



## Unit Introduction

**Grade Level:** High School

**Teaching Time** (Options)

- Integrated throughout year
- Integrated throughout semester



## *Exploring Environmental Issues Related to the Eastern Oyster in Chesapeake Bay*

### Unit Overview

*Exploring Environmental Issues Related to the Eastern Oyster in Chesapeake Bay* is a high school level transdisciplinary unit of study that incorporates both State and National Education Standards for science, with connections to Common Core, and the Maryland Environmental Literacy Standards. There are also strong connections to the College, Career, and Civic Life Standards (*C3 Framework for Social Studies*), including history, economics, and politics.

The sequence was developed by a team of NOAA educators with guidance from teachers in the Chesapeake Bay region, who reviewed the lessons. The writing team included: Bart Merrick and Donna Stotts from the NOAA Chesapeake Bay Office, and high school educators, Hemalatha Bhaskaran, Catherine Bornhoeft, and Kris Jensen, who reviewed the modules for accuracy of lesson objectives in support of the standards, age appropriateness, and effectiveness of the 5-E strategy, among other evaluative questions. The Oyster Project writing team members, Molly Harrison and Peg Steffen, were instrumental in helping to develop the overall format, and reviewing the lessons.

**NOTE:** Resources from many informal or higher education institutions were used or adapted in the creation of these lessons. More information

regarding **credits** can be found in this *Introduction* and under *References* for each Module.

This learning sequence is comprised of four modules, each building on the knowledge and skills of the previous one, and each with different overarching questions. These modules build on in-depth issue analysis skills as students investigate a local environmental issue that they are concerned about and want to investigate. The lessons have been developed with three dimensional learning in mind, “the idea that science is both a body of knowledge, and an evidence-based model and theory-building enterprise that extends and refines previous knowledge.” (<http://www.nextgenscience.org/three-dimensions>)

**Dimension 1: Practices (SEPs)** describe behaviors that scientists engage in as they investigate and build models and theories about the natural world and the key set of engineering practices that engineers use as they design and build models and systems.

**Dimension 2: Crosscutting Concepts (CCs)** have application across all domains of science. As such, they are a way of linking the different domains of science. They include: Patterns, similarity, and diversity; Cause and effect; Scale, proportion and quantity; Systems and system models; Energy and matter; Structure and function; Stability and change.

**Dimension 3: Disciplinary Core Ideas (DCIs)** (content) have the power to focus K–12 science curriculum, instruction, and assessments on the most important aspects of science. They must have broad importance across multiple sciences of engineering disciplines, provide a key tool for understanding or investigating, relate to the interests or life experiences of students, and be teachable over multiple grade levels to increase depth of understanding.

These dimensions are addressed in each lesson and the learning sequence builds toward deeper understandings, and increased science and issue investigation skills.

**Module 1 addresses the following:**

- SEPs** Engaging in Argument from Evidence
- CCs** Cause and Effect
- DCIs** LS2.C: Ecosystem Dynamics, Functioning, and Resilience  
LS4.D: Biodiversity and Humans

**Module 2 addresses the following:**

- SEPs** Using Mathematics and Computational Thinking  
Constructing Explanations and Designing Solutions  
Engaging in Argument from Evidence
- CCs** Cause and Effect  
Systems and System Models  
Stability and change
- DCIs** LS2.A: Interdependent Relationships in Ecosystems  
LS2.C: Ecosystem Dynamics, Functioning, and Resilience  
LS4.D Biodiversity and Humans  
ETS1.B: Developing Possible Solutions

### Module 3 addresses the following:

- SEPs Developing and Using Models  
Analyzing and Interpreting Data  
Using Mathematics and Computational Thinking  
Constructing Explanations and Designing Solutions  
Engaging in Argument from Evidence
- CCs Cause and Effect  
Systems and System Models
- DCIs LS2.A - Interdependent Relationships in Ecosystems

### Module 4 addresses the following:

- SEPs Analyzing and Interpreting Data  
Using Mathematics and Computational Thinking  
Constructing Explanations and Designing Solutions  
Engaging in Argument from Evidence
- CCs Cause and Effect
- DCIs LS2.C Ecosystem Dynamics, Functioning, and Resilience  
LS4.D Biodiversity and Humans  
ETS1.B: Developing Possible Solutions

**NOTE:** Depending on what issue(s) students choose to investigate, the SEPs, CCs, and DCIs may potentially be very different than what is listed here. This is an example of what you may expect.

