



MASSACHUSETTS ENVIROTHON

2017 Mass Envirothon Current Issue

Agricultural Soil and Water Conservation

Background and Strategies for Community Research 3.0*

The Mass Envirothon Current Issue challenges your team to investigate an important environmental issue as it occurs in your community, to develop recommendations, and to present your findings to a panel of judges at the Envirothon competition. Use the background and links on these pages as a starting point for your research into agricultural soil and water conservation in your community.

** Updated 2/17/17. Look for further updates at <https://massenvirothon.org/areas-of-learning/current-issue/2017-current-issue/>. For previous versions contact Will Snyder at wsnyder@umext.umass.edu*

Local agriculture is booming in Massachusetts, from urban community gardens to rural orchards and pastures, from row crops to working forests. Local garden, farm, and forest production can strengthen local economies - providing not only food and fiber, but also fostering community.

But all is not well. More local agriculture also means more intensive use of local land and water resources, with the potential for resource depletion, pollution, and increased pressure on local ecosystems and biodiversity. In addition, climate change is shifting the basic conditions for growing – bringing long term warming, short term weather volatility, and increased intensity in the water cycle that affect soil chemistry and ecology in fundamental ways.

Healthy soil and water resources provide essential ecosystem services for forest and farm production. And well managed farms and forests can contribute in a variety of ways to preventing and reducing the effects of accelerating climate change.

How can we use land and water resources in ways that keep these essential resources healthy? In particular, can we build healthy soils that ensure a supply of high quality food and fiber and at the same time protect our water resources and ecosystem future?

This year's Envirothon teams will look at the essential, fundamental ecosystem services that soil and water provide, and at decisions and actions for the management and protection of this ecological foundation.

Science is an essential tool, helping us to understand both the workings of the natural systems we depend upon and the effects of our practices within those systems. Understanding the science of soil and water will be an important part of preparing to respond to this year's Current Issue problem.

To ensure that your Current Issue presentation is the best possible, your team should undertake a **broad exploration**:

- Get to know the soil and water resources in your community in terms of their ecological functions and their value for working forests, farms, and gardens.
- Assess the ecosystem services and “disservices” that our current land uses produce.
- Get acquainted with the land use history of your community, and the effects of those uses on the soil, water, and the natural communities we find there now.
- Get to know the specific pathways of the water cycle in your local ecosystem – soil moisture as well as streams, ponds, and groundwater – and the implications for growing things for human use.
- Investigate the carbon cycle in your local ecosystems – particularly the importance of organic material for healthy soil.
- Meet scientists who research the chemistry, physics, biology, and ecology of soil and water.
- Meet natural resource managers and local officials who translate science into practical strategies for conserving soil and water resources.
- Meet farmers, gardeners, and foresters whose livelihoods depend on soil and water conservation.
- Become familiar with soil and water conservation best management practices; their purposes and implementation, and how they relate to management of wildlife, forest, and aquatic systems.
- Use various kinds of maps to understand and explain soil and water problems and conservation options.
- Consider how climate change is relevant to use of soil and water resources in your community.

Through this research, you will identify a soil and water conservation issue critical to your community, assess potential solutions, and make specific recommendations for action.

A Note on Resources

This guide, ***Background and Strategies for Community Research***, should be your primary source of guidance and resource links for your investigations in Massachusetts. These pages also suggest some ways to get started on your community research. The Mass Envirothon Current Issue website for 2017 (<https://massenvirothon.org/areas-of-learning/current-issue/2017-current-issue/>) includes the latest updates of this ***Background and Strategies*** guide as well as links to workshop presentations from 2016-17 Mass Envirothon workshops and Community Award information.

The U.S. Department of Agriculture’s **Natural Resources Conservation Service** website at <https://www.nrcs.usda.gov/> is a comprehensive storehouse of general and local information on soil and water conservation for farmers, scientists, natural resource managers, teachers, policy-makers, and general public audiences

- The **NRCS Massachusetts website** is at <https://www.nrcs.usda.gov/wps/portal/nrcs/site/ma/home/>
- **Videos, teaching activities**, and other educational resources are available in the Soil Health for Educators section:
http://www.nrcs.usda.gov/wps/portal/nrcs/detailfull/soils/health/assessment/?cid=nrcs142p2_053870

Your ***Massachusetts Envirothon Team Resource Manual*** (provided to all registered teams), particularly the sections on Soil and Water but also the sections on Forest and Wildlife, include relevant information on the importance of soil and water conservation. In particular, see the **“Envirothon Soil Evaluation Exercise”** in the Soil section.

