Wastewater Issues in Watersheds: The Perfect STEM Topic (Waquoit Bay National Estuarine Research Reserve)

Course description: Wastewater treatment is the perfect topic for incorporating STEM into your curriculum while educating your students on an issue of crucial importance to the future of our region. The goal of this course is to increase understanding of wastewater issues by using it as an example to meet standards in science, technology, engineering, and mathematics, and to improve teachers' and students' understanding of the importance of coastal salt marshes and bays and the impact of too many nutrients upon them. Teachers will try out classroom and web-based activities, explore coastal salt water and freshwater habitats and visit experimental wastewater treatment systems. The course is also designed to promote stewardship of watersheds and estuaries.

The course incorporates investigations in the field and the use of on-line data. We will introduce teachers to research and researchers including Hillary Sullivan of Woods Hole Research Center who is a graduate research fellow at Waquoit Bay NERR. Experts from the Association to Preserve Cape Cod will provide information on cyanobacteria. Course content and activities will be aligned with Massachusetts State Science and Math standards and Next Generation Science Standards.

Credit: The course is offered for 1 graduate credit. Graduate credit is optional and is available from Framingham State College for $75.00 per credit. Please register and pay for graduate credit through Framingham University at (registration link will be added when available).

PDPs: Participants who complete all requirements for the course can receive 15 PDP points through the Woods Hole Science and Technology Education Partnership (WHSTEP). Note: participants can get either PDPs or graduate credit from Framingham- not both.

Grade levels: The course is designed for science, technology, and math teachers in grades 5 through 12. Others are welcome to apply.

Schedule: Tuesday and Wednesday, April 18 and 19, 2023

Location: 131 Waquoit Highway (Route 28) Waquoit Bay National Estuarine Research Reserve, East Falmouth, MA

Field Trip sites:
The Massachusetts Alternative Septic System Testing Center (MASSTEC): MASSTC is the nation's leading third-party testing and research facility for innovative/alternative (I/A) onsite septic system treatment technologies. (4 Kittredge Road, Sandwich, MA)
The Green Center at Alchemy Farm: The Green Center is a non-profit educational institute to create ecologically-derived human support systems" which include renewable energy, aquaculture, housing, and landscapes. Hilda Maingay and Earle Barnhart will welcome us into their home and give a tour of the many sustainable ideas they have put into practice. (233 Hatchville Road, East Falmouth).
Oyster aquaculture site: This site has been used to raise shellfish for the Town of Falmouth and research on the role oysters play in taking up nitrogen has been conducted here. (Waquoit Bay Reserve Headquarters)

Nitrex Barrier Pilot Site: This pilot project is still removing nitrogen from groundwater entering the Waquoit Bay (Waquoit Bay Reserve Headquarters)

Registration: Please register at http://waquoitbayreserve.org/event-registration/?ee=1328

Information about Waquoit Bay Reserve including driving directions can be found at www.waquoitbayreserve.org

Instructor:

Joan Muller, Education Coordinator, Waquoit Bay National Estuarine Research Reserve
joan.muller@mass.gov

Course objectives: Participants will be able to

1. Access and use NERRS/NOAA educational products with students.
2. Describe the nitrogen cycle and how humans have altered it, leading to impacts on coastal systems.
3. Teach basic estuarine concepts by guiding students in using field and laboratory research techniques analogous to those used at Research Reserves.
4. Meet Massachusetts Learning Standards and Next Generation Science Standards appropriate to the grade and subject they teach. (see list of a few examples below)
5. Give evidence to support the basic concepts in the Estuary Principles (see below).

Estuarine Principles

1. Estuaries are interconnected with the world ocean and with major systems and cycles on Earth.
2. Estuaries are dynamic ecosystems with tremendous variability within and between them in physical, chemical, and biological components.
3. Estuaries support an abundance of life, and a diversity of habitat types.
4. Ongoing research and monitoring is needed to increase our understanding of estuaries and to improve our ability to protect and sustain them.
5. Humans, even those living far from the coast, rely on goods and services supplied by estuaries
6. Human activities can impact estuaries by degrading water quality or altering habitats; therefore, we are responsible for making decisions to protect and maintain the health of estuaries.

