02.a. Classify species of aquatic organisms as fresh water, marine, or diadromous, and by their genus and species AQ.09.01.01.a. Identify the following types of aquaculture systems: raceways, ponds, recirculating systems, and net pens or cages. AQ.12.01.01.b. Explain the Best Aquaculture Practices (BAP) certification and describe Hazard Analysis and Critical Control Point (HACCP) Compliance. FPP.01.01.01.a. Discuss the history and describe and explain the components (e.g., processing, distribution, byproducts) of the food products and processing industry.
Common Core State Standards	WHST 11-12.4 Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose and audience

Learning Objectives	Activities	CT AFNR, NGSS, CCSS
Identify the organizations, departments and administrations that monitor, inspect and determine safe practices of commercial fisheries products.	<ul style="list-style-type: none"> • Discuss the role and responsibilities of the FDA and USDA in respect to inspection and safety of seafood products • Define and explain HACCP management practices and their role in seafood safety • Research the state and federal organizations that monitor and regulate commercial fishing such as NOAA, EPA and the CT DEEP 	AQ.13.01.01.b FPP.01.01.01.a. FPP.02.02.02.b FPP.02.04.01.a RST.11-12.4
Identify seafood products, species, and forms in which they are marketed.	<ul style="list-style-type: none"> • Identify species commonly used in local markets • Recognize specific cuts and forms of fish • Categorize shellfish products and market forms • Use differences in morphological features of finfish, mollusks and crustaceans to classify and differentiate among species 	AQ.03.01.02.a. AQ.04.02.05.b. FPP.01.01.01.a. WHST.11-12.4
Identify and compare methods of commercial fishing.	<ul style="list-style-type: none"> • Compare and contrast commercial fisheries capture methods • Debate sustainable methods of commercial fisheries and vs. non-sustainable methods • Observe commercial fishing methods through documentaries, technology and underwater cameras. • Discuss the environmental impact of commercial methods • Review state and federal regulations for commercial fisheries 	AQ.01.01.03.c AQ.02.01.01.a. AQ.09.01.02.a AQ.12.01.03.b. FPP.01.01.01.a.

<p>Locate the sources of local and global commercial fisheries products.</p>	<ul style="list-style-type: none"> ● Create a map display that shows the source of common aquaculture products ● Visit a grocery store or seafood market to explore origin of common aquaculture products and market forms ● Distinguish between seafood products that are raised in aquaculture and those that are commercially harvested. 	<p>AQ.09.01.01.a. AQ.09.01.02.a. FPP.01.01.01.a.</p>
<p>Describe how commercial seafood products are processed, shipped and stored prior to market.</p>	<ul style="list-style-type: none"> ● Discuss quality control, storage and display of finfish and shellfish products ● Read and compare various seafood standards provided by seafood markets and grocery stores 	<p>AQ.12.01.01.a FPP.02.04.01.a. FPP.04.03.06.b AQ.12.01.02.b. RST.11-12.4</p>
<p>Compare and contrast sustainable vs. non-sustainable commercial fisheries methods</p>	<ul style="list-style-type: none"> ● Research historical data of common commercial fisheries, specifically those in decline ● Discuss/debate commercial fisheries methods and species in respect to sustainability and economics ● Visit websites such as Monterey Bay Aquarium, Greenpeace and Seafood Watch to make informed decisions about choosing sustainable seafoods 	<p>AQ.02.01.01.a. AQ.04.02.05.b. FPP.01.01.01.a.</p>

Unit 2	Aquaculture Methods and Products
Essential Questions	<ol style="list-style-type: none"> 1. What are the common methods used in aquaculture production? 2. What are the species commonly raised in aquaculture production?

Priority Standards Assessed in Learning

Connecticut Agriculture, Food, and Natural Resources Standards	<p>AQ.01.01.03.a. Research and summarize major components of aquaculture (e.g., oyster farming, and commercial kelp beds, etc.).</p> <p>AQ.07.01.01.b. Evaluate hatchery systems for suitability in rearing the following species: trout, salmon, tilapia, catfish, shrimp, lobster, oysters, crayfish, clams, and kelp.</p> <p>AQ.08.01.05.c. Analyze the pros and cons for the use of net pens for raising fish, in the world’s oceans.</p> <p>AQ.09.01.01.a. Identify the following types of aquaculture systems: raceways, ponds, recirculating systems, and net pens or cages.</p> <p>AQ.09.01.02.a. Identify equipment and handling facilities used in modern aquaculture production.</p> <p>AQ.09.02.01.b. Evaluate an aquaculture facility to determine if standards have been met.</p> <p>AQ.13.01.01.b. Describe the function of the following agencies as related to aquaculture: NOAA, DEEP, EPA, World Aquaculture Society, SeaGrant, FDA, USDA, Army Corps of Engineers, and United States Coast Guard.</p> <p>FPP.01.02.02.b. Discuss the application of industry standards in the food products and processing industry.</p> <p>FPP.02.01.03.b. Develop a basic equipment and facility maintenance program.</p> <p>FPP.02.02.02.b. Explain the implementation of the seven principles of HACCP.</p> <p>FPP.02.04.01.a. Explain safety standards that must be observed in facility design and equipment use.</p>
Common Core State Standards	RST.11-12.4 Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 9-10 texts and topics

Supporting Standards

Connecticut Agriculture, Food, and Natural Resources Standards	<p>AQ.01.02.01.b. Analyze the impact of aquaculture production methods on end product qualities (e.g., price, sustainability, marketing, labeling, animal welfare, etc.).</p> <p>AQ.08.01.05.a. Identify and describe how the following environmental factors impact aquaculture production: temperature, salinity, ammonia, nitrate, nitrite, dissolve oxygen, and pH.</p> <p>FPP.01.01.01.a. Discuss the history and describe and explain the components (e.g., processing, distribution, byproducts) of</p>
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	the food products and processing industry.
Common Core State Standards	WHST 11-12.4 Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose and audience

Objectives	Activities	CT AFNR, NGSS, CCSS
Identify the organizations, departments and administrations that monitor, inspect and determine safe practices of aquaculture methods and products.	<ul style="list-style-type: none"> • Discuss the role and responsibilities of the FDA and USDA in respect to inspection and safety of seafood products • Define and explain HACCP and BAP management practices and their role in seafood safety • Perform a mock seafood facilities inspection • Research how local shellfish commissions regulate shellfish grounds/water rights. 	AQ.01.01.03.a. AQ.07.01.01.b. AQ.13.01.01.b. FPP.01.01.01.a. FPP.02.02.02.b FPP.02.04.01.a RST.11-12.4
Identify and compare methods of closed and open aquaculture.	<ul style="list-style-type: none"> • Discuss the advantages and disadvantages of aquaculture production methods • Debate sustainable methods of aquaculture vs. non-sustainable methods • Compare and contrast closed vs open aquaculture • Identify and discuss the advantages/disadvantages of different methods of closed and open aquaculture. 	AQ.07.01.01.b. AQ.08.01.05.a. AQ.08.01.05.c. AQ.09.01.01.a. AQ.09.01.02.a. FPP.01.01.01.a.
Locate the sources of local and global aquaculture products.	<ul style="list-style-type: none"> • Create a map display that shows the source of common aquaculture products • Visit a grocery store or seafood market to explore origin of common aquaculture products and market forms • Visit local aquaculture facilities/operations • Distinguish between seafood products that are raised in aquaculture and those that are commercially harvested. 	AQ.09.01.01.a. AQ.09.01.02.a. FPP.01.01.01.a.
Develop a plan to improve aquaculture facilities to comply with food safe health and safety regulations.	<ul style="list-style-type: none"> • Evaluate the school's facility from the perspective of a potential customer. • Discuss the positive and negative aspects of the current school lab arrangement with respect to marketing, product safety and biosecurity • Identify potential lab improvement needs and create a lab 	AQ.01.02.01.b. AQ.07.01.01.b. AQ.09.01.02.a. AQ.09.02.01.b. FPP.01.02.02.b. FPP.02.01.03.b.

	<p>improvement plan</p> <ul style="list-style-type: none"> ● Review HACCP, FDA and USDA regulations as they pertain to our facility 	FPP.02.04.01.a.
Identify and remediate sanitation and biosecurity concerns associated with the school aquaculture facility	<ul style="list-style-type: none"> ● Conduct periodic HACCP inspections and identify unsanitary conditions or biosecurity issues ● Remediate problems identified during inspection 	AQ.13.01.01.b. FPP.01.02.02.b. FPP.02.01.03.b. FPP.02.04.01.a. WHST 11-12.4

Unit 3	Mariculture
Essential Questions	<ol style="list-style-type: none"> 1. How does mariculture differ from the other methods of aquaculture? 2. How does mariculture help to lessen the impact of overharvesting native populations of aquatic organisms?