This collection of activities engages students by analyzing historical events, and why conflicts arise over the use of natural resources. The Eastern oyster in Chesapeake Bay has been a source of conflict since the mid-1880s even to the point of violence. How did politics, culture, and economics influence the events of this historic struggle for oysters? If we look at each of these topics (politics, culture, and economics) as separate systems that intersect with the environmental/ ecological system, we become aware of just how complicated environmental issues can become.

The environmental education model, *Investigating and Evaluating Environmental Issues and Actions (IEEIA)*, is integrated throughout the entire Unit, to help students acquire the skills necessary to thoroughly examine locally relevant environmental issues, which includes identifying the complex variables that affect these systems.

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IEEIA follows the goals and objectives of **The Tbilisi Declaration (1977)**, which is the foundation for which current international environmental education emerged. It is a ground-breaking global public proclamation that describes the **goals** of **environmental education** that:

1. *Foster clear awareness of, and concern about, economic, social, political, and ecological interdependence in urban and rural areas;*
2. *Provide every person with opportunities to acquire the knowledge, values, attitudes, commitment, and skills needed to protect and improve the environment;*

3. *Create new patterns of behavior of individuals, groups, and society as a whole towards the environment.*

The categories of environmental education *objectives* are:

**Awareness**—to help social groups and individuals acquire an awareness and sensitivity to the total environment and its allied problems.

**Knowledge**—to help social groups and individuals gain a variety of experience in, and acquire a basic understanding of, the environment and its associated problems.

**Attitudes**—to help social groups and individuals acquire a set of values and feelings of concern for the environment and the motivation for actively participating in environmental improvement and protection.

**Skills**—to help social groups and individuals acquire the skills for identifying and solving environmental problems.

**Participation**—to provide social groups and individuals with an opportunity to be actively involved at all levels in working toward resolution of environmental problems.

**Teacher Note:** The goals and objectives listed above come from the [Global Development Research Center](http://www.gdrc.org/), <http://www.gdrc.org/>. Additional references for The Tbilisi Declaration can be found here, <https://www.gdrc.org/uem/ee/tbilisi.html>.

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**Environmental Issue Analysis** and **IEEIA Model** integration begin in **Module 1**.

The **IEEIA Model** is a research-based curriculum that builds student skills in how to investigate and evaluate science-related social issues, and has been proven empirically to change learner behavior that improves environmental stewardship. (ERIC- <http://files.eric.ed.gov/fulltext/ED320761.pdf> )

Each consecutive module builds on the skills taught in earlier module lessons that are necessary to thoroughly investigate environmental issues as we move through the Unit. This means not only collecting data, evaluating existing science data, and understanding science concepts, but recognizing how complex environmental and human social systems are interrelated.

These skills include: (1) identifying environmental events, problems, and issues; (2) assessing stakeholders' beliefs and values related to an issue; (3) developing research questions and sampling instruments to collect data, and interpreting that data; (4) analyzing methods of environmental action and action strategies, and; (5) taking action as a culminating activity.

Note that # 3 above, *developing research questions and sampling instruments to collect data, and interpreting that data*, does not mean to just collect scientific laboratory or environmental field data, but *social data* as well:

- What do people know?
- What do people *think* they know?
- What do people think should be done to solve an environmental problem?
- Would *they* take action to solve the problem?

Perhaps an environmental investigation *may not* lend itself well to collecting stakeholder data. That is a decision left up to the student. Regardless, all students should know how to obtain more in depth information about stakeholder knowledge, opinions, and concerns, because this will help them as they evaluate issues in their adult lives.

### *“Environmental Issues ARE Social Issues!”*

Environmental issues involve people. *Polluted water* is not an environmental issue. It is an environmental topic, or perhaps an environmental problem, because humans value clean water. But how are the environmental system and the human social system interconnected? Environmental issues are *complex*, not just from a scientific standpoint, but from a societal perspective, as well. How did the water become polluted, and how, or if, are we are going to clean it up?

*To solve environmental issues, one must first understand what an environmental issue is. It involves a disagreement between individuals, or groups of individuals, who do not agree on how to solve an environmental problem. (Hungerford, et al, 2003)*

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In **Module 1: A Historical Perspective of Oyster-Related Environmental Issues – The Chesapeake Bay Oyster Wars**, students explore how human events (economic, political, and social in nature) have affected the oyster population, a critically important ecosystem in Chesapeake Bay. Identifying the differences between environmental events, problems, and issues is integral to developing an understanding of locally relevant and complex environmental issues.