The National Conservation Foundation’s 2017 Envirothon Current Issue is “Agricultural Soil and Water Conservation Stewardship”. Maryland Envirothon has prepared study materials and links, which may be found here: <https://www.envirothon.org/the-competition/current-competition>

Questions? Contact Will Snyder, UMass Extension, wsnyder@umext.umass.edu .

Background on the Science of Soil and Water

Soil Science

Like soil itself, soil science is often overlooked and taken for granted. Fortunately, government agencies and professional societies have assembled some great web resources that introduce key topics clearly, and often include teaching activities. **Examples:**

From the Soil Science Society of America:

- Introduction to ecosystem services provided by soils <http://www.soils4teachers.org/soil-and-environment>
- Connections to familiar disciplines (chemistry, physics, etc.) <http://www.soils4teachers.org/soil-by-subject>
- High school science activities <http://www.soils4teachers.org/lessons-and-activities#General9>

From the USDA Natural Resources Conservation Service

- Soil Biology <https://www.nrcs.usda.gov/wps/portal/nrcs/main/soils/health/biology/>

“Soil Quality” and “Soil Health” (See <https://www.nrcs.usda.gov/wps/portal/nrcs/main/soils/health/>)

Soil Quality refers to the capacity of the soil to perform several essential ecosystem functions, whether in forest, tilled field, pasture, lawn, or wetland:

- Regulate water - Soil helps control where rain, snowmelt, irrigation water, and dissolved solutes flow.
- Sustain diversity and productivity in plant and animal life
- Filter and buffer potential pollutants via physical, chemical, and biological processes
- Cycle nutrients – storing and transforming carbon, nitrogen, phosphorus, and many other nutrients
- Provide physical stability and support - for plant roots, also for human structures.

Soil Health is an equivalent term, but the word “health” reminds us that soil is best understood as a living system, and helps to focus our attention on the biological and ecological aspects of the resource:

Only "living" things can have health, so viewing soil as a living ecosystem reflects a fundamental shift in the way we care for our nation's soils. Soil isn't an inert growing medium, but rather is teeming with billions of bacteria, fungi, and other microbes that are the foundation of an elegant symbiotic ecosystem. Soil is an ecosystem that can be managed to provide nutrients for plant growth, absorb and hold rainwater for use during dryer periods, filter and buffer potential pollutants from leaving our fields, serve as a firm foundation for agricultural activities, and provide habitat for soil microbes to flourish and diversify to keep the ecosystem running smoothly.

Water Science

- Overview of the water cycle <http://water.usgs.gov/edu/watercycle.html>
- Conservation and the Water Cycle <http://www.wcc.nrcs.usda.gov/factpub/aib326.html>
- Hydrologic Information and Data for Massachusetts <https://ma.water.usgs.gov/infodata/>
- Climate effects on the water cycle <https://www.epa.gov/climate-impacts/climate-impacts-water-resources#Other%20sectors>

The Carbon Cycle

- United States Carbon Cycle Science Program
<https://www.carboncyclescience.us/what-is-carbon-cycle>
<http://www.carboncycle.org/programs/carbon-cycle-literacy/>
<http://www.carboncycle.org/carbon-farming/>
- Environmental Protection Agency: All about Carbon Dioxide
<https://www3.epa.gov/climatechange/kids/basics/today/carbon-dioxide.html>
- Sustainable Agriculture Research & Education. *Building Soils for Better Crops*. See Chapter One “Organic Matter, The Key to Healthy Soils” at
http://whatcom.wsu.edu/ag/documents/soil_compost/BuildingSoilsBetterCrops.pdf
- Cornell University Cooperative Extension, Agronomy Fact Sheet 91 “The Carbon Cycle and Soil Organic Carbon” at <http://nmsp.cals.cornell.edu/publications/factsheets/factsheet91.pdf>
- “The Trouble with Earthworms” (2007) <http://www.npr.org/templates/story/story.php?storyId=9105956>