Next Generation Science Frameworks

Life Sciences 2 Ecosystems: Interactions, Energy, and Dynamics

LS2.A Interdependent Relationships in Ecosystems
LS2.B Matter and Energy in Organisms and Ecosystems
LS2.C Ecosystems Dynamics, Functioning and Resilience

Earth Systems Science 2 Earth's Systems

ESS2.C: The Roles Of Water In Earth's Surface Processes

Earth Systems Science 3 Earth and Human Activity

ESS3.C: Human Impacts On Earth Systems

Massachusetts Science, Technology, and Engineering Standards

(a few examples, not inclusive)

5-ESS3-1. Obtain and combine information about ways communities reduce human impact on the Earth's resources and environment by changing an agricultural, industrial, or community practice or process. (Examples of changed practices or processes include treating sewage, reducing amounts of materials used, …preventing runoff from agricultural activities.)

7.MS-LS2-1. Analyze and interpret data to provide evidence for the effects of periods of abundant and scarce resources in the growth of organisms and the size of the population in an ecosystem.

7.MS-LS2-3. Develop a model to describe that matter and energy are transferred among living and non-living parts of an ecosystem and that both matter and energy are conserved through these processes.

7.MS-LS2-5. Evaluate competing design solutions for protecting an ecosystem. Discuss benefits and limitations of each design.

7.MS-LS2-6 (MA). Explain how changes to the biodiversity of an ecosystem- the variety of species found in an ecosystem -may limit the availability of resources humans use.

HS-LS2-1. Analyze data sets to support explanations that biotic and abiotic factors affect ecosystem carrying capacity.

HS-LS2-6. Analyze data to show ecosystems tend to maintain relatively consistent numbers and types of organisms even when small changes in conditions occur but that extreme fluctuations in conditions may result in a new ecosystem. Construct an argument support by evidence ecosystems with greater biodiversity tend to have greater resistance to change and resilience.

HS.LS2-7. Analyze direct and indirect effects of human activities on biodiversity and ecosystem health, specifically habitat fragmentation, introduction of non-native or invasive species, overharvesting, pollution, and climate change. Evaluate and refine a solution for reducing the impacts of human activities on biodiversity and health.

HS-ESS3-3. Illustrate relationships among management of natural resources, the sustainability of human populations, and biodiversity. (Examples include waste management and the development of new technologies.)

Course expectations: Participants will be expected to:

1. Attend all components of the two-day session and a two-hour evening virtual follow up session later in the spring.
4. Complete in-class assignments.
5. Participate in activities and discussions.
6. Keep a reflection journal during the course.
7. Incorporate information, curriculum, and resources provided in class into their own classroom teaching and provide a written reflection upon the experience, or, if the timing isn't appropriate, write up a plan for how it will be implemented into the curriculum next year.
8. Participate in evaluation of the course.

Course Outline **Wastewater Treatment: The Perfect STEM Topic**

April 18 9:00 am – 4:30 pm

Introductions to Each Other, Waquoit Bay Reserve, and NOAA Resources

Morning:

Sign in, coffee

Morning: Introductions of participants and presenters; overview of course

Introduction to NERRS system, mission

Estuary principles and concepts

Definition of estuary and watershed

STEM, Next Generation Science Standards

Introduction of journal

Simple watershed/groundwater movement modeling activities (Joan Muller, Education Coordinator, WBNERR)

Putting it all in context: A Closer Look at the Nitrogen Cycle (Hillary Sullivan, Woods Hole Research Center, WBNERR Davidson fellow, and board member of WHSTEP)

Visit to estuary, collect samples for nitrogen lab activity

Visit oyster aquaculture site (discussion on how oysters can help clean the bay, try out field measuring activity)

Visit Permeable Reactive Barrier site (discussion on possible role in helping to improve water quality in bay)

Lunch: (provided)

Afternoon:

Visit fresh water pond. Collect samples, use water quality sampling tools, and learn about Cyanobacteria (guest presenter, Karen Malkus-Benjamin, Association to Preserve Cape Cod Cyanobacteria Quality Control Manager) as well as invertebrates, plants, and general pond ecology.