Priority Standards Assessed in Learning
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Connecticut Agriculture, Food, and Natural Resources Standards	<p>AQ.01.01.03.a. Research and summarize major components of aquaculture (e.g., oyster farming, and commercial kelp beds, etc.).</p> <p>AQ.03.01.02.a. Classify species of aquatic organisms as fresh water, marine, or diadromous, and by their genus and species</p> <p>AQ.07.01.01.b. Evaluate hatchery systems for suitability in rearing the following species: trout, salmon, tilapia, catfish, shrimp, lobster, oysters, crayfish, clams, and kelp.</p> <p>AQ.07.01.02.a. Describe the sexual reproduction process in fish, crustaceans and mollusks.</p> <p>AQ.08.01.05.a. Identify and describe how the following environmental factors impact aquaculture production: temperature, salinity, ammonia, nitrate, nitrite, dissolve oxygen, and pH.</p> <p>AQ.08.01.05.c. Analyze the pros and cons for the use of net pens for raising fish, in the world’s oceans.</p> <p>AQ.14.03.01.c. Demonstrate proper technique for taking water samples to perform water quality assessments.</p> <p>AQ.14.03.06.b. Take, record and analyze TAN measurements</p> <p>ESS.01.01.01.a. Identify sample types and sampling techniques used to collect laboratory and field data.</p> <p>ESS.01.02.02.c. Calibrate and use environmental monitoring instruments according to standard operating procedures.</p>
Common Core State Standards	WHST 11-12.4 Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose and audience

	<p>RST.11-12.4 Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 9-10 texts and topics</p> <p>MP 4 Model with mathematics</p> <p>MP 5 Use appropriate tools strategically</p>
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Supporting Standards

<p>Connecticut Agriculture, Food, and Natural Resources Standards</p>	<p>AQ.04.01.01.c. Explain how the components and systems of aquatic species anatomy and physiology relate to the production and use of aquatic species.</p> <p>AQ.09.01.01.a. Identify the following types of aquaculture systems: raceways, ponds, recirculating systems, and net pens or cages.</p> <p>AQ.14.01.02.b. Compare and contrast freshwater, saltwater, and brackish water.</p> <p>AQ.14.03.07.b. Measure, record and analyze the following water quality factors as necessary: water hardness, carbon dioxide, salinity, iron, chlorine, and hydrogen sulfide.</p> <p>AQ.14.03.02.b. Conduct a dissolved oxygen test. Analyze and record test results.</p> <p>NRS.01.01.02.b. Describe the interdependence of organisms within an ecosystem.</p> <p>NNRS.02.02.01.b. Assess and explain how different kinds of human activity affect the use and availability of natural resources (i.e., agriculture, industry, transportation, etc.).</p> <p>RS.01.02.04.c. Conduct a field inventory of aquatic species, and record and document findings.</p> <p>NRS.02.02.04.a. Examine and describe the manner in which modern lifestyles are related to the depletion of natural resources.</p> <p>NRS.02.04.06.a. Identify characteristics of healthy marine and coastal natural resources.</p>
<p>Common Core State Standards</p>	<p>WHST.11-12.1.e Provide a concluding statement or section that follows from or supports the argument presented.</p> <p>WHST.11-12.2a Introduce a topic and organize complex ideas, concepts, and information so that each new element builds on that which precedes it to create a unified whole; include formatting (e.g., headings), graphics (e.g., figures, tables), and multimedia when useful to aiding comprehension</p> <p>MP1 Make sense of problems and persevere in solving them.</p> <p>MP2 Reason abstractly and quantitatively.</p>

Objectives	Activities	CT AFNR, NGSS, CCSS
Identify methods of Mariculture	<ul style="list-style-type: none"> ● Research and identify different methods of saltwater aquaculture ● Research and identify species used in saltwater aquaculture ● Identify, research and visit local saltwater aquaculture businesses to compare and contrast methods and species 	AQ.01.01.03.a. AQ.07.01.01.b. AQ.08.01.05.c. AQ.09.01.01.a.
Acquire samples of Saltwater Organisms	<ul style="list-style-type: none"> ● Collect saltwater organisms using different methods of capture ● Safely handle, transport and acclimate live organism to a prepared aquatic system ● Research the rules and regulations of a Scientific Collectors Permit 	AQ.03.01.02.a. AQ.14.01.02.b. NRS.01.02.04.c.
Identify Long Island Sound organisms and define their ecological role in their environment.	<ul style="list-style-type: none"> ● Identify Long Island Sound organisms using a dichotomous key. ● Identify and describe in writing the life history of common Long Island Sound species. ● Use differences in morphological features of finfish, mollusks and crustaceans to identify and differentiate among species ● Classify organisms using zoological taxonomy system ● Report captured organisms to the CT DEEP, per Collection Permit requirements 	AQ.03.01.02.a. AQ.14.01.02.b. NRS.01.02.04.c. RST.11-12.4 WHST.11-12.4
Design, create and maintain a simulated saltwater ecosystem	<ul style="list-style-type: none"> ● Use appropriate techniques and aquaculture practices to plan and create a simulated saltwater system ● Demonstrate proper use, care and sanitation of aquaculture systems and related equipment ● Develop and use a task list for cleaning and maintaining a saltwater system 	AQ.08.01.05.a. AQ.04.01.01.c. AQ.14.01.02.b. NRS.02.04.06.a. WHST.11-12.4
Safely and accurately test and analyze various water parameters	<ul style="list-style-type: none"> ● Safely perform water tests according to instruction and classroom guidelines ● Sample and test saltwater parameters using water test kits ● Determine and record specific chemical levels based on water test results ● Assess water quality by recording and analyzing results of the water tests ● Discuss environmentally sound practices for disposal of 	AQ.14.03.01.c. AQ.14.03.02.b. AQ.14.03.06.b. AQ.14.03.07.b. RST.11-12.4 WHST.11-12.2a WHST.11-12.4 MP1

	<p>wastewater and water testing chemicals.</p> <ul style="list-style-type: none"> • Locate, read and interpret SDS for water testing reagents 	<p>MP4 MP5</p>
<p>Identify and compare trends in water quality of Long Island Sound with a simulated aquatic ecosystem.</p>	<ul style="list-style-type: none"> • Analyze the water quality of a system and compare the results to Long Island sound water parameters. • Test, record and analyze all forms of nitrogen in a saltwater system • Analyze water test results to conclude, in writing, filtration, cycling and overall health of a saltwater system • Compare and contrast differences in saltwater and freshwater parameters through testing and analysis. • Read articles on hypoxia and discuss oxygen gain and consumption in Long Island Sound 	<p>AQ.08.01.05.a. AQ.14.03.01.c. AQ.14.03.06.b. AQ.14.01.02.b. AQ.14.03.07.b. ESS.01.01.01.a ESS.01.02.02.c. NRS.02.04.06.a. WHST.11-12.2a WHST.11-12.4 MP1 MP3 MP4</p>
<p>Compare and contrast the life cycles of Long Island Sound organisms</p>	<ul style="list-style-type: none"> • Describe in writing the life cycles of the different varieties of plankton, mollusks, crustaceans and fish • Compare and contrast reproductive processes in mollusks, crustaceans and fish 	<p>AQ.03.01.02.a. AQ.04.01.01.c. AQ.07.01.02.a. NRS.01.01.02.b. WHST.11-12.4</p>
<p>Test and control salinity in a mariculture system</p>	<ul style="list-style-type: none"> • Mix and balance correct amounts of salt to achieve a specific salinity in a saltwater system • Use three different methods (refractometer, hydrometer and colorimeter) to test the salinity levels in water • Express in writing the differences between saltwater, freshwater and estuarine environments • Test and compare the salinity from three different natural bodies of water that link to Long Island Sound 	<p>AQ.14.01.02.b. AQ.14.03.01.c. WHST.11-12.4 MP4 MP5</p>
<p>Explore the unique ecological aspects of Long Island Sound</p>	<ul style="list-style-type: none"> • Read given articles and answer questions on the unique ecological attributes of estuary environments • Map and label the specific zones of Long Island Sound. • Identify different habitats and explain the specific organisms that reside in each • Identify wetlands and describe their ecological importance 	<p>AQ.08.01.05.a. NRS.01.01.02.b. NRS.02.04.06.a. RST.11-12.4 WHST.11-12.4</p>

Identify the negative environmental impacts on Long Island Sound’s water quality and ecology	<ul style="list-style-type: none"> ● Research and explain in writing the sources and impacts of eutrophication ● Research and discuss hypoxia in Long Island Sound ● Research and discuss human impacts on the Long Island Sound and its tributaries ● Acquire water samples and test different water parameters of the Long Island Sound 	<p>AQ.08.01.05.a. NNRS.02.02.01.b. NRS.02.02.04.a. RST.11-12.4 WHST.11-12.2a WHST.11-12.4</p>
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Unit 4	Seafood Products and Marketing
Essential Questions	<ol style="list-style-type: none"> 1. What are the common forms of seafood available at any given market in the U.S.? 2. What are the processes and organizations used to inspect and deliver seafood products from water to table?

Priority Standards Assessed in Learning
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Connecticut Agriculture, Food, and Natural Resources Standards	<p>AQ.01.02.01.a. Identify and categorize terms and methods related to aquaculture production (e.g., sustainable, conventional, humanely raised, natural, organic, etc.).</p> <p>AQ.01.02.02.a. Research and examine marketing methods for aquaculture products and services (e.g., conventional, niche markets, locally grown, etc.).</p> <p>AQ.04.02.05.b. Evaluate and select products from aquatic animals based on industry standards.</p> <p>AQ.09.02.01.b. Evaluate an aquaculture facility to determine if standards have been met.</p> <p>AQ.10.01.02.b. Determine costs and expenses of aquaculture vehicles, vessels, tools and equipment.</p> <p>AQ.12.01.01.b. Explain the Best Aquaculture Practices (BAP) certification and describe Hazard Analysis and Critical Control Point (HACCP) Compliance.</p> <p>AQ.12.01.03.b. Evaluate the process of preparing an aquaculture product from harvest to final packaging.</p> <p>AQ.12.02.02.b. Evaluate appropriate market for an aquatic crop.</p> <p>AQ.13.01.01.b. Describe the function of the following agencies as related to aquaculture: NOAA, DEEP, EPA, World Aquaculture Society, SeaGrant, FDA, USDA, Army Corps of Engineers, and United States Coast Guard.</p> <p>FPP.01.02.01.a. Explain the purposes of organizations that are part of or regulate the food products and processing industry.</p> <p>FPP.01.02.02.b. Discuss the application of industry standards in the food products and processing industry.</p> <p>FPP.02.02.02.b. Explain the implementation of the seven principles of HACCP.</p>
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	<p>FPP.02.04.01.a. Explain safety standards that must be observed in facility design and equipment use.</p> <p>FPP.03.01.06.c. Prepare and label foods according to the established standards of regulatory agencies.</p> <p>FPP.04.02.01.c. Evaluate, grade and classify processed meat, egg, poultry, fish and dairy products.</p> <p>FPP.04.03.06.b. Select methods and conditions for storing raw and processed food products.</p>
Common Core State Standards	<p>WHST.11-12.4 Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose and audience</p> <p>RST.11-12.4 Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 9-10 texts and topics</p> <p>MP.4 Model with mathematics</p> <p>MP.5 Use appropriate tools strategically</p>