Physical Properties and Nutrient Cycles

See these links to sections in *Building Soils for Better Crops* (available as text or pdf at

<http://www.sare.org/Learning-Center/Books/Building-Soils-for-Better-Crops-3rd-Edition>)

- Soil Particles, Water, and Air <http://www.sare.org/Learning-Center/Books/Building-Soils-for-Better-Crops-3rd-Edition/Text-Version/Soil-Particles-Water-and-Air>
- Soil Degradation: Erosion, Compaction, and Contamination <http://www.sare.org/Learning-Center/Books/Building-Soils-for-Better-Crops-3rd-Edition/Text-Version/Soil-Degradation-Erosion-Compaction-and-Contamination>
- Nutrient Cycles and Flows <http://www.sare.org/Learning-Center/Books/Building-Soils-for-Better-Crops-3rd-Edition/Text-Version/Nutrient-Cycles-and-Flows>

Climate Change Science – Coming decades are expected to present serious challenges to soil and water conservation, whether in the garden or on cropland, pasture, and forest. Changes will take the form of increasing intensity of the water cycle - with more extreme weather events, floods, and droughts – and long term temperature warming punctuated by high and low extremes. How will soil ecosystems and hydrological regimes be affected? What conservation measures will promote resiliency? Can good agricultural conservation practices play a significant role in keeping carbon out of the atmosphere? For some background, see:

<http://www.climatehubs.oce.usda.gov/northeast>

<https://www.nrcs.usda.gov/wps/portal/nrcs/main/national/climatechange/>

Organizations and Agencies Concerned with Agricultural Soil & Water Conservation

USDA Natural Resources Conservation Service (NRCS) <https://www.nrcs.usda.gov/wps/portal/nrcs/site/soils/home/>

- NRCS programs offer a variety of technical and financial assistance. See

<https://www.nrcs.usda.gov/wps/portal/nrcs/main/ma/programs/>

Massachusetts Department of Agricultural Resources <http://www.mass.gov/eea/agencies/agr/>

Massachusetts Conservation Districts http://maacd.org/index_files/about.htm

Massachusetts land trusts <http://www.massland.org/>

Massachusetts watershed associations <http://www.commonwaters.org/>

Municipal Agricultural Commissions <http://www.massagcom.org/>

Municipal Conservation Commissions https://www.maccweb.org/about_commissions.html

Massachusetts Audubon Society <http://www.massaudubon.org/>

Massachusetts Department of Conservation and Recreation <http://www.mass.gov/eea/agencies/dcr/>

Issues & Opportunities in Massachusetts Soil & Water Conservation

As you explore soil and water conservation in your community, you are likely to encounter people talking about some of the following issues, ideas, and solutions. Links to give you a running start on these investigations are below.

Best Management Practices (BMPs) for soil & water conservation in agriculture and forestry

Part Three “Ecological Soils Management” in *Building Soils for Better Crops* (available as text or pdf at <http://www.sare.org/Learning-Center/Books/Building-Soils-for-Better-Crops-3rd-Edition>) includes a wealth of specific information about particular practices that build health soils. In particular, see sections on:

- Cover crops
- Crop Rotations
- Preventing and Lessening Compaction
- Reducing Tillage
- Nutrient Management

Soil Health Management: <https://www.nrcs.usda.gov/wps/portal/nrcs/main/soils/health/mgmt/>

Forest harvest BMPs: <http://www.mass.gov/eea/docs/dcr/stewardship/forestry/ma-forestry-bmp-manual-rd.pdf>

Urban farming and gardening – By some definitions, a food system is sustainable if it is ecological sound, economically viable, socially just. Urban farming and gardening are a growing phenomenon in Massachusetts. What are the sustainability benefits and costs? <http://ensia.com/features/urban-agriculture-is-booming-but-what-does-it-really-yield/>

Urban Gardening: Managing the Risks of Contaminated Soil <http://ehp.niehs.nih.gov/121-a326/>