Students will explore and compare historic and current management issues, and the factors that create environmental conflicts by reading and evaluating journal publications, news articles, or other media sources.

**IEEIA model** skill development begins in **Module 1**. With these skills, students will be able to:

- Recognize the differences between environmental events, problems, and issues; and
- Identify stakeholders, their beliefs and values, and the stand they have taken on an environmental issue.

This is the *key* to thoroughly investigating an environmental issue, and is included in MD Environmental Literacy Standards, **Standard 1: Investigating Environmental Issues**.

[https://docs.google.com/a/noaa.gov/document/d/1EzEkQCvr82YfmT\\_8T4d4xIjNzq296vsxWkNYuvG\\_T4/edit?usp=sharing](https://docs.google.com/a/noaa.gov/document/d/1EzEkQCvr82YfmT_8T4d4xIjNzq296vsxWkNYuvG_T4/edit?usp=sharing)

### **Enduring Understandings**

In-depth understanding of different viewpoints about how to solve environmental problems is critical to decision making regarding the issues related to the problem.

## Learning Objectives

Students will be able to:

- Identify and compare the differences between environmental events, problems, and issues;
- Evaluate how a person's beliefs and values influence how they stand on an issue;
- Identify stakeholders, beliefs, and values from various written or multimedia sources, and;
- Draw comparisons between historic oyster management issues, and current management issues related to oyster restoration in Chesapeake Bay.

## Essential Questions

- How do we differentiate between an environmental problem and an environmental issue?
- Is one individual's or group of individuals' viewpoint more important than that of another?
- How does technology, politics, or historical events influence people's lives?
- How do we take into consideration perspectives of all stakeholders' beliefs and values when making critical decisions about how to solve an environmental problem?

## RESOURCE CREDITS:

We would like to extend a special thanks to Professor Emeritus Harold Hungerford, Professor Trudi Volk, and Ben Watts from Stipes Publishing, LLC for their assistance and support while developing this Module. We communicated by phone and email, and included the basic development skills from the IEEIA Model necessary for improving the environmental literacy of students. For a more thorough understanding, and additional skills not included in this High School Unit, see the Teacher's Edition of the IEEIA book.

Hungerford, H.R., Volk, T.L., Ramsey, John M., Litherland, Ralph A., & Peyton, R. Ben. (2003). *Investigating and Evaluating Environmental Issues and Actions: Skill Development Program*. Champaign, IL: Stipes Publishing, L.L.C.

Stipes Publishing, LLC - <http://www.stipes.com/catalog/environmental-education>

Maryland Sea Grant and Dr. Victor S. Kennedy provided the graph from *Sixteen decades of political management of the oyster fishery in Maryland's Chesapeake Bay*, written by Kennedy, Victor S. and Linda L. Breisch, [http://mdsg.umd.edu/sites/default/files/files/16\\_Decades.pdf](http://mdsg.umd.edu/sites/default/files/files/16_Decades.pdf).

The graph used in the Extension Activity in Module 1 was developed by MD Sea Grant using data provided by Kennedy and Breisch. See source below:

*A History of Oyster Harvests and Laws* Graph from *Sixteen decades of political management of the oyster fishery in Maryland's Chesapeake Bay*. (1983). Data: Kennedy and Breisch; Graph: MD Sea Grant

Retired MD Department of Natural Resources forester and historian, Ross Kimmel, wrote the main article used in the environmental issue analysis exercise. Thank you to both you and the MD Department of Natural Resources for letting us use this article.

Kimmel, Ross. (Winter, 2008). *Oyster Wars: The Historic Fight for the Bay's Riches*. Natural Resource Magazine. Maryland Department of Natural Resources.

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**Module 2: Investigating Sustainable Resource Management Using the Fish Banks Simulation** is a role-playing interactive computer simulation that allows teams of students to manage fisheries stocks with “competing” fishing companies. **FishBanks, Ltd.**, <https://mitsloan.mit.edu/LearningEdge/simulations/fishbanks/Pages/fish-banks.aspx> illustrates sustainable resource management by demonstrating how the actions of individuals who pursue their own self-interests in the pursuit of economic gain can result in the depletion of a resource that is considered a “common” resource for a larger group of people. A resource “commons” includes water, soil, wild game, timber, and other natural resources, some of which are renewable (sustainable), and others that are not.