Supporting Standards

Connecticut Agriculture, Food, and Natural Resources Standards	<p>AQ.01.01.03.c. Predict trends and implications of future developments within different sectors of the aquaculture industry on production practices and the environment.</p> <p>AQ.12.01.02.b. Evaluate different methods to keep processed aquatic species fresh.</p> <p>AQ.12.02.01.b. Explain the elements in developing a marketing plan.</p> <p>AQ.12.01.04.b. Describe the process of creating value added aquaculture products.</p> <p>AQ.12.02.01.b. Explain the elements in developing a marketing plan.</p> <p>FPP.02.01.03.b. Develop a basic equipment and facility maintenance program.</p>
Common Core State Standards	<p>WHST.11-12.1.e Provide a concluding statement or section that follows from or supports the argument presented.</p> <p>MP.1 Make sense of problems and persevere in solving them.</p> <p>MP.2 Reason abstractly and quantitatively.</p>

Learning Objectives	Activities	CT AFNR, NGSS, CCSS
Identify the organizations, departments and administrations that monitor, inspect and determine safe practices of aquaculture methods and products.	<ul style="list-style-type: none"> ● Discuss the role and responsibilities of the FDA and USDA in respect to inspection and safety of seafood products ● Explain the Best Aquaculture Practices (BAP) certification and describe Hazard Analysis and critical Control Point (HACCP) compliance ● Research how local shellfish commissions regulate shellfish grounds/water rights ● Visit local seafood markets to review the inspection and safety procedures 	AQ.01.01.03.a. AQ.12.01.01.b. AQ.13.01.01.b. FPP.01.02.01.a. FPP.02.02.02.b FPP.02.04.01.a RST.11-12.4
Identify and explain characteristics of quality control, storage and display of local seafood products	<ul style="list-style-type: none"> ● Discuss quality control, storage and display of finfish and shellfish products ● Define and discuss biosecurity in respect to seafood facilities and food safety ● Review and compare various seafood standards provided by seafood markets and grocery stores ● Visit local seafood departments to observe methods of handling, storage, display and quality control ● Read and analyze seafood labels and shellfish tags ● Create a food label according to established standards of regulatory agencies 	AQ.04.02.05.b. AQ.09.02.01.b. AQ.12.01.02.b. AQ.12.01.03.b. FPP.01.02.01.a. FPP.03.01.06.c. FPP.04.02.01.c. FPP.04.03.06.b. RST.11-12.4 WHST.11-12.1.e
Safely prepare various seafood products for consumption	<ul style="list-style-type: none"> ● Evaluate, safely handle and prepare seafood products for consumption <i>or</i> provide an outline of aforementioned ● Identify the characteristics of fresh seafood ● Discuss the health risks of consuming raw or undercooked seafood products ● Identify market cuts and forms of seafood ● Define and differentiate fresh vs. frozen seafood 	AQ.04.02.05.b. AQ.12.01.02.b. FPP.01.02.02.b. FPP.04.02.01.c. FPP.04.03.06.b. WHST 11-12.4
Identify the four P's of marketing and explain the variables involved in seafood product marketing	<ul style="list-style-type: none"> ● Define and discuss the four P's (Product, Price, Promotion and Place) involved in an aquaculture marketing plan ● Evaluate a seafood package based on the four P's ● Design a diagram outlining the four P's in respect to a local seafood product of choice 	AQ.01.01.03.c. AQ.01.02.02.a. AQ.12.02.01.b. AQ.12.02.02.b RST.11-12.4

<p>Examine and complete a net worth spreadsheet</p>	<ul style="list-style-type: none"> ● Create a personal five year plan based on career and personal goals and develop a net worth spreadsheet ● Differentiate liabilities and assets for both personal income and business use ● Complete and analyze an online amortization schedule for an intermediate and long term liability ● Generate a list of aquaculture facility assets and liabilities ● Design and complete a net worth spreadsheet using these aquaculture facility assets and liabilities 	<p>AQ.01.02.01.a. AQ.10.01.02.b. FPP.02.01.03.b. WHST 11-12.4 MP1 MP2 MP4 MP5</p>
<p>Develop a marketing plan for an aquaculture or commercial fisheries product</p>	<ul style="list-style-type: none"> ● Research and develop a marketable package for a local seafood product ● Develop labels for a package including sustainability, nutritional information, product source and safe handling instructions ● Develop prices for products based on local market and production costs ● Create 'added value' for a given aquaculture product 	<p>AQ.12.01.03.b. AQ.12.02.01.b. AQ.12.01.04.b. FPP.03.01.06.c. FPP.04.03.06.b. RST.11-12.4 WHST.11-12.1.e MP4 MP5</p>
<p>Create a marketing campaign for Ledyard Aquaculture.</p>	<ul style="list-style-type: none"> ● Develop a marketing campaign for Ledyard aquaculture products ● Design a Logo for Ledyard Aquaculture 	<p>FPP.03.01.06.c. FPP.04.03.06.b. RST.11-12.4</p>

Vocabulary:

Acclimation	HACCP	Primary Consumers	Trawling
Benthic	Hydrometer	Primary Producers	USDA
Brackish	Hypoxia	Purse Seining	Zooplankton
Cage Culture	Longline	Refractometer	
Colorimetric Test	Meroplankton	Salinity	
Dichotomous Key	Pelagic	Secondary Consumer	
Dredge	Pen/Net Aquaculture	Seine Net	
Estuary	Phytoplankton	Shellfish Commission	
Eutrophication	Pond Aquaculture	String Aquaculture	
FDA	Pot/Trap	Tertiary Consumers	

Assessments:

Lab activities

[Water Analysis](#)

Field Trips - Collection and Visits to Facilities

[Class assignments](#)

[Quizzes/Tests](#)

[Projects](#)

Connections to College/Career Readiness:**Resources/Materials:**

- Fundamentals of Aquaculture: Step by Step Guide to Commercial Aquaculture
- Text: [Aquaculture Science, Second Edition](#). Parker.
- Production Tanks and Fish
- Re-Circulating Systems Equipment and Materials
- Long Island Sound: An Atlas of Natural Resources
- Marine Animals of Southern New England and New York: Dichotomous Key
- LongIslandSoundStudy.net
- Aquaculture lab equipment
- Aquarium Equipment
- Collection Equipment
- Bluff Point
- www.ct.gov/deep/ Department of Energy and Environmental Protection

Course Title	Aquaculture Research and Design
Agriculture Pathway	Aquaculture System Career Pathway
Length of Course	One Semester
Ledyard High School Vision of the Graduate	Demonstrate critical thinking skills to find solutions, support arguments, and overcome challenges in a variety of content areas. Demonstrate an ability to solve problems of varying complexity across a variety of content areas.
Course Overview	The Aquaculture Research and Design unit provides students with the opportunity to apply skills from previous units in the design, maintenance, restoration, techniques or construction of a working aquatic system or working components of an aquatic system. Students will research, plan, implement and report on their project over the course of the semester.
Units of Study	1. Senior Aquaculture Research and Design Project

Unit 1	Senior Aquaculture Research and Design Project
Essential Questions	<p>1. How does one plan, implement and evaluate an AFNR project ?</p> <p>2. How does one present project work?</p>

Priority Standards Assessed in Learning
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Connecticut Agriculture, Food, and Natural Resources Standards	<p>AQ.09.01.01.b. Critique designs for an aquaculture facility and prescribe alternative layouts and adjustments for the safe and efficient use of the facility.</p> <p>AQ.09.01.01.c. Design an aquatic facility, focusing on aquatic species requirements, efficiency, safety and ease of handling.</p> <p>AQ.09.01.02.c. Select equipment and implement handling procedures and improvements to enhance production efficiency of aquatic species.</p> <p>AQ.09.01.03.c. Construct a recirculating aquaculture system (RAS) based on dynamic interaction including flow rate, size, capacity, plumbing, friction loss, species and component requirements.</p> <p>AQ.09.02.01.c. Design a facility that meets standards for the legal, safe, ethical and efficient production of aquatic species.</p> <p>AQ.10.01.01.c. Design vehicles, vessels, tools and equipment used in aquaculture</p> <p>AQ.13.01.01.c. Network with an aquaculture industry professional.</p> <p>AQ.14.01.02.c. Rear aquaculture species in freshwater, saltwater, and brackish water.</p>
Next Generation Science Standards	HS-ETS1-2. Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering
Common Core State Standards	<p>RST.11-12.3. Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks; analyze the specific results based on explanations in the text</p> <p>RST.11-12.4. Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 11–12 texts and topics</p> <p>WHST.9-12.9 Draw evidence from informational texts to support analysis, reflection, and research. (HS-PS3-4),(HS-PS3-5)</p> <p>SL 11-12.2. Integrate multiple sources of information presented in diverse formats and media (e.g., visually, quantitatively, orally) in order to make informed decisions</p> <p>SL.11-12.5 Make strategic use of digital media (e.g., textual, graphical, audio, visual, and interactive elements) in presentations to enhance understanding of findings, reasoning, and evidence and to add interest.</p> <p>MP.1. Make sense of problems and persevere in solving them</p> <p>MP.2 Reason abstractly and quantitatively</p>

Supporting Standards	
Connecticut Agriculture, Food, and Natural Resources Standards	<p>AQ.09.01.04.c. Design and construct a functional bio filtration system.</p> <p>AQ.07.01.01.c. Design and build appropriate hatchery for a given aquatic species.</p> <p>AQ.01.02.c. Spawn aquaculture species.</p> <p>AQ.09.03.01.c. Describe the procedures for the treatment and disposal of hazardous materials and hazardous waste.</p> <p>AQ.10.01.02.b. Determine costs and expenses of aquaculture vehicles, vessels, tools and equipment.</p> <p>AQ.11.01.03.c. Design a nutritional program for fish that utilizes standard industry practices.</p> <p>AQ.12.01.01.c. Apply BAP and create a HACCP Plan for processing aquaculture products.</p> <p>AQ.12.01.02.c. Prepare, preserve and market aquatic species for retail sales.</p> <p>AQ.15.01.05.c. Choose an aquaponics system based on aquatic animal and plant species to be grown.</p> <p>AQ.15.01.06.c. Develop a management program to control aquaponics pests.</p> <p>AQ.15.01.08.c. Evaluate issues that must be overcome to make aquaponics sustainable.</p>
Next Generation Science Standards	<p>HS-ETS1-3. Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts.</p>
Common Core State Standards	<p>RST.11-12.9 Synthesize information from a range of sources (e.g., texts, experiments, simulations) into a coherent understanding of a process, phenomenon, or concept, resolving conflicting information when possible.</p> <p>SL 11-12.1. Initiate and participate effectively in a range of collaborative discussions (one on-one, in groups, and teacher-led) with diverse partners on grades 11–12 topics, texts, and issues, building on others’ ideas and expressing their own clearly and persuasively.</p> <p>and solve problems, evaluating the credibility and accuracy of each source and noting any discrepancies among the data.</p> <p>MP.3 Construct viable arguments and critique the reasoning of others.</p> <p>MP.4. Model with mathematics.</p>