Classroom lab activity: Compare nitrogen levels and varieties in various habitats around Reserve headquarters using basic laboratory techniques. Use microscopes to view cyanobacteria samples.

Journal reflection/discussion- how to incorporate day's activities in classroom.

April 19 9:00 am – 4:30 pm

Morning (Meet at MASSTEC in the morning)

Tour MASSTEC (Bryan Horsley- ½ hour presentation, 1 hour tour)

Drive to New Alchemy Farm

Presentation and tour by Earle Barnhart and Hilde Maingay

Lunch at Alchemy Farm in "The Ark" (provided)

Drive to WBNERR.

On-line resources and classroom activities from NOAA and others.

Incorporating into the school year: Break up into groups by level and/or subject, teachers make plans on how they will incorporate into curriculum (provide Common Core Frameworks and/or Next Generation Science Standards)

Post test and course evaluation

Course texts and materials: Readings and reference materials will be drawn from the following sources, as well as from NOAA and other web sites. Additional lesson plans, curriculum materials, and power point presentations will be provided.
Estuary Education (noaa.gov)
NOAA Data in the Classroom: Monitoring Estuarine Water Quality: Teacher Resources | NESDIS (noaa.gov)
Watershed in a Box activity: Watershed in a Box (noaa.gov)

Other resources and papers on studies done at Waquoit Bay NERR including:
- Paper from Ken Forman (Nitrex Barrier)
- Paper from Rick York (Oysters as filters)

Course requirements: Participants will be expected to:

1. Attend all components of the two-day session and a two-hour virtual follow up session.

3. Complete a pretest and posttest. (test scores won't affect your grade if taking for credit- this will just be used as a pre-assessment to help us plan the course and a post assessment to gauge how much people improve)

4. Complete in-class and homework assignments.

5. Participate in activities and discussions.

6. Keep a reflection journal during the course.

7. Incorporate information, curriculum, and resources provided in class into their own classroom teaching and reflect upon the experience (or if the timing is not correct for implementing this semester, write up a plan on how it will be incorporated next semester).

8. Participate in evaluation of the course.

All requirements must be completed by June 16, 2023.

Grading criteria
Participants earning graduate credit and those earning PDPs must complete exercises assigned as part of class work. The field, classroom, and computer-based activities completed during the course will be worth 30 percent of the grade, participation and contributions to discussions will be worth 20%, the reflection journal will be worth 20 percent and the write up of the classroom experience will be worth 30 percent.

Participants taking the course for PDPs but not for graduate credit will not be graded; but should complete all assignments. They will have until June 15 to complete requirements.

Assignments: The follow up reflection piece (including photos or scanned examples of student work) should be sent to Joan Muller via e-mail at joan.muller@mass.gov no later than June 15, 2023.

Reflection on teaching experience: Teachers will incorporate information, curriculum, and materials introduced in the class into their classroom. After trying out the activity, they will write a reflection piece describing what they did and analyzing how the lesson went.

Format: Reflection piece should include:

1. Teacher's name, school
2. Grade level, subject area, number of students in class.
3. What you were hoping to accomplish- Learning objectives or expected outcomes
4. Relevant science or math standards
5. Relevant estuarine concepts and principles
6. Materials and equipment
7. What you did- how it went
8. Tips and hints for other teachers
9. Lessons learned/reflection – what you would do differently, how you would improve it, what worked really well
10. Your sources of information and recommended references and links