There are two versions of the Fish Banks simulation:

- The **Fish Banks Game Kit**, which includes software, game board, boats, money, instructional materials for the teacher, and *Decision Forms* and *Role Description Guidelines* for students. No registration is necessary for this option. This version can either be purchased through **the System Dynamics Society**, <http://www.systemdynamics.org/products/fish-bank/>, or borrowed from NOAA.
- **Online Multiplayer Web-Based Simulation** – all student and teacher materials can be found online after the teacher has *registered* through the MIT Learning Edge Web site, <https://mitsloan.mit.edu/LearningEdge/simulations/fishbanks/Pages/fish-banks.aspx>.

More detailed information is provided in **Module 2**, and each version provides specific instructions for how to set up the game, how to play the game, and how to debrief. PowerPoint presentations, videos, and detailed instruction manuals are included in the game kit, and the Web-based simulation.

Students are very briefly introduced to Fish Banks, before they begin. The process takes a few hours, so more than one class period is required. In the game debriefing “game behavior” is graphed, including how the number of ships affected the total catch and fish population. What is often not considered during game play is the lag time between the decisions made (how hard to fish an area), before a decline in population is observed (the total number of fish caught over years of fishing).

Similarities in the interactions between social and environmental systems are compared in the Fish Banks simulation, with the historic and current fisheries management related issues in Chesapeake Bay.

The *Tragedy of the Commons* (Hardin, 1968), <http://science.sciencemag.org/content/162/3859/1243.full-text.pdf+html>, is included as an extension for this module, which allows students to reflect, and think deeply about how we use common resources, and how resource management (or no management) affects human and environmental systems for the long term.

### Enduring Understandings

How do we make informed decisions to sustainably manage our natural resources when there are so many complex interactions taking place across more than one system? (e.g., social, ecological, and economic systems related to oyster management)

### Learning Objectives

- Students will be able to explain the difference between renewable and nonrenewable resources, the meaning of sustainable use of these resources, and discuss how these resources are used by society.
- Students will model carrying capacity, and explore the concept of sustainable harvest of renewable resources using a computer simulation.
- Students will analyze data from the computer simulation (game behavior), and analyze changes that could promote sustainable resource use.
- Students will examine how the simulation models carrying capacity of the fishery.
- Students will identify underlying causes of behavior and limiting factors that contributed to the decline in the fishery.
- Students will analyze the causes and effects of overexploitation of resources.
- Students will use literature to draw comparisons between the Fish Banks simulation, and oyster management issues, both historic and current, using the principles in a *Tragedy of the Commons* to demonstrate understanding of the complexity of environmental issues.

### Essential Questions

- How do management policies contribute to resource protection, restoration, or depletion?
- How do communication and the act of negotiation benefit natural resource management decisions?
- How does the *Tragedy of the Commons* by Garrett Hardin (1968) reflect the same concerns regarding the harvesting of a commons in Chesapeake Bay?
- How are ecosystems and economic systems interrelated?

### RESOURCE CREDITS:

#### *Fish Banks*

We would like to extend a special thanks to Professor Emeritus Dennis L. Meadows and Professor John Sterman for their assistance and support while developing this Module. We communicated by phone and email, where both made the Game Kit and Online Simulation available to teachers.

LaVigne, Anne. (2015). FishBanks Lesson Guide and Handouts for 5<sup>th</sup>-12<sup>th</sup> grade audience. Creative Learning Exchange, <http://static.clexchange.org/ftp/newsletter/CLEx24.2.pdf>



FishBanks, Ltd. game was originally developed by Dennis Meadows, Emeritus Professor of Systems Management, University of New Hampshire.

The Web version of Fish Banks was developed by Professor John Sterman (MIT Sloan School of Management), with help from Professor Andrew King (Tuck School of Business), Dennis Meadows, Keith Eubanks, and Forio.com. Available from <https://mitsloan.mit.edu/LearningEdge/simulations/fishbanks/Pages/fish-banks.aspx>

Game Kit screen shots from System Dynamics Society, <http://www.systemdynamics.org/products/fish-bank/>

Simulation screen shots from web version of FishBanks.

Tables of Contents from Fish Banks Training Manuals provided by each version of the simulation.