Learning Objectives	Activities	CT AFNR, NGSS, CCSS
Develop a plan for an independent, AFNR-related project.	<ul style="list-style-type: none"> ● With assistance from the instructor, identify a suitable topic to meet the established requirements for the senior research and design project ● Submit a formal project proposal delineating goals, activities, procedures, and materials ● Conduct necessary background research to develop a plan. 	AQ.09.01.01.b. AQ.09.01.01.c. AQ.09.01.02.c. AQ.09.01.04.c. AQ.07.01.01.c. AQ.09.03.01.c. AQ.10.01.01.c. AQ.11.01.03.c. AQ.13.01.01.c. AQ.15.01.05.c. AQ.15.01.06.c. AQ.15.01.08.c. HS-ETS1-2. RST.11-12.3. RST.11-12.4. RST.11-12.9 SL 11-12.1. SL 11-12.2. MP.1. MP.2.
Execute a project plan in order to meet established goals. Assess progress and modify plans as needed.	<ul style="list-style-type: none"> ● Complete planned activities ● Maintain a journal to record successes and challenges ● Discuss issues with advisor, peers and outside resource persons in order to solve problems ● Conduct research as needed to identify and solve problems ● Make adjustments to the plan as needed. 	AQ.01.02.c. AQ.09.03.01.c. AQ.09.01.03.c. AQ.10.01.02.b. AQ.11.01.03.c. AQ.12.01.01.c. AQ.14.01.02.c. HS-ETS1-2. HS-ETS1-3. RST.11-12.3. RST.11-12.4. RST.11-12.9 SL 11-12.1. SL 11-12.2. MP.1. MP.2.

Present a project summary.	<ul style="list-style-type: none"> ● Prepare and present a summary of the work goals, accomplishments, challenges, and final outcome. ● Prepare an as-built drawing or other appropriate visual documentation of the work accomplished. ● Prepare a bill of materials and costing for the work accomplished ● Present to the finished work for final assessment. 	RST.11-12.4. SL 11-12.1. SL.11-12.5 HS-ETS1-3. MP.1. MP.2.
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Vocabulary:
Varies - as appropriate to the individual project.

Assessments:
[Plans and Journals](#)
[Practical Work Evaluations](#)
[Completed project](#)
Summary Presentation

Connections to College/Career Readiness:

Resources/Materials:
Reference: [Aquatic Systems Engineering: Devices and How they Function](#), P.R. Escobal
Reference: [Aquaponics Food Production: Raising Fish and Plants for Food and Profit](#), Nelson and Pade
Reference: [Ichthyology](#), Lager, Bardach and Miller
Reference: [Principles of Aquaculture](#), Wiley
Reference: [Sustainable Aquaculture](#), Bardach
Text: [Aquaculture Science](#), Second Edition. Parker. Delmar
Digital Resource: Southeastern Regional Aquaculture Center Publishing: www.srac.msstate.edu

Materials:
Recirculating Systems and associated Equipment and Materials
General Aquaculture Equipment
PVC Plumbing – Fittings and pipe and associated tools and equipment
Water Testing Safety Equipment and Kits
Available Aquatic Organisms

Course Title	Aquaculture Systems & Production
Agriculture Pathway	Aquaculture System
Length of Course	One Semester
Ledyard High School Vision of the Graduate	Demonstrate an ability to communicate information clearly and effectively through a variety of media, including written, oral, visual, musical, and/or video productions. Demonstrate an ability to solve problems of varying complexity across a variety of content areas. Demonstrate critical thinking skills to find solutions, support arguments, and overcome challenges in a variety of content areas.
Course Overview	Aquaculture Systems and Production explores the various production methods, systems, equipment and aquatic species used in the aquaculture industry. Students will focus on the different types of filtration systems and the methods used to sustain good water quality and fish health, specifically mechanical, biological and chemical filtration. Students will address and utilize these methods in our own facility through practical work and water analysis. They will perform tasks which include: monitoring production systems, logging fish growth and health, determining feeds and feed conversions, water quality analysis, diagnosis and treatment, and the maintenance and sanitation of aquaculture systems and equipment.
Units of Study	<ol style="list-style-type: none"> 1. Aquaculture systems: methods, components and equipment 2. Methods of filtration 3. Water quality analysis and treatment 4. Aquatic species 5. Feeds and feeding requirements

Unit 1	Aquaculture systems: methods, components and equipment
Essential Questions	<ol style="list-style-type: none"> 1. What are the different methods, components and equipment used in the rearing of aquatic species? 2. How do these systems function in the growth, health and production of aquatic species?

Priority Standards Assessed in Learning
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Connecticut Agriculture, Food, and Natural Resources Standards	<p>AQ.09.01.01.a. Identify the following types of aquaculture systems: raceways, ponds, recirculating systems, and net pens or cages.</p> <p>AQ.09.01.02.a. Identify equipment and handling facilities used in modern aquaculture production.</p> <p>AQ.09.01.03.a. Identify and describe the following parts of a recirculating aquaculture system (RAS): tank, sump or reservoir, pump, solid waste filter, U/V sterilizer, heat exchanger, bio-filter, and aeration.</p> <p>AQ.09.01.03.b. Explain the basic electrical, plumbing and mechanical components of aquaculture systems.</p>
Common Core State Standards	<p>RST.11-12.4 Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 9-10 texts and topics</p> <p>WHST 11-12.4 Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose and audience</p>

Supporting Standards

Connecticut Agriculture, Food, and Natural Resources Standards	<p>AQ.02.01.02.c. Devise, implement and evaluate safety procedures and plans for working with aquatic animals.</p> <p>AQ.14.01.02.c. Rear aquaculture species in freshwater, saltwater, and brackish water.</p> <p>AQ.05.01.01.c. Perform diagnostic tests to detect health problems in aquatic species.</p>
Common Core State Standards	<p>WHST.11-12.2a Introduce a topic and organize complex ideas, concepts, and information so that each new element builds on that which precedes it to create a unified whole; include formatting (e.g., headings), graphics (e.g., figures, tables), and multimedia when useful to aiding comprehension</p>

Learning Objectives	Activities	CT AFNR, NGSS, CCSS
Identify aquaculture equipment and components and describe their role in filtration and water quality.	<ul style="list-style-type: none"> ● Identify and define in writing the use and function of aquaculture equipment ● Describe the typical functions of aquatic systems components and their role in a production system. 	AQ.09.01.01.a. AQ.09.01.02.a. AQ.09.01.03.a. AQ.09.01.03.b.
Demonstrate appropriate maintenance techniques for recirculating aquaculture systems	<ul style="list-style-type: none"> ● Demonstrate appropriate maintenance techniques for a functioning re-circulating system ● Demonstrate proper use, care and sanitation of aquaculture equipment ● Develop and use a task list for cleaning and maintenance of re-circulating systems ● Analyze and remedy system malfunctions 	AQ.02.01.02.c AQ.14.01.02.c. AQ.05.01.01.c.
Demonstrate proper care and sanitation of aquaculture equipment	<ul style="list-style-type: none"> ● Safely use aquaculture equipment for it's intent and purpose ● Demonstrate safe practices in the lab and classroom while working with equipment, tools and production systems ● Discuss the importance of biosecurity 	AQ.02.01.02.c AQ.14.01.02.c. AQ.05.01.01.c.
Assess the operational status of an aquatic system and its components	<ul style="list-style-type: none"> ● Perform a 'walk through' of the lab noting system conditions. ● Identify system malfunctions and make suggestions to remedy the issue. ● Perform system maintenance based on operational assessment 	AQ.09.01.03.a. AQ.09.01.03.b. RST.11-12.4 WHST.11-12.4

Unit 2	Methods of filtration
Essential Questions	<ol style="list-style-type: none"> 1. What are the different methods of filtration used in aquaculture? 2. What functions do these filtration devices provide? 3. How does filtration improve the water quality of a system?