Pollution Prevention and Remediation

Nutrient management in fields, water bodies, and watersheds

- <http://www.mass.gov/eea/agencies/agr/pesticides/plant-nutrient-management.html>
- <https://www.epa.gov/nutrientpollution>

Erosion and Sedimentation

- <https://www.nrcs.usda.gov/wps/portal/nrcs/main/national/landuse/crops/erosion/>
- Pesticides
 - Pesticides in soil <http://npic.orst.edu/envir/soil.html>
 - Environmental fate <http://extoxnet.orst.edu/faqs/index.htm>
 - Pesticides in Groundwater <http://water.usgs.gov/edu/pesticidesgw.html>

Lead

- https://soiltest.umass.edu/sites/soiltest.umass.edu/files/fact-sheets/pdf/SPTNL_5%20Soil%20Lead_062316_1.pdf

Food waste, food rescue, and compost – New regulations require diverting organic material from the waste stream

<https://www.epa.gov/sustainable-management-food>

<http://www.mass.gov/eea/agencies/massdep/recycle/reduce/food-waste-ban.html>

Composting these materials can be a rich source of organic material and nutrients.

<https://www.epa.gov/recycle/composting-home>

https://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/newsroom/features/?cid=nrcs143_023537

Protection of Agricultural Land – Community Open Space & Recreation Plans, and Master Plans are available at town hall (and sometimes online). These documents provide some indication of the value that your community places on agricultural soil and water conservation, and what priorities have been identified.

<http://www.mass.gov/eea/grants-and-tech-assistance/guidance-technical-assistance/open-space-resources/>

Master Plans: Local Land Use Planning and Conservation Strategies

<http://www.massaudubon.org/our-conservation-work/advocacy/shaping-the-future-sustainable-planning/publications-community-resources/guidebook-to-involvement-in-your-community/chapter-3-local-land-use-planning-and-conservation-strategies>

Massachusetts' legal protections for land and waters related to forests and agriculture include

- Agricultural Preservation Restrictions
<http://www.mass.gov/eea/agencies/agr/land-use/agricultural-preservation-restriction-program-apr.html>
- Mass General Laws Chapter 61
<http://masswoods.net/landowner-programs/chapter-61-current-use-tax-programs>
- Massachusetts Wetlands Protection Act
<http://www.mass.gov/eea/docs/dep/water/resources/a-thru-m/maccinspire.pdf>

Hydroponics – Growing food indoors, under lights, without soil. Does this make sense ecologically? economically? Where? What are the sustainability benefits and costs?

<http://civileats.com/2015/04/13/why-you-cant-have-organic-food-without-soil/>

<http://www.cnn.com/2015/06/24/vertical-farming-the-next-big-thing-for-food-and-tech.html>

Getting Started on Your Community Research

The following pages introduce several starting points for your Current Issue research. To do a good job, your team will eventually need to be acquainted with all these areas. But you can start with any one of them. The resources and directions for research here barely scratch the surface of what is out there to be explored in your community. Don't feel limited by the suggestions here!

As you prepare for your team's presentation at the 2017 Envirothon, you should consider these questions:

Take a look around your watershed. What is growing here? What soil and water ecosystem services does your community and local economy depend upon?

What soil and water conservation efforts are taking place in your community right now? What do these efforts show about the value that individuals and community place on soil and water?

Explain the science that underlies these efforts. What are they contributing to the sustainable use, management, and protection of soil and water systems? Are they building healthy soil?

What more should be done to conserve soil and water in your community? Why and how should this be done? What are the obstacles, and how might they be overcome?

Starting Points:

▲ **(Re)familiarize yourself with some essential scientific concepts** and ask: where is an example of this right in our neighborhood? How would I explain the science?