### ***Tragedy of the Commons Resources***

*The Lorax* (YouTube Video), <https://www.youtube.com/watch?v=FSSrYnc1yQs>

The Tragedy of the Commons - Garrett Hardin, [http://www.garretthardinsociety.org/articles/art\\_tragedy\\_of\\_the\\_commons.html](http://www.garretthardinsociety.org/articles/art_tragedy_of_the_commons.html)

Truax, <http://woodfloors.org/truax.pdf>, National Wood Flooring Association

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After reviewing the history, and exploring the concept of sustainability, **Module 3: Targeting Oyster Restoration – Evaluating Habitat Requirements for the Eastern Oyster**, considers the habitat conditions required for oysters to thrive and reproduce in Chesapeake Bay. Students learn about the oyster life cycle, different habitat requirements for reproduction, larval, and adult stages.

The **University of Maryland Horn Point Oyster Hatchery** provides important information, explaining the process of oyster spawning, and the stages of their life cycle.

Using secondary sources of information, including scientific data, students determine the best site(s) for oyster restoration using online tools, including **NOAA’s Oyster Decision Support Tool**, <http://www.chesapeakebay.noaa.gov/habitats-hot-topics/oyster-decision-support-tool-helps-visualize-habitat-restoration-data>, and other science resources. The interactions of biotic and abiotic factors associated with suitable oyster habitat are evaluated, and students make recommendations of where oyster restoration should occur.

Perhaps the students’ research indicates that there are certain areas that would allow oysters to thrive, but those sites may conflict with other stakeholder uses. Does the site impede traffic for commercial or recreational boaters? Does the proposed sanctuary conflict with oyster harvesting, fishing, or crabbing sites of commercial watermen? Do local waterfront residents believe it will impact the aesthetic appeal or value of their property?

Transcripts from a public hearing regarding the creation of oyster sanctuaries are provided in **Module 3**. Students once again analyze the resource for stakeholders' beliefs and values, and are asked to consider solutions to constituents' primary concerns. The transcripts, however, do not necessarily represent all the possible stakeholders' opinions about oyster sanctuaries, nor their level of knowledge about how and why particular sites were chosen for protection, among other possible questions.

Using all of the data, skills, and background information thus far, students will *practice* investigating an environmental issue related to oyster sanctuaries in Chesapeake Bay. As in any scientific practice, they should identify variables, develop research questions, and collect and analyze data.

- **Stakeholder Data**  
To accomplish this, students learn how to design survey instruments to collect data about stakeholder knowledge, opinions, concerns, and possible solutions to the problem. These instruments include questionnaires, opinionnaires, combination instruments, and interviews. Sampling technique (who and how will students reach potential stakeholders), bias, sample size are other considerations that are considered.
- **Environmental Data**  
Physical surveys may also be used to collect environmental conditions or exact information of a specific site.

### **Enduring Understandings**

The ability of organisms to live and reproduce in an aquatic system is affected by biotic and abiotic factors

### **Learning Objectives**

- Students will make connections between biotic and abiotic conditions in the Chesapeake. Data and evidence about these conditions will be applied to decisions about oyster restoration in the Chesapeake Bay.
- Students will use GIS data to support decision making.
- Students will utilize new knowledge about the oyster life cycle and habitat conditions that support oyster survival within each life stage to make decisions regarding potential oyster restoration sites in the Chesapeake Bay.

### **Essential Questions**

- How do declines in water quality cause stress in individual organisms or populations of organisms?
- How does land use affect water quality, and how can we alter land use patterns to improve water quality?
- Does restoring oyster populations by creating sanctuaries improve water quality or increase habitat for fish species?

## RESOURCE CREDITS:

NOAA Chesapeake Bay Office, <http://chesapeakebay.noaa.gov/>  
*Oyster Decision Support Tool*, <http://chesapeakebay.noaa.gov/habitats-hot-topics/oyster-decision-support-tool-helps-visualize-habitat-restoration-data> and  
<http://chesapeakebay.noaa.gov/products/oyster-decision-support-tool>. The ODST Data Partners include:

- Keith Campbell Foundation
- Maryland Department of Natural Resources
- Morgan State University Estuarine Research Center
- NOAA Restoration Center
- Oyster Recovery Partnership
- University of Maryland Oyster Paynter Lab

Professor Emeritus Victor S. Kennedy was contacted by email, and gave the writers permission to use the *Eastern Oyster Chapter* of the **Habitat Requirements for Chesapeake Bay Living Resources** publication. Because the link for the (PDF) was no longer working, we are including it in the Module with Dr. Kennedy's permission.