Priority Standards Assessed in Learning
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Connecticut Agriculture, Food, and Natural Resources Standards	<p>AQ.14.03.06.c. Analyze management practices that will reduce TAN in aquaculture systems.</p> <p>AQ.14.03.08.c. Select appropriate management methods to control weeds and algae in aquaculture systems.</p> <p>AQ.08.02.01.c. Demonstrate the use of water- testing instruments and water-treatment equipment to treat wastewater.</p> <p>AQ.09.01.03.a. Identify and describe the following parts of a recirculating aquaculture system (RAS): tank, sump or reservoir, pump, solid waste filter, U/V sterilizer, heat exchanger, bio-filter, and aeration.</p> <p>AQ.09.01.04.a. Describe how the bio-filter of a recirculating aquaculture system (RAS) converts ammonia to nitrite, and nitrite to nitrate.</p> <p>AQ.09.01.04.b. Diagram the nitrogen cycle in relation to aquaculture.</p>
Common Core State Standards	<p>WHST 11-12.4 Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose and audience</p> <p>SL.11-12.5 Present information, findings, and supporting evidence clearly, concisely, and logically such that listeners can follow the line of reasoning and the organization, development, substance, and style are appropriate to purpose, audience, and task.</p> <p>MP 4 Model with mathematics</p> <p>MP 5 Use appropriate tools strategically</p>

Supporting Standards

Connecticut Agriculture, Food, and Natural Resources Standards	<p>AQ.02.01.02.c. Devise, implement and evaluate safety procedures and plans for working with aquatic animals.</p> <p>AQ.14.03.08.b. Explain methods to control weeds and algae in aquaculture systems.</p>
Common Core State Standards	<p>MP.3 Construct viable arguments and critique the reasoning of others.</p> <p>MP 4 Model with mathematics</p>

MP 5 Use appropriate tools strategically

Objectives	Activities	CT AFNR, NGSS, CCSS
Compare and contrast the three methods of filtration in aquatic systems	<ul style="list-style-type: none"> ● Define and differentiate among the three primary methods of filtration (biological, chemical, and mechanical) ● Explain in writing each method of filtration in production systems ● Identify and describe the equipment used for the three methods of filtration 	AQ.09.01.03.a AQ.09.01.04.a. AQ.14.03.06.c. WHST 11-12.4
Evaluate and implement biological filtration in recirculating systems	<ul style="list-style-type: none"> ● Identify and assess different types of biological filtration ● Perform biofilter checks ● Perform surface area calculations of biomedica to determine proper biofiltration according to water volume and crop sizes ● Perform and graph results of nitrogen tests to determine effectiveness of biofiltration 	AQ.09.01.03.a AQ.09.01.04.a. AQ.09.01.04.b. AQ.14.03.06.c. SL.11-12.5 MP 4 MP5
Evaluate and implement chemical filtration in recirculating systems	<ul style="list-style-type: none"> ● Identify and assess different types of chemical filtration ● Introduce specific chemicals to a water sample to determine their effectiveness in controlling specific water parameters ● Assess production species health to determine specific types of chemical treatment ● Treat production tank water with specific chemicals to stabilize pH and minimize chlorine and ammonia 	AQ.02.01.02.c AQ.08.02.01.c. AQ.14.03.08.c. MP 4 MP5
Evaluate and implement mechanical filtration in recirculating systems	<ul style="list-style-type: none"> ● Identify and assess different methods of mechanical filtration ● Perform maintenance of mechanical filters such as settling tanks, canister filters, bead filters and external power filters. ● Identify and diagnose problems with mechanical filters 	AQ.02.01.02.c AQ.08.02.01.c.

Unit 3	Water quality analysis and treatment
Essential Questions	<ol style="list-style-type: none"> 1. Which water parameters should be tested to determine the health of a system? 2. What trends and ranges should be identified and assessed in the determination of water quality of a system?

Priority Standards Assessed in Learning

Connecticut Agriculture, Food, and Natural Resources Standards	<p>AQ.14.03.01.c. Demonstrate proper technique for taking water samples to perform water quality assessments.</p> <p>AQ.14.03.02.c. Demonstrate methods of correcting dissolved oxygen deficiency in aquaculture systems.</p> <p>AQ.14.03.04.c. Demonstrate methods of correcting the pH of water in aquaculture systems.</p> <p>AQ.14.03.07.b. Measure, record and analyze the following water quality factors as necessary: water hardness, carbon dioxide, salinity, iron, chlorine, and hydrogen sulfide.</p> <p>AQ.05.01.01.b. Identify protocols needed to diagnose, treat and prevent common aquatic diseases to maintain healthy populations.</p> <p>AQ.05.01.02.b. Diagnose illnesses and disorders of aquatic species based on symptoms and problems caused by diseases, parasites and physiological disorders.</p> <p>AQ.05.01.02.c. Treat common diseases, parasites and physiological disorders of aquatic species.</p>
Common Core State Standards	<p>RST 11-12.4 Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 11-12 texts and topics.</p> <p>WHST.11-12.2a. Introduce a topic and organize ideas, concepts, and information to make important connections and distinctions; include formatting (e.g., headings), graphics (e.g., figures, tables), and multi-media when useful to aiding comprehension</p> <p>WHST 11-12.4 Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose and audience</p>

Supporting Standards

Connecticut Agriculture, Food, and Natural Resources Standards	<p>AQ.14.03.02.b. Conduct a dissolved oxygen test. Analyze and record test results.</p> <p>AQ.14.03.06.b. Take, record and analyze TAN measurements</p>
Common Core State Standards	<p>SL. 11-12.5 Make strategic use of digital media (e.g., textual, graphical, audio, visual, and interactive elements) in presentations to enhance understanding of findings, reasoning, and evidence and to add interest.</p>

	MP 4 Model with mathematics MP 5 Use appropriate tools strategically
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Objectives	Activities	CT AFNR, NGSS, CCSS
Safely and accurately test and analyze various water parameters to assess the impact on fish health.	<ul style="list-style-type: none"> ● Safely perform water tests according to instruction and classroom guidelines ● Sample and test water parameters using water test kits ● Determine and record specific chemical levels based on water test results ● Assess water quality by recording and analyzing results of the water tests ● Discuss environmentally sound practices for disposal of wastewater and water testing chemicals. ● Locate, read and interpret SDS for water testing reagents 	AQ.14.03.01.c. AQ.14.03.02.c AQ.05.01.01.b AQ.05.01.02.b. AQ.14.03.06.b. RST.11-12.4 WHST.11-12.4 MP4 MP5
Record and compare water quality data	<ul style="list-style-type: none"> ● Use spreadsheets to record and assess ongoing growth and feed data ● Develop and use a task list for cleaning and maintenance of re-circulating systems ● Create and complete growth and water quality logs for chosen production species ● Provide an overall analysis of growth, production and health of a chosen production species 	AQ.05.01.01.b AQ.14.03.01.c. AQ.14.03.02.c AQ.14.03.06.b. AQ.14.03.07.b. SL. 11-12.5
Assess written descriptions of aquatic systems problems and respond with a diagnosis and solutions.	<ul style="list-style-type: none"> ● Read, assess, and respond to scenarios involving water quality issues, systems malfunction or fish health. ● Perform water tests on an unknown sample to determine specific problems with water quality ● Diagnose equipment malfunction based on a written description of system conditions ● Provide solutions to water quality issues based on water test results and a written description of system conditions 	AQ.05.01.02.b. AQ.05.01.02.c AQ.14.03.06.b. AQ.14.03.07.b. RST.11-12.4 WHST.11-12.4
Implement necessary actions in a functioning aquatic system to enhance or remedy the quality of the water.	<ul style="list-style-type: none"> ● Test and assess water quality using various water test kits and devices. ● Make appropriate recommendations for water based on results. ● Use data to implement changes to a functioning aquatic system to improve the water quality 	AQ.05.01.01.b AQ.05.01.02.c AQ.14.03.01.c. AQ.14.03.02.c AQ.14.03.04.c

		AQ.14.03.06.b. AQ.14.03.07.b. WHST.11-12.2a WHST.11-12.4
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Unit 4	Aquatic species
Essential Questions	<ol style="list-style-type: none"> 1. What species are commonly used in typical aquaculture practices? 2. Which methods of aquaculture are used to raise these species?

Priority Standards Assessed in Learning

Connecticut Agriculture, Food, and Natural Resources Standards	<p>AQ.03.01.01.c. Demonstrate the proper formatting and usage of binomial nomenclature.</p> <p>AQ.03.01.02.a. Classify species of aquatic organisms as fresh water, marine, or diadromous, and by their genus and species.</p> <p>AQ.04.02.01.b. Compare and contrast desirable anatomical and physiological characteristics of aquatic plants and animals within and between species.</p> <p>AQ.04.02.03.a. Describe the life cycle of aquaculture species.</p> <p>AQ.05.01.03.b. Evaluate the health and productivity of fish and shellfish populations.</p> <p>AS.02.01.02.a. Identify major animal species by common and scientific names.</p>
Common Core State Standards	<p>RST 11-12.4 Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 11-12 texts and topics.</p> <p>WHST.11-12.2a. Introduce a topic and organize ideas, concepts, and information to make important connections and distinctions; include formatting (e.g., headings), graphics (e.g., figures, tables), and multi-media when useful to aiding comprehension</p>

Supporting Standards

Connecticut Agriculture, Food, and Natural Resources Standards	<p>AQ.07.01.01.b. Evaluate hatchery systems for suitability in rearing the following species: trout, salmon, tilapia, catfish, shrimp, lobster, oysters, crayfish, clams, and kelp.</p> <p>AQ.09.01.01.a. Identify the following types of aquaculture systems: raceways, ponds, recirculating systems, and net pens or cages.</p>
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	AQ.09.01.02.a. Identify equipment and handling facilities used in modern aquaculture production.
Common Core State Standards	SL. 11-12.5 Make strategic use of digital media (e.g., textual, graphical, audio, visual, and interactive elements) in presentations to enhance understanding of findings, reasoning, and evidence and to add interest.

Objectives	Activities	CT AFNR, NGSS, CCSS
Identify and outline aquaculture production/commercial fisheries species	<ul style="list-style-type: none"> Identify aquaculture species by common and binomial name Use differences in morphological features of finfish to identify and differentiate among species Identify and describe in writing the roles and uses of aquaculture production species Compare and contrast production species water parameters and tolerance ranges 	AQ.03.01.01.c. AQ.03.01.02.a. AQ.04.02.01.b AQ.05.01.03.b. AS.02.01.02.a
Identify life stages of common aquaculture species	<ul style="list-style-type: none"> Identify the life stages of common aquatic species Outline the differences between the life cycles of fish, crustacean and mollusks 	AQ.03.01.02.a AQ.04.02.01.b AQ.04.02.03.a AQ.05.01.03.b. AS.02.01.02.a WHST.11-12.2a. SL. 11-12.5
Outline the basic requirements of common aquaculture species	<ul style="list-style-type: none"> Outline the basic needs of each species based on life stages and other characteristics Practice feeding species using teacher direction Create a species profile outlining species origin, requirements, uses and specific methods of raising/rearing. 	AQ.03.01.01.c AQ.04.02.01.b AQ.04.02.03.a AQ.07.01.01.b. AQ.09.01.01.a. AQ.09.01.02.a. AS.02.01.02.a
Evaluate, select and manage aquatic organisms in an aquaculture facility.	<ul style="list-style-type: none"> Research common species used in recirculating systems aquaculture Outline specific water quality and filtration requirements for aquatic species 	AQ.04.02.01.b AQ.07.01.01.b. AQ.09.01.01.a. AQ.09.01.02.a.