- Soil Health
- Water cycle
- Crop nutrition
- Nutrient pollution
- Carbon cycle

▲ Explore with Maps

- **Bird's Eye View.** A fun way to explore your community is by flying over it using <http://www.bing.com/maps>.
- **NRCS Soil Surveys.** Soil surveys are detailed reports on the soils of an area. They include maps with soil boundaries and photos, descriptions, and tables of soil properties and features. See https://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/survey/?cid=nrcs142p2_053375 <https://websoilsurvey.nrcs.usda.gov/app/HomePage.htm>
- **Team maps.** The Massachusetts Executive Office of Energy & Environmental Affairs provides registered Envirothon teams with large-scale color printed maps of their communities showing information for use in research and presentations.
- **Oliver.** Oliver, the MassGIS online mapping tool at http://maps.massgis.state.ma.us/map_ol/oliver.php can be used to map a variety of themes related to soil and water
- **WaterWatch.** USGS depictions of streamflow, flood, drought <https://waterwatch.usgs.gov/>
- **GRACE Groundwater and Soil Moisture Conditions** (from satellite data) <http://drought.unl.edu/MonitoringTools/NASAGRACEDataAssimilation.aspx>
- **Mass DEP Water Supply Protection Areas** <http://maps.massgis.state.ma.us/images/dep/omv/wspviewer.htm>
- **Web Soil Survey.** NRCS site maintained online as the single authoritative source of soil survey information <https://websoilsurvey.sc.egov.usda.gov/App/HomePage.htm>

▲ **Find people in your community who can help you find and understand the soil and water conservation issues and practices around you, and connect you with farmers and land managers.**

- Contact your Conservation Commission and/or Agriculture Commission
- Contact a local land trust or other public interest land-holder
- Contact your Conservation District

▲ **Become familiar with soil and water on at least TWO specific sites in your community, including at least one where food is being grown.**

- Dig holes, examine soil profiles and test the soil. Practice the **Soil Evaluation Exercise** in your Envirothon manual.
- In particular, assess the kinds and amounts of organic material that are present.
- Ask about the land use history of the site.
- Investigate the hydrology of each site: Where is the water on the site, and how does it flow – on the surface and in the ground? What is the site's role and significance in the watershed? How deep is the water table? How much soil moisture is present?
- What ecosystem services are the soil and water involved in on this site? In addition to ways that humans benefit directly, what effect do the soil and water have on forest and wildlife habitat?
- What soil and water conservation challenges/issues are represented on the site?
- What specific practices promoting soil health and soil & water conservation might be recommended?

▲ **Collect your own scientific data at your selected sites**

- The NRCS website includes an array of guides, lesson plans, and other resources for teaching and learning about soils and soil health:
 - *Soil Health Kit Guides and Videos help teachers and educators implement their soils curriculum. Each guide includes an introduction to the soil property, discussion of the inherent and management factors influencing it, and explanation of the property's relationship to soil function. The educator's guides also include detailed information on a method to measure the soil property and interpretations of the test results. Helpful to educators, the guides double as lesson plans with thought-provoking questions so students can start to apply what they have learned. Videos cover the concepts and soil properties from overview to testing. See https://www.nrcs.usda.gov/wps/portal/nrcs/detailfull/soils/health/assessment/?cid=nrcs142p2_053870*
 - The NRCS web page on *Soil Health in Massachusetts* includes links to a Massachusetts Soil Health Worksheet as well as information on university labs where you can get your soil tested: <https://www.nrcs.usda.gov/wps/portal/nrcs/main/ma/soils/health/>

▲ **Be on the lookout for good stories!** The work of building healthy soil is an ongoing, complex and challenging endeavor, particularly in light of changing climate. The ecology of soil and water is full of interesting anecdotes. You are invited to share what you find through the **EnviroTrek** or the **Envirothon Community Awards**:

<https://massenvirothon.org/areas-of-learning/activities-programs/community-awards/>

The history of soil and water conservation is full of interesting narratives. Farmers and environmentalists often hold similar conservation values but have different perspectives on how to put them in action. Here are some stories compiled by NRCS: <https://www.nrcs.usda.gov/wps/portal/nrcs/main/ma/newsroom/stories/>

The 2017 Current Issue Problem:

In mid-March, your team will receive the 2017 Current Issue Problem, which will provide the specific questions that you will need to address in your Current Issue presentation at the May 18 Envirothon. For more information, see <https://massenvirothon.org/areas-of-learning/current-issue/> or contact Will Snyder at wsnyder@umext.umass.edu.