Dr. Don (Mutt) Meritt, University of Maryland, Horn Point Laboratory Oyster Hatchery, was contacted by email for permission to include information about the oyster life cycle in the *Student Pages*, <http://hatchery.hpl.umces.edu/oysters/oysters-life-cycle/>.

Maryland Department of Natural Resources, *Maryland Oyster Restoration and Aquaculture Development Plan Public Hearing Comments*, August 5, 2010.

Chesapeake Bay Program, *Chesapeake Field Guide*  
[http://www.chesapeakebay.net/fieldguide/critter/eastern\\_oyster](http://www.chesapeakebay.net/fieldguide/critter/eastern_oyster)

Maryland Sea Grant, [www.mdsg.umd.edu/](http://www.mdsg.umd.edu/)  
*Oysters in the Environment*,  
[http://ww2.mdsg.umd.edu/interactive\\_lessons/oysters/oysback.htm](http://ww2.mdsg.umd.edu/interactive_lessons/oysters/oysback.htm)

Paula and David Jasinski, of Chesapeake Environmental Communications, provided the diagram of Oyster Life Cycle, in *Chesapeake Bay Ecosystem Atlas*, <http://www.chesapeakedata.com/wp/>

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The final module in the High School Unit, **Module 4: Environmental Research and Stewardship Action**, provides the opportunity for students to perform an in-depth investigation about an environmental issue of their choosing that applies the IEIIEA skills they were introduced to during the first three modules. The issue chosen by the student could be related to oysters, or another local environmental issue that they are concerned about.

Finally, students will learn about different categories of environmental action. They will develop recommendations for solutions to the environmental issue they have chosen, and if motivated, will carry out an action plan.

Together, the learning that takes place in the High School Unit provides students a deeper

understanding of how technology, politics, economics, and other components of human social systems influence management of the natural resources and environmental systems that form the foundation of our quality of life. Simple awareness of science-related problems and issues is not enough to inform students of the decision-making process required to wisely manage the resources we depend upon for food or other human necessities. In-depth understanding of how, and why we make the choices we do concerning environmental protection is paramount to seeing the “whole picture,” and helps us realize the complexities of environmental issues.

### **Enduring Understandings**

Informed decision making is necessary to address environmental issues.

### **Learning Objectives**

Students will be able to:

- Choose an environmental issue to investigate based on their interests and concerns;
- Evaluate the differences between environmental events, problems, and issues related to the issue they choose;
- Develop research questions to investigate the issue;
- Determine the knowledge, beliefs, and values of stakeholders involved with the issue by creating survey instruments, if applicable;
- Collect physical data to support their argument, if applicable;
- Develop conclusions and inferences based on the data collected;
- Identify methods of action, and choose one or more as recommendations to solve an environmental problem;
- Present their research and findings to the community; and
- Create and carry out an action plan;

### **Essential Questions**

- What current environmental issues are locally relevant to citizens?
- What individual actions can we take to improve the environment?
- What factors influence whether or not a person will take action regarding an environmental issue?

**In summary, the challenge for this investigative unit is to answer the following overarching question:**

*How do we increase Chesapeake Bay oyster populations, while providing economic, cultural, and ecological benefits?*

### **RESOURCE CREDITS:**

Again, we would like to extend a special thanks to Professor Emeritus Harold Hungerford and Professor Emeritus Trudi Volk, Southern Illinois University at Carbondale, and Ben Watts from Stipes Publishing, LLC for their assistance and support while developing this Module. We communicated by phone and email to provide basic skill development of the IEEIA Model. For a more thorough understanding, and additional skills not included in this High School Unit, see the Teacher's Edition of the IEEIA book.

Hungerford, H.R., Volk, T.L., Ramsey, John M., Litherland, Ralph A., & Peyton, R. Ben. (2003). *Investigating and Evaluating Environmental Issues and Actions: Skill Development Program*. Champaign, IL: Stipes Publishing, L.L.C.

Stipes Publishing, LLC - <http://www.stipes.com/catalog/environmental-education>

*Types and Benefits of Environmental Action and Action Projects* were highlighted, and the link for the *Shuswap Watershed Education Handbook* publication download was shared with educators: [http://shuswapwatershed.ca/pdf/Education\\_Handbook.pdf](http://shuswapwatershed.ca/pdf/Education_Handbook.pdf)

Fulton, K., Weaver, S. and Cooperman, J. (February 2011), *Shuswap Watershed Education Handbook*, Version 2.1, p. 23-25. Prepared for the Shuswap Watershed Project.