	<ul style="list-style-type: none"> • Manage recirculating systems based on species specific requirements 	AQ.05.01.03.b. AS.02.01.02.a RST 11-12.4 WHST.11-12.2a.
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Unit 5	Feeds and feeding requirements
Essential Questions	<ol style="list-style-type: none"> 1. What is the proper amount of feed to provide a given aquatic species? 2. What are the feed requirements for a given aquatic species?

Priority Standards Assessed in Learning

Connecticut Agriculture, Food, and Natural Resources Standards	AQ.02.01.02.c. Devise, implement and evaluate safety procedures and plans for working with aquatic animals. AQ.04.01.01.c. Explain how the components and systems of aquatic species anatomy and physiology relate to the production and use of aquatic species. AQ.04.01.04.a. Describe the properties, locations, functions and types of aquatic species tissues. AQ.11.01.01.b. Determine the relative nutritional value of feedstuffs based on ingredients and by evaluating their general quality and condition. AQ.11.01.02.b. Appraise the adequacy of feed rations using data from the analysis of feedstuffs, aquatic animal requirements and performance. AQ.11.01.03.b. Feed fish a balance ration using standard industry practices.
Common Core State Standards	RST.11-12.4 Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 9-10 texts and topics MP 4 Model with mathematics MP 5 Use appropriate tools strategically

Supporting Standards

Connecticut Agriculture, Food, and Natural Resources Standards	AQ.04.01.01.b. Identify the following external morphologic features of a crustacean: carapace, abdomen, walking legs, and claws. AQ.04.01.06.a. Describe the functions of the aquatic species body systems and system components.
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Common Core State Standards	WHST.11-12.4 Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience SL. 11-12.5 Make strategic use of digital media (e.g., textual, graphical, audio, visual, and interactive elements) in presentations to enhance understanding of findings, reasoning, and evidence and to add interest.
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Objectives	Activities	CT AFNR, NGSS, CCSS
Demonstrate safe handling techniques of specific sed on aquatic organisms for specific purposes.	<ul style="list-style-type: none"> ● Outline the basic morphological and anatomical features of common fish, crustaceans and mollusks. ● Demonstrate proper handling and transport techniques of aquatic organisms ● Identify anatomical features of finfish that may result in human injury ● Properly acquire a sample of fish from a production system for transport or measurements 	AQ.04.01.01.b. AQ.04.01.01.c. AQ.04.01.04.a. AQ.04.01.06.a.
Determine and implement feed requirements, feed type and feed amounts for lab production species.	<ul style="list-style-type: none"> ● Compare common feeds and nutritional requirements used for our production species ● Weigh, measure and record a sample production fish to determine average fish weight and crop size ● Determine feed percentages based on average fish weight and crop size ● Determine feed amounts per day based on crop size ● Determine feed types based on life stages and nutritional requirements ● Create and implement feeding schedule ● Feed according to schedule 	AQ.02.01.02.c. AQ.04.01.01.c. AQ.04.01.04.a. AQ.11.01.01.b AQ.11.01.02.b. AQ.11.01.03.b RST.11-12.4 SL. 11-12.5 MP 4 MP 5
Determine, analyze and record feed conversion ratios and growth information	<ul style="list-style-type: none"> ● Measure and record fish growth and feed using spreadsheets ● Calculate feed conversion ratio based on feed and weight gain ● Analyze production based on feed, growth, health and other factors. 	AQ.02.01.02.c. AQ.11.01.01.b AQ.11.01.02.b. AQ.11.01.03.b WHST.11-12.4 MP 4 MP 5

Course Vocabulary:

Activated Carbon	Check Valve	Production/Culture Tank	Sump
Air Diffuser	Clarifier	Protein Skimmer	Un-ionized Ammonia
Air Lift	Directional valve	Recirculating System	UV Filter
Bead Filter	External Power Filter	Refractometer	Wet/Dry Trickle Filter
Biofiltration	Hardness	Regenerative Blower	Zeolite
Biomeida	Hydrometer	Settling Tank	
Bioreactor	In-Line Heater	Sodium Bicarbonate	
Calcium Chloride	Magnetic Drive Pump	Sodium Chloride	
Carbon Dioxide	Nitrification	Sodium Thiosulphate	
Carbonic Acid	Pressure Gauge	Submersible Pump	

Assessments:

Written assessments

[Practical skill assessments](#)

Project work and final project assessments

Connections to College/Career Readiness:**Resources:**

Reference: [Aquatic Systems Engineering: Devices and How they Function](#), P.R. Escobal

Reference: [Principles of Aquaculture](#), Wiley

Text: [Aquaculture Science](#), Second Edition. Parker. Delmar

Digital Resource: Southeastern Regional Aquaculture Center Publishing: www.srac.msstate.edu

Materials:

Recirculating Systems and associated Equipment and Materials

General Aquaculture Equipment

PVC Plumbing – Fittings and pipe and associated tools and equipment

Water Testing Safety Equipment and Kits

Course Title	Sustainable Aquaculture & Aquaponics
Agriculture Pathway	Aquaculture Systems
Length of Course	One Semester
Ledyard High School Vision of the Graduate	Demonstrate an ability to communicate information clearly and effectively through a variety of media, including written, oral, visual, musical, and/or video productions. Demonstrate an ability to solve problems of varying complexity across a variety of content areas. Demonstrate critical thinking skills to find solutions, support arguments, and overcome challenges in a variety of content areas.
Course Overview	This class explores modern practices of sustainable aquaculture. Students will evaluate our current aquatic systems and create a plan to implement sustainable practices for future operation, focusing mainly on aquaponics – a combination of both aquaculture and hydroponics. Our goal is to continue the growth and production in the aquaculture facility while attempting to integrate new methods and systems to reduce & reuse the resources we commonly use in our daily operations.
Units of Study	<ol style="list-style-type: none"> 1. Sustainable practices in aquaculture 2. Recirculating Aquaculture Systems 3. Aquaponics Systems 4. Water Parameters 5. Aquatic Organism/Plant Health and Safety

Unit 1	Sustainable Practices in Aquaculture
Essential Questions	<ol style="list-style-type: none"> 1. What resources are used/discharged in a typical aquaculture operation? 2. What methods can be implemented into aquaculture operations to improve sustainability?

Priority Standards Assessed in Learning
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Connecticut Agriculture, Food, and Natural Resources Standards	<p>AQ.01.03.02.a. Research and summarize sustainability in aquaculture systems.</p> <p>AQ.09.01.01.b. Critique designs for an aquaculture facility and prescribe alternative layouts and adjustments for the safe and efficient use of the facility.</p> <p>AQ.15.01.01.c. Compare and contrast aquaponics to traditional farming and aquaculture.</p> <p>AQ.15.01.08.c. Evaluate issues that must be overcome to make aquaponics sustainable.</p> <p>AQ.15.01.07.b. Review Good Agricultural Practices (GAPs) as it relates to aquaponics.</p>
Common Core State Standards	<p>WHST.11-12.2a Introduce a topic and organize complex ideas, concepts, and information so that each new element builds on that which precedes it to create a unified whole; include formatting (e.g., headings), graphics (e.g., figures, tables), and multimedia when useful to aiding comprehension</p> <p>SL.11-12.5 Present information, findings, and supporting evidence clearly, concisely, and logically such that listeners can follow the line of reasoning and the organization, development, substance, and style are appropriate to purpose, audience, and task.</p>

Supporting Standards

Connecticut Agriculture, Food, and Natural Resources Standards	<p>AQ.01.01.03.a. Research and summarize major components of aquaculture (e.g., oyster farming, and commercial kelp beds, etc.).</p> <p>AQ.08.01.01.b. Analyze characteristics of water that influence the biosphere and sustain life.</p> <p>AQ.08.01.05.b. Explain how aquaponics can be utilized to enhance sustainable aquaculture practices by reducing water consumption and waste production.</p> <p>AQ.14.01.01.b. Compare and contrast different water sources for aquaculture enterprises.</p> <p>AQ.15.01.01.b. Describe species of plants and animals suited for aquaponics.</p> <p>AQ.15.01.08.a. Define sustainability.</p>
Common Core State Standards	<p>SL. 11-12.5 Make strategic use of digital media (e.g., textual, graphical, audio, visual, and interactive elements) in presentations to enhance understanding of findings, reasoning, and evidence and to add interest.</p>

Learning Objectives	Activities	CT AFNR, NGSS, CCSS
List and describe the practices used in common aquaculture operations.	<ul style="list-style-type: none"> ● Class discussion on common aquaculture practices. ● List and compare the methods of past to present aquaculture. ● Critique aquaculture management techniques in respect to resources input/output. 	AQ.01.01.03.a AQ.08.01.01.b AQ.09.01.01.b.
Outline the resources used/discharged in a typical recirculating system.	<ul style="list-style-type: none"> ● Create a chart/picture of the resource input/output of a typical recirculating system. ● Discuss the resources and energy input/ output of a closed aquaculture production system. ● Brainstorm methods to improve our resource input/output. 	AQ.09.01.01.b. AQ.14.01.01.b. WHST.11-12.2a
Discuss the sustainable methods used in modern agriculture.	<ul style="list-style-type: none"> ● Research sustainable methods used in aquaculture. ● Discuss the advantages of aquaponics in aquaculture. ● Compare the methods used in our lab to a modern sustainable aquaculture system. 	AQ.01.03.02.a AQ.15.01.01.c. AQ.15.01.08.c. AQ.08.01.05.b. AQ.15.01.08.a. SL.11-12.5
Develop ideas to implement sustainable methods into our current aquaculture lab systems.	<ul style="list-style-type: none"> ● Brainstorm ideas that may reduce the resources and energy used in our aquaculture lab. ● Develop ideas for the use of our discharge water/waste ● Compile a list of potential sustainable methods that could be integrated into our current program. ● Research and present creative ideas to the class for discussion and critique 	AQ.01.03.02.a AQ.09.01.01.b. AQ.15.01.07.b. AQ.15.01.01.b. SL. 11-12.5
Evaluate the energy use of an aquatic system	<ul style="list-style-type: none"> ● Calculate the amount of energy used in the aquaculture lab production systems ● Determine the cost/month based on energy consumption ● Create a Energy Guide tag for a production 	

Unit 2	Recirculating Aquaculture Systems
Essential Questions	<ol style="list-style-type: none"> 1. What are the advantages and disadvantages in using Recirculating systems in aquaculture? 2. What modifications or changes can we make to our lab systems to improve sustainability while maintaining water quality and production.