*Conversation Mapping* resource links and training were provided by Sustainable Maryland, <http://sustainablemaryland.com/>, and the University of Maryland, Environmental Finance Center, <https://efc.umd.edu/>.

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## Other Important NOAA Goals Addressed in High School Unit

In addition to addressing the Next Generation Science and other education standards, the project was also developed with the NOAA Bay Watershed and Education Training (B-WET) Program <http://chesapeakebay.noaa.gov/bay-watershed-education-and-training-b-wet/bay-watershed-education-and-training-b-wet>, and Meaningful Watershed Educational Experiences (**MWEEs**) in mind.

The Oyster Modules, in combination with valuable oyster-related field experiences, support the goals of a Meaningful Watershed Education Experience, (MWEE) for the high school grade band. [http://www.chesapeakebay.net/documents/Revised\\_MWEE\\_definition\\_-\\_FINAL.pdf](http://www.chesapeakebay.net/documents/Revised_MWEE_definition_-_FINAL.pdf)

The *Oysters in the Chesapeake Bay Education Project* also addresses issues in the **Choptank Complex Habitat Focus Area**, and provides direct education opportunities and support for K-12 students and teachers living in the Choptank Complex Watershed. <http://chesapeakebay.noaa.gov/habitats-hot-topics/choptank-complex-announced-as-habitat-focus-area>  
<http://chesapeakebay.noaa.gov/images/stories/hottopics/choptankhfafactsheet4.18.14.pdf>

**Envision the Choptank** is a collaborative initiative that engages communities, nonprofits, and

government agencies in developing joint solutions to improve the health and productivity of native oysters and support a fishable, swimmable Choptank. See link below:

<https://www.habitatblueprint.noaa.gov/wp-content/uploads/2016/04/envisionthechoptankfactsheet112116.pdf>

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## Additional References and Resources

### Education Standards

- Maryland Environmental Literacy Standards, <http://marylandpublicschools.org/programs/Documents/Environmental/MDEnvironmentalLitStandards.pdf>
- Maryland Environmental Literacy Infusion by Grade-Bands, [http://marylandpublicschools.org/programs/Pages/Environmental-Education/elci\\_gb.aspx](http://marylandpublicschools.org/programs/Pages/Environmental-Education/elci_gb.aspx)
- C3 Framework for Social Studies State Standards, <http://www.socialstudies.org/system/files/c3/C3-Framework-for-Social-Studies.pdf>
- Next Generation Science Standards, <http://www.nextgenscience.org/>
- Maryland Environmental Literacy Requirement: Origin & Development <http://maeoe.org/maryland-environmental-literacy-requirement-origin-development/>

### IEEIA-Related Resources and Research

- *Changing Learner Behavior Through Environmental Education*, <http://www.elkhornsloughctp.org/uploads/files/1374624954Changing%20learner%20behavior%20-%20H%20and%20V.pdf>
- **ERIC Summary:** *Investigating and Evaluating Environmental Issues and Actions: Skill Development Modules. A Curriculum Development Project Designed to Teach Students How to Investigate and Evaluate Science-Related Social Issues. Modules I-VI. Teacher's Edition.* <http://eric.ed.gov/?id=ED257664>
- Stipes Publishing – Environmental Education Publications, <http://www.stipes.com/catalog/environmental-education>
- Standard 1: Environmental Issues , <http://archives.marylandpublicschools.org/msde/programs/environment/tk/els.htm>

**Maryland Association of Environmental and Outdoor Education** – Environmental Literacy <http://maeoe.org/definition-of-environmental-literacy/>

### NOAA Chesapeake Bay Office

- NOAA Bay Watershed and Education Training (B-WET) Program  
<http://chesapeakebay.noaa.gov/bay-watershed-education-and-training-b-wet/bay-watershed-education-and-training-b-wet>
- Meaningful Watershed Educational Experience  
[http://www.chesapeakebay.net/documents/Revised\\_MWEE\\_definition\\_-\\_FINAL.pdf](http://www.chesapeakebay.net/documents/Revised_MWEE_definition_-_FINAL.pdf)

### **The Tbilisi Declaration**

- The Global Development Research Center <http://www.gdrc.org/uem/ee/tbilisi.html>
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