Priority Standards Assessed in Learning
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Connecticut Agriculture, Food, and Natural Resources Standards	<p>AQ.01.03.02.a. Research and summarize sustainability in aquaculture systems.</p> <p>AQ.09.01.03.b. Explain the basic electrical, plumbing and mechanical components of aquaculture systems.</p> <p>AQ.09.01.04.a. Describe how the bio-filter of a recirculating aquaculture system (RAS) converts ammonia to nitrite, and nitrite to nitrate.</p> <p>AQ.15.01.01.c. Compare and contrast aquaponics to traditional farming and aquaculture.</p>
Common Core State Standards	<p>WHST.11-12.4 Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience</p> <p>SL. 11-12.4 Present information findings, and supporting evidence clearly, concisely, and logically such that listeners can follow the line of reasoning and the organization, development, substance, and style are appropriate to purpose, audience, and task</p>

Supporting Standards

Connecticut Agriculture, Food, and Natural Resources Standards	<p>AQ.09.01.01.b. Critique designs for an aquaculture facility and prescribe alternative layouts and adjustments for the safe and efficient use of the facility.</p> <p>AQ.15.01.05.b. Compare and contrast the following aquaponics systems; Float, Flood-and-Drain and Nutrient Film Technique (NFT).</p>
Common Core State Standards	<p>WHST.11-12.1.e Provide a concluding statement or section that follows from or supports the argument presented.</p>

Objectives	Activities	CT AFNR, NGSS, CCSS
Identify and describe the function of each component of a recirculating system	<ul style="list-style-type: none"> ● Identify and describe in writing the function of specific recirculating system components ● Outline a typical layout of a recirculating system detailing filtration devices and water movement. ● Discuss the advantages and disadvantages to recirculating systems aquaculture ● Outline and explain a lab system including components, function and flow. 	AQ.09.01.03.b. AQ.09.01.01.b.
Compare and contrast the role of biological and mechanical filtration in an aquaponics system	<ul style="list-style-type: none"> ● Explore the various types of filtration in the aquaculture lab. ● Describe and demonstrate use of the mechanical and biological filters used in the aquaculture lab. ● Perform water tests to determine biological filtration. ● Demonstrate filtration maintenance by performing flushes and checks. 	AQ.09.01.03.b. AQ.09.01.04.a.
Identify aquaculture/aquaponics equipment and components and describe their role in filtration and water quality.	<ul style="list-style-type: none"> ● Identify aquaculture equipment. ● Describe the functions and purpose of specific aquaculture equipment ● Outline the each filtration device improves water quality. ● Perform tasks associated with various equipment used in aquaculture ● Discuss the similarities and differences of filtration components between recirculating systems and aquaponics systems. 	AQ.01.03.02.a. AQ.09.01.04.a AQ.15.01.01.c. AQ.09.01.01.b. AQ.15.01.05.b. RST.11-12.4
Research and implement new methods of filtration and water movement to improve water quality and sustainability in recirculating systems.	<ul style="list-style-type: none"> ● Compare and contrast modern filtration equipment. ● Conduct on-line research of one current issues regarding past aquaculture practices and another on sustainable aquaculture practices ● Write a persuasive essay on selected issues ● Cite sources appropriately ● Take a clear stand on a current issue ● Present findings to peers for discussion ● Discuss possible implementation on sustainable practices 	AQ.01.03.02.a. AQ.09.01.03.b. AQ.15.01.01.c. AQ.15.01.05.b. WHST.11-12.4 WHST.11-12.1.e SL. 11-12.4

Unit 3	Aquaponics Systems
Essential Questions	<ol style="list-style-type: none"> 1. What are the functioning components and requirements of a typical aquaponics system? 2. What are the considerations that must be addressed when designing and operating an aquaponics system?

Priority Standards Assessed in Learning
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Connecticut Agriculture, Food, and Natural Resources Standards	<p>AQ.09.01.03.b. Explain the basic electrical, plumbing and mechanical components of aquaculture systems.</p> <p>AQ.09.01.04.c. Design and construct a functional bio filtration system.</p> <p>AQ.15.01.02.b. Describe favorable attributes for plant species used in aquaponics</p> <p>AQ.15.01.03.a. List plant nutrients required for growth.</p> <p>AQ.15.01.04.c. Choose aquatic animal species for use in an aquaponics system.</p>
Common Core State Standards	<p>WHST.11-12.4 Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience</p> <p>RST.11-12.4 Determine the meaning of words and phrases as they are used in text, including analyzing how an author uses and refines the meaning of a key term over the course of a text</p> <p>MP.3 Construct viable arguments and critique the reasoning of others.</p> <p>MP 4 Model with mathematics</p> <p>MP 5 Use appropriate tools strategically</p>

Supporting Standards

Connecticut Agriculture, Food, and Natural Resources Standards	<p>AQ.08.01.01.b. Analyze characteristics of water that influence the biosphere and sustain life.</p> <p>AQ.08.01.05.b. Explain how aquaponics can be utilized to enhance sustainable aquaculture practices by reducing water consumption and waste production.</p> <p>AQ.09.01.01.b. Critique designs for an aquaculture facility and prescribe alternative layouts and adjustments for the safe and efficient use of the facility.</p> <p>AQ.15.01.05.b. Compare and contrast the following aquaponics systems; Float, Flood-and-Drain and Nutrient Film Technique (NFT).</p> <p>AQ.15.01.08.b. Discuss how aquaponics is sustainable.</p> <p>AQ.15.01.01.a. Define aquaponics.</p>
Common Core State Standards	<p>WHST.11-12.1.e Provide a concluding statement or section that follows from or supports the argument presented.</p>

Objectives	Activities	CT AFNR, NGSS, CCSS
Identify the components of an aquaponics system and describe their role in filtration, water quality and organism growth.	<ul style="list-style-type: none"> ● Identify and describe in writing the function of specific aquaculture and aquaponics equipment. ● Describe a typical layout of an aquaponics system detailing the water movement, functions and filtration. ● Design a video of a walkthrough of the greenhouse’s aquaponics system detailing the filtration, nutrients, organisms and water flow. 	AQ.09.01.03.b. AQ.15.01.01.a. AQ.15.01.02.b AQ.15.01.04.c AQ.08.01.05.b. AQ.15.01.05.b.
Outline and discuss the essential nutrients of aquaponics systems and plant growth	<ul style="list-style-type: none"> ● Discuss the three essential nutrients in plant growth and their availability in aquatic systems. ● Read, take notes and graph the Nitrogen cycle and its role in aquaculture filtration and plant use. ● Create a chart displaying plant deficiencies and supplements. 	AQ.15.01.02.b AQ.15.01.03.a. AQ.08.01.01.b. RST.11-12.4
Explore various methods and types of aquaponics systems	<ul style="list-style-type: none"> ● Research and evaluate three different types of aquaponics systems. ● List advantages and disadvantages of each system. ● Critique homemade aquaponics systems that are commonly sold online. ● Design, sketch and present an aquaponics system for a small aquarium. 	AQ.09.01.03.b. AQ.15.01.01.a. AQ.15.01.02.b AQ.15.01.05.b.
Plan, design, construct and assess a functioning aquaponics system.	<ul style="list-style-type: none"> ● Plan and design an aquaponics system for a specific area or use. ● Sketch a plan and materials list for an aquaponics system using notes from research and discussion. ● Build an aquaponics system based on a design plan. ● Use proper tools, materials and safety measures during construction. ● Journal and assess procedures and results of the planning, design, and construction of an aquaponics system. ● Select appropriate aquatic organisms and plants for the system. ● Summarize the aquaponics system upon completion. 	AQ.09.01.03.b. AQ.09.01.04.c. AQ.15.01.02.b AQ.15.01.04.c AQ.09.01.01.b AQ.15.01.08.b. WHST.11-12.4 WHST.11-12.1.e MP 4 MP 5
Size and design specific filtration devices and pump equipment for an aquaculture/aquaponics system.	<ul style="list-style-type: none"> ● Determine the appropriate size pumps for an aquatic system. ● Determine friction loss of PVC pipe and fittings ● Design and evaluate a filtration device to capture particulate matter in an aquatic system ● Perform and graph results of nitrogen tests to determine 	AQ.09.01.03.b. AQ.09.01.04.c. AQ.09.01.01.b MP 3 MP4

	<p>effectiveness of biofiltration</p> <ul style="list-style-type: none">● Evaluate Biofiltration based on volume of tank and surface area of Biomedia	MP5
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Unit 4	Water Parameters
Essential Questions	<ol style="list-style-type: none"> 1. What are the ideal water parameters of a recirculating and aquaponics system? 2. What are the methods of water quality control and remediation?

Priority Standards Assessed in Learning
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Connecticut Agriculture, Food, and Natural Resources Standards	<p>AQ.05.01.01.c. Perform diagnostic tests to detect health problems in aquatic species.</p> <p>AQ.08.01.01.b. Analyze characteristics of water that influence the biosphere and sustain life.</p> <p>AQ.08.02.01.c. Demonstrate the use of water- testing instruments and water-treatment equipment to treat wastewater.</p> <p>AQ.09.01.04.a. Describe how the bio-filter of a recirculating aquaculture system (RAS) converts ammonia to nitrite, and nitrite to nitrate. facility.</p> <p>AQ.09.01.04.b. Diagram the nitrogen cycle in relation to aquaculture.</p> <p>AQ.14.03.01.a. Identify water quality factors that are important in aquaculture systems.</p> <p>AQ.14.03.01.c. Demonstrate proper technique for taking water samples to perform water quality assessments.</p> <p>AQ.14.03.02.b. Conduct a dissolved oxygen test. Analyze and record test results.</p> <p>AQ.14.03.03.b. Take, record and analyze water temperature measurements.</p> <p>AQ.14.03.04.b. Take, record and analyze pH measurements.</p> <p>AQ.14.03.06.c. Analyze management practices that will reduce TAN in aquaculture systems.</p> <p>AQ.14.03.07.b. Measure, record and analyze the following water quality factors as necessary: water hardness, carbon dioxide, salinity, iron, chlorine, and hydrogen sulfide.</p> <p>AQ.15.01.02.b. Describe favorable attributes for plant species used in aquaponics.</p> <p>AQ.15.01.03.b. Describe plant nutritional deficiencies.</p>
Common Core State Standards	<p>RST.11-12.4 Determine the meaning of words and phrases as they are used in text, including analyzing how an author uses and refines the meaning of a key term over the course of a text</p> <p>WHST.11-12.2a Introduce a topic and organize complex ideas, concepts, and information so that each new element builds on that which precedes it to create a unified whole; include formatting (e.g., headings), graphics (e.g., figures, tables), and multimedia when useful to aiding comprehension</p>

Supporting Standards	
Connecticut Agriculture, Food, and Natural Resources Standards	<p>AQ.01.01.03.a. Research and summarize major components of aquaculture (e.g., oyster farming, and commercial kelp beds, etc.).</p> <p>AQ.05.02.01.a. Explain the importance of biosecurity to the aquaculture industry.</p> <p>AQ.07.01.01.b. Evaluate hatchery systems for suitability in rearing the following species: trout, salmon, tilapia, catfish, shrimp, lobster, oysters, crayfish, clams, and kelp.</p> <p>AQ.09.01.01.b. Critique designs for an aquaculture facility and prescribe alternative layouts and adjustments for the safe and efficient use of the facility.</p>
Common Core State Standards	<p>SL.11-12.5 Present information, findings, and supporting evidence clearly, concisely, and logically such that listeners can follow the line of reasoning and the organization, development, substance, and style are appropriate to purpose, audience, and task.</p>

Objectives	Activities	CT AFNR, NGSS, CCSS
Test, analyze and adjust the nutrients (NPK) for plant growth in an aquaponics system.	<ul style="list-style-type: none"> ● Discuss the essential nutrients (NPK) in plant growth and their availability in aquatic systems ● Safely perform necessary water tests to determine the proper nutrient amounts in an aquaponics system. ● Create an ongoing log of water sampling and results using spreadsheets. ● Suggest and implement supplements for improved plant growth ● Locate, read and interpret SDS for water testing reagents 	<p>AQ.08.01.01.b. AQ.08.02.01.c. AQ.09.01.04.a AQ.09.01.04.b. AQ.14.03.01.c. AQ.14.03.04.b. AQ.14.03.07.b. AQ.15.01.02.b. AQ.15.01.03.b. RST.11-12.4 WHST.11-12.2a SL.11-12.5</p>
Test and assess the water quality of an aquaponics system.	<ul style="list-style-type: none"> ● Safely perform necessary water tests to determine the proper nutrients and water quality in an aquaponics system. ● Create an ongoing log of water sampling and results using spreadsheets. ● Suggest and implement remediation based on results ● Locate, read and interpret SDS for water testing reagents 	<p>AQ.08.01.01.b AQ.08.02.01.c. AQ.09.01.04.a AQ.09.01.04.b. AQ.14.03.01.c. AQ.14.03.02.b. AQ.14.03.03.b. AQ.14.03.04.b. AQ.14.03.06.c.</p>

		AQ.14.03.07.b. SL.11-12.5
Perform the maintenance procedures to maintain or remediate water quality in an aquaponics system.	<ul style="list-style-type: none"> ● Manage aquaponics systems based on species specific requirements ● Assess water quality by recording and analyzing results of the water tests ● Demonstrate filtration maintenance by performing flushes and checks. ● Diagnose and remedy water quality issues 	AQ.05.01.01.c. AQ.14.03.01.a. AQ.14.03.01.c. AQ.14.03.06.c.

Unit 5	Aquatic Organism/Plant Health and Safety
Essential Questions	<ol style="list-style-type: none"> 1. What types of aquatic plant and animal organisms are suited for aquaponics? 2. What are the requirements for plants and animals used in aquaponics?

Priority Standards Assessed in Learning
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Connecticut Agriculture, Food, and Natural Resources Standards	<p>AQ.04.01.06.c. Explain the impact of aquatic species body systems on performance, health, growth and reproduction</p> <p>AQ.04.02.01.b. Compare and contrast desirable anatomical and physiological characteristics of aquatic plants and animals within and between species.</p> <p>AQ.04.02.02.c. Develop efficient procedures to produce consistently high-quality aquaculture species well suited for their intended purposes.</p> <p>AQ.04.02.05.a. Research and summarize the use of products and by-products derived from aquatic animals.</p> <p>AQ.15.01.01.b. Describe species of plants and animals suited for aquaponics.</p> <p>AQ.15.01.02.b. Describe favorable attributes for plant species used in aquaponics</p> <p>AQ.15.01.02.c. Choose plant species for use in an aquaponics system.</p> <p>AQ.15.01.03.c. Calculate amount of supplement plant nutrients needed in an aquaponics system.</p> <p>AQ.15.01.04.c. Choose aquatic animal species for use in an aquaponics system.</p> <p>AQ.15.01.04.c. Choose an aquaponics system based on aquatic animal and plant species to be grown.</p>
Common Core State Standards	<p>SL 11-12.1. Initiate and participate effectively in a range of collaborative discussions (one on-one, in groups, and teacher-led) with diverse partners on grades 11–12 topics, texts, and issues, building on others’ ideas and expressing their own clearly and persuasively and solve problems, evaluating the credibility and accuracy of each source and noting any discrepancies among the data.</p> <p>RST.11-12.4 Determine the meaning of words and phrases as they are used in text, including analyzing how an author uses and refines the meaning of a key term over the course of a text</p> <p>MP 4 Model with mathematics</p> <p>MP 5 Use appropriate tools strategically</p>

Supporting Standards	
Connecticut Agriculture, Food, and Natural Resources Standards	AQ.01.01.01.b. Evaluate and describe characteristics of aquatic organisms that developed in response to the aquatic specie's environment and led to their commercial use. AQ.03.01.02.a. Classify species of aquatic organisms as fresh water, marine, or diadromous, and by their genus and species
Common Core State Standards	MP.3 Construct viable arguments and critique the reasoning of others.

Objectives	Activities	CT AFNR, NGSS, CCSS
Research and select specific plant species for aquaponics system	<ul style="list-style-type: none"> • Determine the appropriate plants for use in aquaponics systems • Germinate or make cuttings of plants to use in aquaponics systems • Use proper techniques to germinate, root, and grow plants in various type of media • Monitor plant growth and health 	AQ.15.01.01.b. AQ.01.01.01.b. AQ.15.01.02.b. AQ.15.01.02.c. AQ.15.01.05.c. RST.11-12.4 MP 5
Describe and implement the basic requirements necessary for good plant growth in an aquaponics system	<ul style="list-style-type: none"> • Identify macro and micro nutrients • Discuss how pH affects plant growth and how it can be regulated in water • Describe the role of nitrates and how it is consumed and produced in an aquatic system • Test and adjust water parameters to accommodate specific plant needs • Provide proper amounts and types plant supplements in accordance to plant needs 	AQ.04.01.06.c. AQ.04.02.02.c. AQ.15.01.02.b. AQ.15.01.02.c. AQ.15.01.03.c. RST.11-12.4 SL 11-12.1 MP.3 MP4 MP5
Research and select animal species for aquaponics system	<ul style="list-style-type: none"> • Research aquatic animal species to use in aquaponics systems • Acclimate and adjust specific water parameters to accommodate chosen animal species • Monitor growth and health of aquatic animal organisms 	AQ.04.02.01.b. AQ.04.02.05.a. AQ.15.01.01.b. AQ.15.01.04.c. AQ.15.01.04.c.

		RST.11-12.4 MP 5
Describe and implement specific system requirements necessary for a healthy aquatic environment for aquatic animal species.	<ul style="list-style-type: none"> • Cycle an aquaponics system using the principles of mechanical and biofiltration • Describe how pH affects aquatic animal health and how it can be regulated • Describe the role of nitrates and how it is consumed and produced in an aquatic system • Test and adjust water parameters to accommodate specific aquatic animal needs 	AQ.04.02.02.c. AQ.15.01.04.c. AQ.01.01.01.b. AQ.04.01.06.c. RST.11-12.4 MP 4 MP 5

Course Vocabulary:

Air diffuser	Float Bed	Production/Culture tank
Air lift	Flood and Drain system	Protein skimmer
Beadfilter	GPM	Regenerative blower
Biofiltration	Hardness	Rockwool
Biomedia	Head	Submersible pump
Bioreactor	Hydrotone	Sump
Carbonic acid	Macronutrients	Sustainable
Chemical filtration	Magnetic drive pump	TAN
Dissolved oxygen	Mechanical filtration	
External power filter	Nutrient Film Technique	

Assessments:

[Written assessments](#)

[Practical skill assessments](#)

[Project work and final project assessments](#)

Connections to College/Career Readiness:**Resources:**

Reference: [Aquaponics Food Production: Raising Fish and Plants for Food and Profit](#), Nelson and Pade

Reference: [Aquatic Systems Engineering: Devices and How they Function](#), P.R. Escobal. DEP

Reference: [Sustainable Aquaculture](#), Bardach

Text: [Aquaculture Science](#), Second Edition. Parker. Delmar

Digital Resource: Southeastern Regional Aquaculture Center Publishing: www.srac.msstate.edu

Materials:

Recirculating System, Aquaponics Systems and Hydroponic systems Equipment and Materials

General Horticulture and Aquaculture Equipment

PVC Plumbing – Fittings and pipe and associated tools and equipment

Water Testing Safety Equipment and Kits